FUJITSU Software
PRIMECLUSTER

Reliant Monitor Services (RMS) with Wizard Tools Configuration and Administration Guide 4.5

Oracle Solaris / Linux

J2S2-1687-02ENZ0(05)
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Contents

1 Preface

Reliant® Monitor Services (RMS) is a software monitor designed to guarantee the high availability of applications in a cluster of nodes. This manual describes how to configure RMS using the RMS Wizards and how to administer RMS using the Cluster Admin GUI.

This manual introduces RMS components and describes necessary configuration data and management tasks for operating RMS correctly. This manual also describes diagnostic procedures, including how to view and interpret RMS log files.

This manual is aimed at system administrators who create and maintain RMS configurations. Familiarity with the following system functions and components is assumed:

- PRIMECLUSTER family of products
- Oracle Solaris or Linux operating system
- Non-PRIMECLUSTER products such as volume managers and storage area networks.

This document assumes that the PRIMECLUSTER software has been installed as described in "Software Release Guide" and "PRIMECLUSTER Installation Guide" for your operating system.

1.1 About this manual

This manual is structured as follows:

- The "Introduction" provides an introduction to RMS terminology and describes basic principles of operation.
- The "Advanced RMS concepts" provides background details about RMS operation including state detection and transition processing.
- The "Using the Wizard Tools interface (hvw)" describes how to configure RMS using the RMS Wizard Tools.
- The "Example of configuration change" illustrates the procedure on how to change the configuration of cluster application using RMS Wizard Tools.
- The "Using the Cluster Admin GUI" describes how to start and use the Cluster Admin graphical user interface (GUI), which is the primary tool for all RMS administrative functions.

- The "Additional administrative tools" describes the RMS clusterwide table, RMS graphs, and the RMS log viewer.
- The "Controlling RMS operation" describes common RMS administrative functions available through the Cluster Admin GUI, including the equivalent CLI procedures.
- The "Appendix—Site preparation" describes network and file settings required for RMS operation.
- The "Appendix—States" lists the object states that are supported by RMS.
- The "Appendix—Object types" lists the object types that are supplied with RMS.
- The "Appendix—Attributes" lists the attributes that are supported by RMS object types.
- The "Appendix—Environment variables" describes the RMS environment variables.
- The "Appendix—Troubleshooting" describes how to troubleshoot RMS using graphical user interface (GUI) and command line interface (CLI) tools.
- The "Appendix—RMS command line interface" lists the RMS administrative CLI commands.

1.2 PRIMECLUSTER documentation list

The documents listed below provide details about PRIMECLUSTER products. Please contact your sales representative for ordering information.

- "PRIMECLUSTER Concepts Guide (Oracle Solaris, Linux)"—Provides conceptual details on the PRIMECLUSTER family of products.
- "PRIMECLUSTER Installation and Administration Guide"—Provides instructions for installing and upgrading PRIMECLUSTER products.
- "PRIMECLUSTER Installation and Administration Guide FUJITSU Cloud Service K5"—Provides instructions for installing and upgrading PRIMECLUSTER products.
- "PRIMECLUSTER Web-Based Admin View Operation Guide"—Provides information on using the Web-Based Admin View management GUI.

- "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide"—Provides instructions for configuring and administering the PRIMECLUSTER Cluster Foundation.
- "PRIMECLUSTER Global Disk Services Configuration and Administration Guide"—Provides information on configuring and administering Global Disk Services (hereinafter GDS).
- "PRIMECLUSTER Global File Services Configuration and Administration Guide"—Provides information on configuring and administering Global File Services (hereinafter GFS).
- "PRIMECLUSTER Global Link Services Configuration and Administration Guide: Redundant Line Control Function"—Provides information on configuring and administering the redundant line control function for Global Link Services (hereinafter GLS).
- "PRIMECLUSTER Global Link Services Configuration and Administration Guide: Redundant Line Control Function for Virtual NIC Mode"—Provides information on configuring and administering the Virtual NIC Mode for Global Link Services (GLS).
- "PRIMECLUSTER Global Link Services Configuration and Administration Guide: Multipath Function"—Provides information on configuring and administering the multipath function for Global Link Services (GLS).
- "PRIMECLUSTER DR/PCI Hot Plug User's Guide"—Provides the operation of Dynamic Reconfiguration function and PCI Hot Plug function by using PRIMECLUSTER.
- "PRIMECLUSTER Messages"—Provides how to set the environment for PRIMECLUSTER. Messages output during system operation are also provided.
- "Software Release Guide" and "Installation Guide"-Provide late-breaking information about installation, configuration, and operation about PRIMECLUSTER.

1.3 Conventions

To standardize the presentation of material, this manual uses a number of notational, typographical, and syntactical conventions.

1.3.1 Notation

This manual uses the following notational conventions.

1.3.1.1 Prompts

Command line examples that require system administrator (or root) rights to execute are preceded by the system administrator prompt, the hash sign (#). Entries that do not require system administrator rights are preceded by a dollar sign ($).

In some examples, the notation <*nodename*># indicates a root prompt on the specified node. For example, a command preceded by `shasta1#` would mean that the command was run as user `root` on the node named `shasta1`.

1.3.1.2 Manual page section numbers

The command names and file names are followed by their manual page section numbers in parentheses, *e.g.*, `cp`(1).

Section numbers of Oracle Solaris 11 or earlier are described in this manual. Since some of the section numbers are updated in Oracle Solaris 12, read and follow the table below:

Section no. of Solaris 11 or earlier	Section no. of Solaris 12	Description
1M	8	System maintenance and Management command
4	5	File format
5	7	Others
7	4	Special device file

1.3.1.3 The keyboard

Keystrokes that represent nonprintable characters are displayed as key icons such as [Enter] or [F1]. For example, [Enter] means press the key labeled **Enter**; [Ctrl-b] means hold down the key labeled **Ctrl** or **Control** and then press the [B] key.

1.3.1.4 Typefaces

The following typefaces highlight specific elements in this manual.

Typeface	**Usage**
`Constant Width`	Computer output and program listings; commands, file names, and other literal programming elements in the main body of text.
Italic	Variables in a command line that you must replace with an actual value. May be enclosed in angle brackets to emphasize the difference from adjacent text; for example, <*nodename*>`RMS`; unless directed otherwise, you should not enter the angle brackets. The name of an item in a character-based or graphical user interface. This may refer to a menu item, a radio button, a checkbox, a text input box, a panel, or a window title.
`Bold`	Items in a command line that you must type exactly as shown.

Typeface conventions are shown in the following examples.

1.3.1.5 Example 1

Several entries from an `/etc/passwd` file are shown below:

```
root:x:0:1:0000-Admin(0000):/:/sbin/ksh
sysadm:x:0:0:System Admin.:/usr/admin:/usr/sbin/sysadm
setup:x:0:0:System Setup:/usr/admin:/usr/sbin/setup
daemon:x:1:1:0000-Admin(0000):/:
```

1.3.1.6 Example 2

To use the `cat`(1) command to display the contents of a file, enter the following command line:

```
$ cat file
```

1.3.2 Command line syntax

The command line syntax observes the following conventions.

Symbol	**Name**	**Meaning**
[ ]	Brackets	Enclose an optional item.
{ }	Braces	Enclose two or more items of which only one is used. The items are separated from each other by a vertical bar (|).
|	Vertical bar	When enclosed in braces, it separates items of which only one is used. When not enclosed in braces, it is a literal element indicating that the output of one program is piped to the input of another.
( )	Parentheses	Enclose items that must be grouped together when repeated.
...	Ellipsis	Signifies an item that may be repeated. If a group of items can be repeated, the group is enclosed in parentheses.

1.4 Important notes and cautions

Important

Indicates important information.

Caution

Indicates a situation that can cause harm to data.

Note

Indicates information that needs special attention.

1.5 Abbreviations

Oracle Solaris might be described as Solaris, Solaris Operating System, or Solaris OS.

If "Solaris X" is indicated in the reference manual name of the Oracle Solaris manual, replace "Solaris X" with "Oracle Solaris 10 (Solaris 10)," "Oracle Solaris 11 (Solaris 11)," or "Oracle Solaris 12 (Solaris 12)."

Red Hat Enterprise Linux is abbreviated as RHEL.

RHEL is abbreviated as Linux.

PRIMEQUEST 3000/2000 Series are abbreviated as PRIMEQUEST.

1.6 Revision history

Revision	**Location**	**Manual code**
Deleted the descriptions of NFS.	9.3	J2S2-1687-02ENZ0(01)
Changed the description of MonitorOnly attribute.	12.1	
Changed the description of RELIANT_SHUT_MIN_WAIT.	13.2	J2S2-1687-02ENZ0(02)
Changed the descriptions of configuration scripts.	2.6.3	J2S2-1687-02ENZ0(03)
Changed the possible values of the RMS script execution environment variable HV_SCRIPT_TYPE.	13.4	
Changed the description of StateChangeScript.	2.6.3	J2S2-1687-02ENZ0(04)

Revision	Location	Manual code
Changed the descriptions when setting scripts in the cluster application.	5.1	J2S2-1687-02ENZ0(05)
Changed the description of Important.	6.3.1 8.4.1	
Added the note of an object that does not operate on the command execution node.	6.3.5	
Added the note when displaying logs from the Cluster Admin.	7.4	
Added the description of the ScriptTimeout attribute to the description of a global environment variable RELIANT_SHUT_MIN_WAIT.	13.2	
Changed the description and the caution of the hvreset command.	15.1	

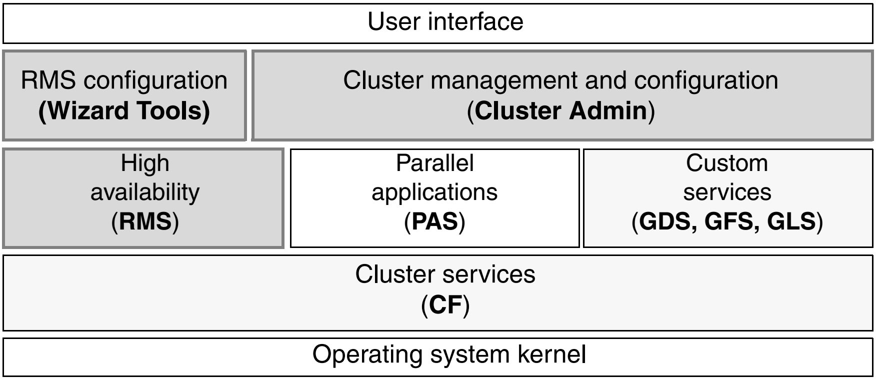
2 Introduction

This chapter contains general information on Reliant Monitor Services (RMS), introduces the PRIMECLUSTER family of products, details how RMS, RMS Wizard Tools, and the RMS Wizard Kit work together to produce high-availability configurations, and introduces Cluster Admin.

Chapter contents:

2.1 PRIMECLUSTER overview

The PRIMECLUSTER family of products is an integrated set of cluster services, including configuration and administration services, high availability, scalability, parallel application support, cluster file system, and cluster volume management. Figure 1 illustrates the relationship of PRIMECLUSTER services to each other and to the operating system environment.


User interface
RMS configuration (Wizard Tools)
Cluster management and configuration (Cluster Admin)
High availability (RMS)
Parallel applications (PAS)
Custom services (GDS, GFS, GLS)
Cluster services (CF)
Operating system kernel

GDS: Global Disk Services
GLS: Global Link Services
GFS: Global File Services

Figure 1: Overview of PRIMECLUSTER products

This manual focuses on PRIMECLUSTER products and services that relate to high availability operation (shown with a solid gray background in the figure above). They are as follows:

- RMS—This high availability manager is a software monitor that provides high availability (HA) for customer applications in a cluster of nodes. Its task is to monitor systems and application resources, to identify any failures, and to provide application availability virtually without interruption in the event of any such failures.

  RMS also provides integrated services for market-specific applications. Contact field engineers for availability and details.

- RMS Wizard Tools—This configuration tool provides a character-based interface to create RMS configurations. It includes templates for generic applications and commonly used resources.

  The RMS Wizard Kit works with the Wizard Tools to configure popular enterprise products for operation with RMS.

- Cluster Admin—The Cluster Admin GUI is the primary administrative tool for RMS.

- Cluster Foundation (CF)—This comprehensive suite provides cluster administration and communication services for user applications and other PRIMECLUSTER services.

PRIMECLUSTER products shown with a dotted background in the figure above are described in their respective manuals. See the section "PRIMECLUSTER documentation list" in the Preface.

2.2 How RMS provides high availability

RMS provides high availability of a customer's application by controlling and monitoring the state of all resources in use by a given application. Resources include items such as network interfaces, local and remote file systems, and storage area networks.

2.2.1 Applications, resources, and objects

RMS relies on a virtual representation of the cluster called a **configuration**. The configuration represents each machine, application, and system resource as an object, and the objects are logically arranged in a tree structure according to their dependencies. For instance, suppose a user application depends on a network interface and a file system in order to operate properly. In the tree structure, the corresponding application object would appear as a parent and the network and file system objects would appear as its children. The tree structure is commonly known as a **graph**.

Each object in the graph contains the **state** of the corresponding item along with any other parameters that may be required. An object is typically in the **online** (enabled, available) state or the **offline** (disabled, unavailable) state, but other states are possible according to the type of object. For the complete list of states supported by RMS, see "Appendix—States".

At runtime, the configuration is managed by the **RMS base monitor**, which initiates actions when an object's state changes, or, in the case of a **timeout**, when an object has remained in the same state for some specified time interval even though a change was expected. This design is known as a **state machine**.

Nodes and heartbeats

Machines that are members of a cluster are called nodes. When RMS monitors the health of a node, its highest priority is to detect a complete failure of the node or its base monitor. Its second priority is to detect slow response times that may be caused by system overloads. RMS uses two mechanisms, heartbeat and ELM to detect these problems.

Refer to the "RMS heartbeat operation".

Detectors

RMS monitors each resource by using **detectors**, which are processes that deliver status reports to the RMS base monitor process. RMS interprets the status reports to determine the state of the corresponding virtual object. When an object's state changes, RMS takes action according to the parameters set in the object. Each object may be associated with a detector.

Detectors are persistent: when RMS starts on a cluster node it starts the detectors for its configuration, which normally continue to run on that node until RMS is shut down. RMS has the ability to restart a detector if it terminates prematurely.

A complete list of the states that can be reported by detectors or displayed in the user interface is presented later in this chapter.

Note that RMS does not use detector processes to monitor the state of machines in the cluster. Instead, each node transmits a **heartbeat** signal at regular intervals, and RMS uses this to determine machine states and connectivity.

Scripts

Each object type has an associated set of **scripts**. A script is a command string (possibly including pipes, redirection, command interpolation, and variable substitution) that can be executed by the operating system shell—in other words, a valid shell script. Normally, each script is designed to interact with items in the operating system such as user applications or physical resources. Scripts provide the only means for RMS to directly influence items outside its virtual representation.

Some scripts are reactive: they define the actions that RMS should take in response to state changes. Other scripts are proactive: they define the actions that RMS should use to take control of individual objects. For instance, RMS would process one script when a resource reports a transition from the online state to the offline state; however, RMS would process a different script when it must force the resource to the offline state.

Scripts are transient: after performing their programmed tasks, they exit and return a status code to the base monitor.

A complete list of the scripts that may be specified for RMS objects is presented later in this chapter.

Object types

Most high-availability applications rely on a set of physical resources such as network interfaces, files systems, or virtual disks. RMS represents these as **`gResource`** objects. Most `gResource` objects have scripts that allow them to be brought online or taken offline.

Internally, RMS represents an actual application that runs in the operating system environment as a **`userApplication`** object. The set of `gResource` objects that represent the actual application's resource requirements are called its **dependent resources**. Bringing a `userApplication` object to the online state, along with all of its dependent resources, is called **online processing**. Taking a `userApplication` object to the offline state, along with all of its dependent resources, is called **offline processing**.

Each node that may run one or more applications in the high availability configuration is represented by a `SysNode` object. Like `gResource` objects and `userApplication` objects, `SysNode` objects can be brought online or taken offline, and they have an associated set of scripts. However, booting up or shutting down the corresponding physical machine requires more than simple script processing.

For the complete list of the RMS object types supported by the Wizard Tools, see "Appendix—Object types".

Shutdown Facility

While scripts and detectors provide a direct interface between RMS and the operating system, the **Shutdown Facility** (SF) provides an indirect interface to the machines in the cluster. When it necessary to take a `SysNode` object offline, RMS works with the SF to guarantee that the corresponding node has been physically shut down, or **killed**. RMS waits for successful completion of the node kill before switching any `userApplication` to another `SysNode`. This prevents any user application from running on two machines at the same time, which could lead to data corruption.

For more information about the Shutdown Facility, see "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide" for your operating system.

2.2.2 Relationship of RMS configurations to the real world

It is important to understand that RMS does not interact directly with "real-world" items such as machines, users' applications, or system resources—it interacts only with the objects in its virtual representation. Figure 2 illustrates the relationship between an actual user application in the operating system environment and the corresponding `userApplication` object in an RMS configuration.

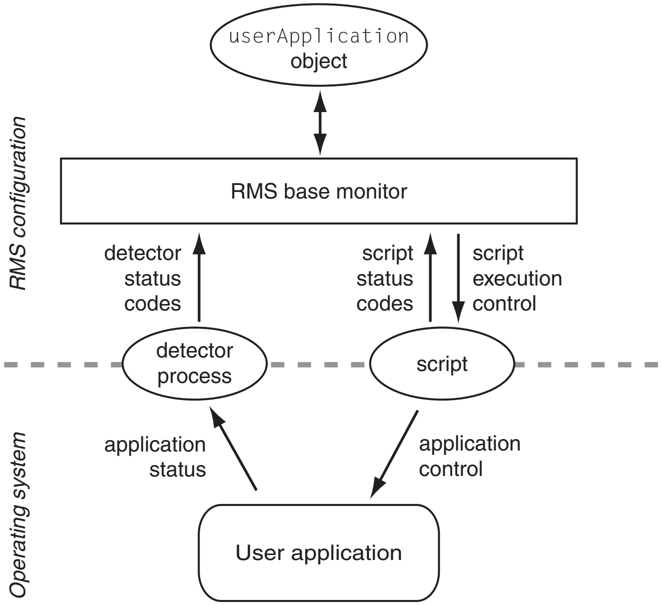


Figure 2: Interface between RMS and the operating system

Note that the interface between the RMS virtual representation and the actual operating system depends entirely on the scripts and detectors provided by the configuration tools. The script in the figure represents any of the standard scripts discussed later in this chapter: it reports whether or not it completed its tasks successfully by returning a status code, and RMS combines this with the status code from the object's detector to determine the object’s state. RMS has no other way to determine what actually happened to the user application in the operating system environment (the part of the figure below the dashed line).

For instance, if a `userApplication` object's `Online` script reports success, its detector reports that it is online, and all of its resources are online, then RMS considers that object to be online, regardless of the state of the actual user application. Similarly, if a resource object's detector reports an `Offline` state, it does not necessarily mean that the physical resource is unavailable.

> For reliable high availability operation, RMS requires scripts that properly control the corresponding real world items, and detectors that accurately reflect the items' states.

Configuration terminology

This manual discusses configuration procedures within the RMS context (represented by the part of Figure 2 above the dashed line). Strictly speaking, our principle concern is with `SysNode` objects, `userApplication` objects, and other RMS entities, and not the real-world items they represent.

However, it is intuitive to use terms such as "node" instead of "`SysNode` object" and "application" instead of "`userApplication` object,"because the relationships are so close, and because it is always understood we are working from the RMS perspective. This also helps to simplify many of the technical discussions. Therefore, unless there is a need to distinguish between an RMS object and the actual item it represents, this manual and the configuration tools it describes use the following terms interchangeably:

- "node" and "`SysNode` object" and "`SysNode`"
- "application" and "`userApplication` object" and "`userApplication`"
- "resource" and "`gResource` object" and "`gResource`"

The descriptions of object states and attributes are abbreviated similarly. For instance, instead of "the `gResource` object that monitors the mount point *xyz* is in the `Offline` state," it is customary to say, "the *xyz* file system is offline." It is also common to refer to a script by its attribute name, so "the script specified by the `PreOnlineScript` attribute" becomes simply "the `PreOnlineScript`."

All the objects that are managed by RMS are collectively described as "RMS resource."

2.2.3 Node and application failover

During normal operation, one instance of RMS runs on each node in the cluster. Every instance communicates with the others to coordinate the actions configured for each `userApplication`. If a node crashes or loses contact with the rest of the cluster, then RMS can switch all `userApplication` objects from the failed node to a surviving node in the cluster. This operation is known as **failover**.

Failover can also operate with individual applications. Normally, a `userApplication` object is allowed to be online on only one node at a time. (Exceptions to this rule are shared objects like Oracle RAC vdisk.) If a fault occurs within a resource used by a `userApplication` object, then only that `userApplication` can be switched to another node in the cluster. `userApplication` failover involves offline processing for the object on the first node, followed by online processing for the object on a second node.

There are also situations in which RMS requires a node to be shut down, or **killed**. In any case, before switching applications to a new node, RMS works together with the PRIMECLUSTER Shutdown Facility to guarantee that the original node is completely shut down. This helps to protect data integrity.

RMS also has the ability to recover a resource locally; that is, a faulted resource can be brought back to the online state without switching the entire `userApplication` to another cluster node.

2.2.4 Controlled applications and controller objects

In some situations, it is desirable for one application to control another in a parent/child relationship. Consider a scenario in which a bank teller application depends on the local network (represented by a network resource object) and a database application. This can be represented by the graph in Figure 3.

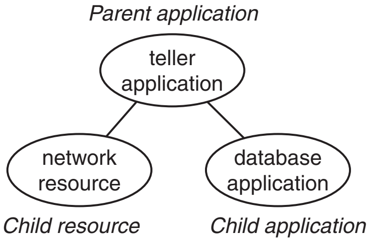


Figure 3: Parent application with two dependencies

Assume that if the network fails in some way, or if the database fails in some way, then the parent teller application cannot complete any transactions. The lines joining the objects in the figure indicate these dependencies. From the RMS perspective, then, we would like both the network resource and the database application to be configured in similar ways: they should both act as dependent resources that must be online if the teller application is to function properly.

However, RMS does not allow any application to be directly configured as the child of another application. Instead, RMS accommodates parent/child relationships between applications by providing an intermediate `controller` object, which is often simply called a **controller**. Unlike other resource objects, a controller has no scripts or detectors. Instead, it propagates online and offline requests from the parent to the child application, and it determines its status from that of the child application.

Figure 4 demonstrates how RMS would represent the banking scenario with the teller application, the controller, and the database application all running on `node1`. For the purposes of this example and the discussions that follow, only the applications and the controller are included in the illustration; the resource object representing the network interface is not shown.

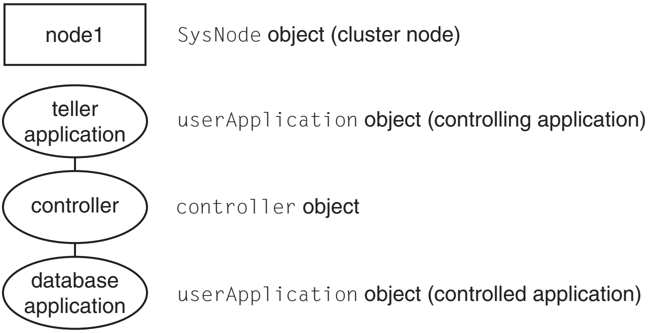

node1
SysNode object (cluster node)
teller application
userApplication object (controlling application)
controller
controller object
database application
userApplication object (controlled application)

Figure 4: RMS representation of controlled application

In accordance with the manual of the PRIMECLUSTER Products that support the operation mode of the controller objects, use the control of the applications by the controller objects.

Each controlled application requires a separate controller as a child of the parent application. Also, controllers exist only for internal RMS management purposes—there is no equivalent in the context of the real-world operating system.

If a child changes to an offline or faulted state, RMS will attempt to recover locally or switch the parent, the child, and the dependent resources to another node.

2.2.4.1 Follow controllers

RMS controllers operate in follow mode: the child application must always run on the same node as the parent. If the parent is switched to another node, the application and all its dependent resources will be switched there too. Likewise, if the child application fails in a way that requires it to be switched to another node, then the parent must be switched there as well.

Assume that the parent teller application tree is originally online on `node1` as shown in Figure 4 above. If either the parent or child application needs to be switched to `node2` for any reason, the rest of the tree follows. Figure 5 illustrates the result.

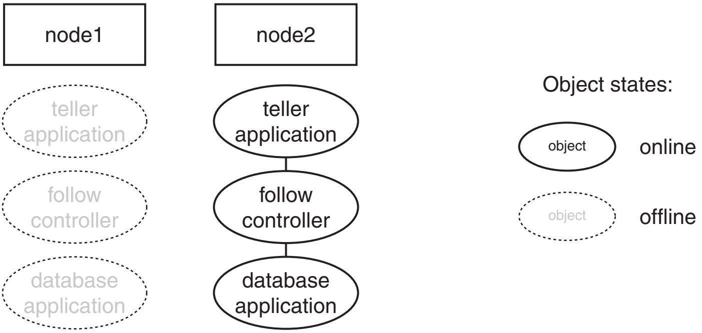


Figure 5: Result of follow-mode switchover

Note the state of the controller in Figure 5. Like the child application, it is brought online only on the same node as the parent. Follow controllers can guarantee that a group of applications and their resources remain closely coupled, so they always run together on the same machine.

When RMS switches an application from `node1` to `node2`, no objects are moved within the corresponding graph. Instead, the objects in the part of the graph corresponding to `node1` are first taken offline, and then the objects in the part of the graph corresponding to `node2` are brought online. The sequence used by RMS in an actual configuration is crucial to high availability operation. For a more detailed discussion, see "Site preparation."

2.2.4.2 Scalable controllers

Generally speaking, **scalability** is the ability of the overall system to adapt to changes in resources or workload. One of the main features of RMS scalable controllers is that they allow the parent and child applications to run on separate machines. This not only provides more flexibility but it may also prevent delays or outages when resources fail in certain combinations.

In our banking scenario, for example, the teller application depends on a network and a database application. Suppose the file system on node1 fails and the database goes offline. If the database controller is operating in follow mode, RMS will attempt to switch the teller and database to node2. However, if the network on node2 is offline or faulted, the teller can't be brought online there either. This is an extreme example, but it illustrates how high loads or resource outages could severely impact a configuration that relies only on a follow controller.

Using a scalable controller can help the configuration adjust dynamically in such situations. If the network is online on node1, while the file system is online on node2, then the database can be switched independently as shown in Figure 6.

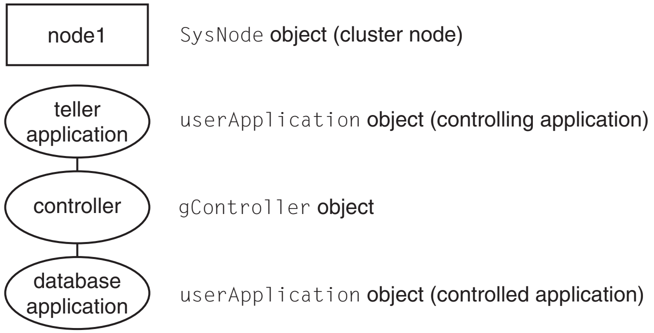

node1
SysNode object (cluster node)
teller application
userApplication object (controlling application)
controller
gController object
database application
userApplication object (controlled application)

Figure 6: Scalable mode child (controlled) application switchover

Conversely, a network outage could cause RMS to switch the teller to node2 while leaving the database online on node1, as shown in Figure 7.

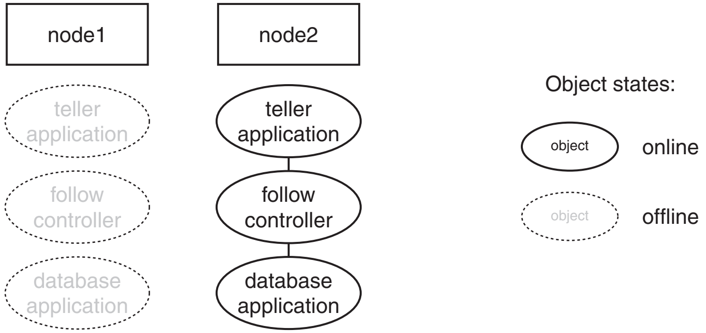


Figure 7: Scalable mode parent (controlling) application switchover

If an application can run on more than one node, RMS allows only one instance of that application to be online in the cluster. That is, an application can run on only one node at a time. However, controller objects do not have the same restriction. Note the state of the controller objects in Figure 6 and Figure 7. For each scalable child application, an instance of its controller is online on every node where that application can run.

2.2.4.3 Further notes about controllers

The follow and scalable modes are mutually exclusive: a controller for a child application can operate in either follow mode or scalable mode, but not both. The Wizard Tools ensure that each controller's configuration is self-consistent.

A parent application can have more than one child application, but the Wizard Tools require the controller type to be the same for all children. If follow mode is used, then there will be one distinct follow controller for each child. If scalable mode is used, there will be one scalable controller with multiple children. For example, suppose the teller application in the banking scenario also has an automated teller machine (ATM) controlled application. The difference between the follow graph and the scalable graph is shown in Figure 8.

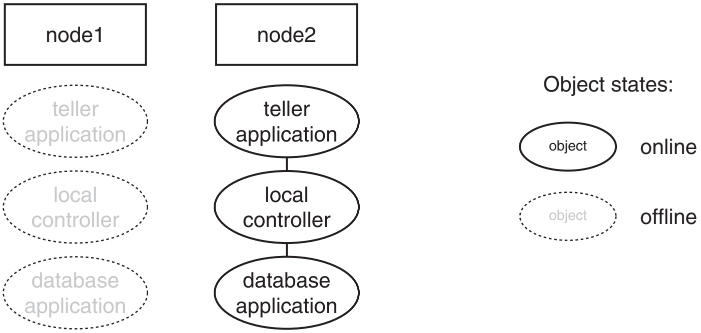


Figure 8: Controller structure with multiple children

For a more detailed discussion, see the section "Scalable controllers".

2.3 How the Wizard Tools provide easy configuration

RMS is a mature product with many features and options. Experts who develop, debug, and fine tune complete RMS configurations must know how RMS works and what RMS needs in order to function properly. For each application in the configuration, the expert must do the following:

- Define the set of resources used by the application, including:
  - Disks
  - Volume managers
  - File systems
  - processes to be monitored
  - IP addresses
- Define the relationship between each resource and its dependent resources, *e.g.*, which file system depends on which virtual or physical disk, which processes depend on which file systems, and so forth.
- Define the relationship between the applications being controlled; for example, which applications must be up and running before others are allowed to start.
- Provide scripts to bring each resource online and offline.
- Provide a detector to determine the state of each resource.

Configuring the above set of requirements by hand can be quite time consuming and prone to errors. This is why the RMS Wizard Tools were developed.

The PRIMECLUSTER RMS Wizard Tools allow the creation of flexible and quality-tested RMS configurations while minimizing your involvement. A simple user interface prompts you for details regarding your applications and resources. Using these details, the Wizard Tools automatically select the proper scripts and detectors and combine them in a pre-defined structure to produce a complete RMS configuration.

Specialists skilled in popular applications and in RMS worked together to create the RMS wizards. The wizards are designed to easily configure RMS for certain popular applications such as Oracle and they are flexible enough to create custom RMS configurations that can control any other type of application.

2.4 RMS wizard products

The RMS wizards are divided into the following separate products:

- RMS Wizard Tools—user interface, general-purpose application wizards, and basic set of subapplication wizards. Provided as a standard component of RMS

- RMS Wizard Kit—set of custom wizards designed to configure specific applications. Available as additional product.

Figure 9 depicts the relationship between RMS, the Wizard Tools, and the RMS Wizard Kit.

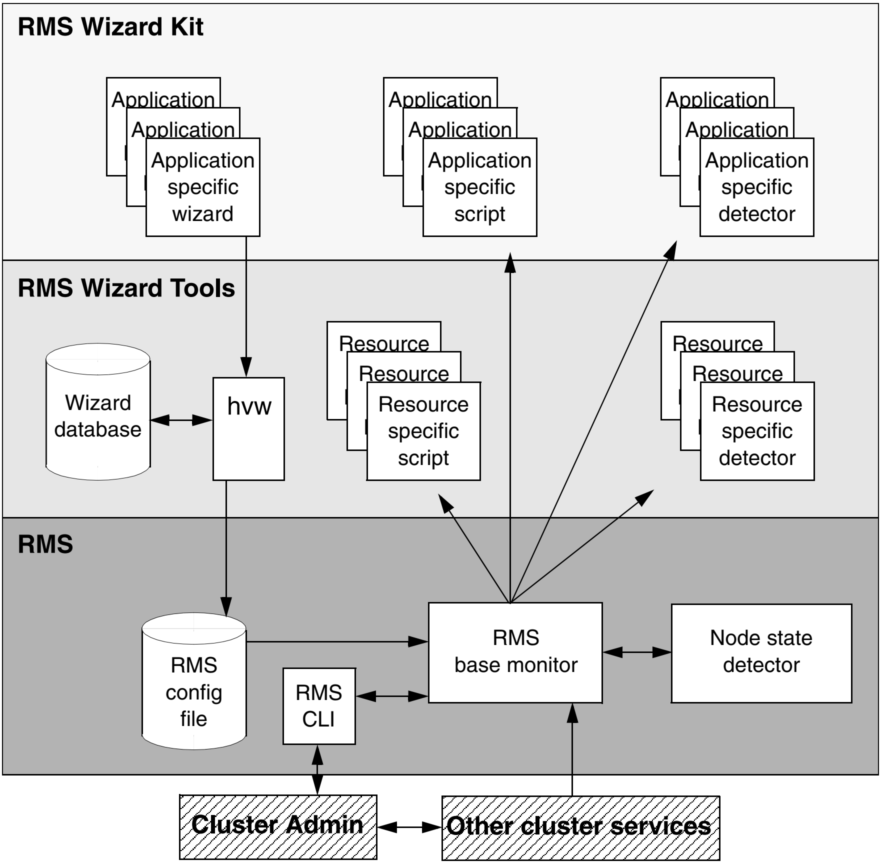


Figure 9: Relationship between RMS and RMS Wizards

For Solaris, as a means of setting the RMS configuration, the userApplication Configuration Wizard, which is a GUI utilizing Web-Based Admin View, is provided.

2.4.1 RMS Wizard Tools

The RMS Wizard Tools provides the following for basic resource types (such as file systems and IP addresses):

- `Online` scripts
- `Offline` scripts
- Detectors

In addition to the basic resource support, the RMS Wizard Tools package contains the `hvw` command, which is the entry point to the user configuration interface. The `hvw` interface provides a simple menu-driven interface to allow a user to enter information specific to applications placed under the control of RMS. `hvw` also provides an interface through which application-specific knowledge can be dynamically added to provide turnkey solutions for those applications typically found in the data center. These application-specific modules are provided by the RMS Wizard Kit.

2.4.2 RMS Wizard Kit

The RMS Wizard Kit provides application knowledge modules which can be used by the `hvw` command. The knowledge modules provide `hvw` with information specific to popular applications, which greatly eases the configuration task. The following are also provided for specific applications:

- `Online` scripts
- `Offline` scripts
- Detectors

i For information on the availability of the RMS Wizard Kit, contact your local customer support service.

2.5 Cluster Admin administration tool

The Cluster Admin GUI is the primary administrative tool for RMS. It allows users full access to the application control functions of RMS, including the following:

- RMS startup and shutdown
- Application startup and shutdown
- Manual application reset and switchover
- Visual cues for resource and application fault isolation
- Fault clearing capability
- Graphs of application and resources
- Logs for nodes and applications
- Maintenance mode control

2.6 RMS components

The RMS product is made up of the following software components that run on each node in the cluster:

- Base monitor
- Detectors
- Scripts
- RMS CLI

2.6.1 Base monitor

The base monitor process is the decision-making segment of the RMS process group. It has the following functions:

- Stores the current configuration of resources as represented by objects, their attributes, and their interdependent relationships
- Receives user requests for specific actions from the Cluster Admin graphical user interface (GUI) or the RMS command line interface (CLI)

- Receives input from detectors and monitors state changes
- Launches scripts to bring applications and their dependent resources online or offline
- Dictates the sequencing of the resource state changes to ensure resources and applications are brought online or offline in the correct order
- Initiates and controls automatic application switchover in case of a resource or node failure, or when directed by a user request
- Performs various administrative functions

2.6.2 Detectors and states

Detectors monitor each object status and return these object statuses to the base monitor.
The detectors that monitor the functions provided by OS are provided by RMS Wizard Tools. Additional application-specific detectors are provided by RMS Wizard Tools and RMS Wizard Kit.
Some objects provided by RMS, such as the controller object, have no detector. Instead, RMS calculates the state of the object based on factors such as transitory processes and the states of its dependent resources.

2.6.3 Scripts

RMS uses scripts to perform actions such as moving a resource from one state to another (for example, from `Offline` to `Online`). The two types of scripts are as follows:

- Request-triggered scripts initiate a state change to a resource.

  The request-triggered scripts are as follows:

  – `InitScript`— It is executed only once when RMS is started.

  – `PreCheckScript`— It is executed to determine if `Online` or `Standby` processing is needed or possible.

  – `PreOfflineScript`— It is executed before a transition to the `Offline` state.

  – `OfflineScript`— It is executed to set a resource to the `Offline` state.

  - `PreOnlineScript`— It is executed before a transition to the `Online` or `Standby` state.
  - `OnlineScript`— It is executed to set a resource to the `Online` state.

- State-triggered scripts react to specific events.

  The state-triggered scripts are as follows:

  - `PostOnlineScript`— It is executed after a transition to the `Online` or `Standby` state.
  - `PostOfflineScript`— It is executed after a transition to the `Offline` state.
  - `OfflineDoneScript`— It is executed after `Offline` processing is completed.
  - `FaultScript`— It is executed when a transition is made to the `Faulted` state.
  - `WarningScript`— It is executed when a transition is made to the `Warning` state.
  - `StateChangeScript`— It is executed when the state of the controlled child application and the state of the node where the child application is running transition.

Scripts that control the functions provided by OS are provided with RMS Wizard Tools.

2.6.4 RMS CLI

The primary interface for configuring RMS is the RMS Wizard Tools, and the primary interface for administering RMS is the Cluster Admin GUI. Both the RMS Wizard Tools and Cluster Admin call the RMS CLI. For example, use the following CLI command to manually switch the userApplication object to another node (SysNode) in the cluster.

▶ # **`hvswitch`** *userApplication SysNode*

Table 1 lists the RMS CLI commands available to administrators. For a complete description of any command's usage, see its online man page. For a list of all commands related to RMS, see "Appendix B Manual Pages" in "PRIMECLUSTER Installation and Administration Guide."

i With few exceptions, RMS CLI commands require root privilege. The exceptions are noted in the following table.

Command	Function
hvassert	Tests an RMS resource for a specified resource state. It can be used in scripts when a resource must achieve a specified state before the script can issue the next command. Does not require root privilege.
hvcm	Starts the base monitor and the detectors for all monitored resources. In most cases, it is not necessary to specify options to the hvcm command. The base monitor is the decision-making module of RMS. It controls the configuration and access to all RMS resources. If a resource fails, the base monitor analyzes the failure and initiates the appropriate action according to the specifications for the resource in the configuration file.
hvconfig	Either displays the current RMS configuration or sends the current configuration to an output file. The output of the hvconfig command is equivalent to the running RMS configuration file, but does not include any comments that are in the original file. Also, the order in which the resources are listed in the output might vary from the actual configuration file.
hvdisp	Displays information about the current configuration for RMS resources. Does not require root privilege.
hvdispall	Displays the resource information of all the nodes in RMS.
hvdump	Gets debugging information about RMS on the local node.
hvlogclean	Either saves old log files into a subdirectory whose name is the time RMS was last started, or, if invoked with the -d option, deletes old log files. In either case, hvlogclean creates a clean set of log files even while RMS is running.

Table 1: Available CLI commands

Command	Function
hvsetenv	Provides an interface for changing the following RMS environment variables on the local node: – HV_RCSTART controls the automatic startup of RMS. – HV_AUTOSTARTUP controls the automatic startup of all applications. Changes made by this command apply only to the command execution node. For more information about these environment variables, see "Appendix—Environment variables".
hvshut	Shuts down RMS on one node or all the nodes in the configuration. The base monitor on the local node sends a message to other online nodes indicating which node or nodes will be shut down.
hvswitch	Manually switches control of a `userApplication` or a `gResource` between `SysNodes` in the RMS configuration.
hvutil	Provides general administration interface to RMS. This command performs the following management operations: – Dynamically setting logging levels – Sending the `userApplication Offline` – Sending the `gResource Offline` – Clearing faulted resources – Stopping cluster nodes in the Wait state – Setting detector time periods – Setting Maintenance Mode, and so forth

Table 1: Available CLI commands

Excluding some commands (such as `hvshut`), `hv_*` commands of RMS only send requests to the base monitor then return immediately. They do not wait for the requests to be processed. The status code 0 (success) at the end of command execution means that the requests have been successfully sent to the base monitor. However, this does not secure that the requests have been processed successfully.

2.7 Object types

An object type represents a group of similar resources that are monitored by the same detector (for example, all disk drives). Using the Wizard Tools, you can create configuration files that contain objects of various types, each representing resources or groups of resources to be monitored by RMS. The supported types are as follows:

- `SysNode`
- `userApplication`
- `gResource`
- `controller`
- `andOp`
- `orOp`

Refer to the "Appendix—Object types" for the supported types, their required attributes, and a brief description of each object.

i This information is provided for reference only. These objects are created by the Wizard Tools during the generation phase of the configuration process. The type of an object may be listed in diagnostic messages for use by RMS experts.

2.8 Object attributes

An attribute is the part of an object definition that specifies how the base monitor acts and reacts for a particular resource during normal operation. An attribute can include a device name and configuration scripts. Users can specify attributes in any order in the object definition.

Refer to the "Appendix—Attributes" for the supported types, their associated values, and a description of each attribute.

i This information is provided for reference only. The values are determined by the Wizard Tools during the generation phase of the configuration process. Refer to the "Using the Wizard Tools interface (hvw)".

2.9 Environment variables

RMS uses global and local environment variables:

- Global environment variables must have the same setting on all the nodes in the cluster. RMS maintains global environment variables in the `ENV` object.
- Local environment variables can vary from node to node. RMS maintains local environment variables in the `ENVL` object.

RMS creates the `ENV` and `ENVL` objects dynamically from the contents of `hvenv` and `hvenv.local` when the base monitor starts up. Refer to the chapter "Setting environment variables" for more information.

- Global variable settings (`ENV`) are included in the configurations checksum that is common to the cluster. The checksum is verified on each node during startup of the base monitor. RMS will fail to start if it detects a checksum difference between the values on any two nodes.
- Local variable settings (`ENVL`) are not included in the configurations checksum that is common to the cluster.

While RMS is running, you can display the environment variables with the hvdisp command which does not require root privilege. Use `hvdisp ENV` for global list and `hvdisp ENVL` for local list.

Refer to the "Appendix—Environment variables" for a complete description of each of these variables.

2.9.1 Setting environment variables

When RMS starts, it reads the values of environment variables from `hvenv` and `hvenv.local` and initializes the `ENV` and `ENVL` objects respectively. To change the values of environment variables before RMS starts up, you need to specify them in the `hvenv.local` file.

These settings will be overridden at installation.

The /tmp directory that is nearly full may result in RMS errors, because the base monitor uses the sort(1) command to sort RMS environment variables.

If you adjust a global variable in the hvenv.local file on one node, you must make the same adjustment to hvenv.local on every other node in the cluster. After stopping RMS on all the nodes, you will have to restart RMS for the change to take effect.

Caution

Do not explicitly set RMS environment variables in the user environment. Doing so can cause RMS to lose environment variables settings.

The values of environment variables are specified as export directives in each file. A typical export directive would appear as follows:

```
export SCRIPTS_TIME_OUT=200
```

Therefore, any changes you make to hvenv.local file will not take effect until the next time RMS starts up. While RMS is running, you can display the environment variables with the following commands:

- hvdisp ENV
- hvdisp ENVL

2.9.2 Script execution environment variables

When the RMS invokes a script on behalf of an object, it provides a set of variables in the script's environment that can be used for decision processing at runtime. Since these variables exist only within the context of the script while it is carrying out its tasks, they are not usually visible in the RMS user or administrator environment. In rare cases, they could appear in a diagnostic message in the system log or on the console.

The section "Script execution environment variables" provides a complete description of each of these variables.

2.10 RMS Directory structure

RMS software consists of a number of executables, scripts, files, and commands, all located relative to the directory specified in the RELIANT_PATH environment variable. Table 2 illustrates the directory structure of the RMS software after it has been correctly installed.

Name	**Contents**
RELIANT_PATH	Base directory. **Default:** /opt/SMAW/SMAWRrms
<RELIANT_PATH>/bin	Executables, including detectors, commands, and scripts.
<RELIANT_PATH>/build	Work and storage area for configuration files.
<RELIANT_PATH>/etc	Miscellaneous files used by RMS and the configuration tools.
<RELIANT_PATH>/include	RMS include files (header files) used by detectors and configuration files.
<RELIANT_PATH>/lib	RMS runtime libraries.
<RELIANT_PATH>/us	RMS source files. The names of the files in this directory are reserved and should not be used to name any configuration files that the user may create.

Table 2: RMS base directory structure

As summarized in Table 3, RMS log files are located in the directory specified in the RELIANT_LOG_PATH environment variable.

Name	**Contents**
`RELIANT_LOG_PATH`	Contains files that can be used for RMS analyzing and debugging, including the RMS switchlog. The base monitor and detectors create log files here. **Default:** `/var/opt/SMAWRrms/log` The same directory has subdirectories that contain backup copies of the RMS log files. Each backup subdirectory has a name of the form *yyyy-mm-dd_HH:MM:SS* to indicate the date and time when the backup was created.

Table 3: Log directory structure

3 Advanced RMS concepts

This chapter describes details of RMS. It includes the following sections:

- "State transition" deals with the RMS state engine.
- "RMS heartbeat operation" describes the monitoring of node states using heartbeats and processing when a node is down.
- "Scalable controllers" describes operational details of scalable controllers and scalable applications.

3.1 State transition

This chapter deals with the RMS state engine. In particular, it describes how states are determined, and how RMS causes state changes and reacts to state changes.

- "Internal organization"
- "Initializing"
- "Online processing"
- "Offline processing"
- "Fault processing"
- "Switch processing"
- "Special states"

3.1.1 Internal organization

A brief description of the object-oriented internal aspects of the base monitor is useful in understanding RMS.

Every object is an independent instance that carries out actions (typically implemented by shell scripts) according to rules based on its state and messages received from detectors or other objects. States, detectors, and scripts are briefly described in the section "Introduction". The following sections provide more details about RMS internal structure and inter-object communication.

3.1.1.1 Application and resource description

The configuration wizards generate a description for all applications that will be monitored by RMS. The description, which is maintained in an RMS-specific meta-language, represents every application with a logical graph that has the following characteristics:

- Resources required by the applications are represented by objects in this graph.
- Parent/child relationships between objects represent interdependencies between resources.
- Object attributes represent the properties of the resources and the actions that are required for specific resources.

The proactive procedures that bring a particular object online or take it offline are specified by referring to shell scripts that are configured as attributes of the object. Other script attributes specify actions to be taken in reaction to state changes of the object as a result of messages from other objects.

A userApplication object has no detector, and if it has been configured by the Wizard Tools or the RMS Wizard Kit, it has no scripts specified. Instead, a child `cmdline` resource is configured with the appropriate scripts, and it is this object that interacts with the actual user application in the operating system environment. In this case, the `userApplication` becomes a logical container that represents the combined states of the resources in its graph.

3.1.1.2 Messages

RMS objects exchange messages for the following purposes:

- To send requests
- To communicate changes in the object states

In general, objects communicate only with their direct parents and children.

RMS sends incoming external requests to the parent `userApplication` object before it forwards the requests to the children. A `userApplication` object can also generate its own requests on the basis of changes to its state (such as a change over to the `Faulted` state).

3.1.2 Initializing

After RMS starts, the initial state of all objects is `Unknown`. RMS changes this state after the object has the necessary information for identifying the actual state.

The following is necessary information for identifying the state:

- For objects with a detector—First report of the detector
- For objects with children—Messages of the children concerning their state

Two conclusions can be drawn from the above:

- Leaf objects without a detector are illegal in an RMS configuration, because they cannot generate a detector report and they are not able to logically derive their state from the state of their children. Their state always remains `Unknown`.
- All transitions from the `Unknown` state are always bottom-up, such as from the leaf object to the `userApplication`. Every object above the leaf object first requires the state of its children before it is able to determine its own state.

`SysNode` objects and `userApplication` objects have no detectors for their physical counterparts. `SysNode` objects receive a detector report directly from the base monitor. `userApplication` objects determine their status from their children.

After the `userApplication` object exits the `Unknown` state, the initializing process of the application ends. From this point, RMS controls the application.

The initializing processes of `userApplication` objects are independent of each other. Therefore, one `userApplication` object may be initialized to an `Online`, `Offline`, or `Standby` state while a second `userApplication` object is still in the `Unknown` state.

The initializing process of `SysNode` objects is also independent. A `SysNode` object exits its initial `Unknown` state after receiving its detector report.

The `Unknown` state is a pure initial state. Once an object exits the `Unknown` state, it does not return to that state.

Example configuration

The examples of RMS processing in the following sections are based on an application `app` configured to run on `fuji2RMS` and `fuji3RMS` as follows:

- For each node, `fuji2RMS` and `fuji3RMS`, there is one `SysNode` object bearing the name of the node.
- For each `SysNode` where a particular user application may run, the corresponding `userApplication` object has one child of type `andOp`, which bears the name of this `SysNode` as the `HostName` attribute. The order in which the nodes were defined in the `userApplication` object determines the priority of the nodes for this application.

  The base monitor identifies each `andOp` object at this level as a **local** object if the value of the `HostName` attribute corresponds to the local node's name, and as a **remote** object if not. The base monitor ignores all remote objects, so that only the local objects and its children are processed.
- As children of this logical *AND* object, the other resources (a command line subapplication and a local file system) are configured according to their internal dependencies.

A diagram of the object hierarchy is shown in Figure 10.

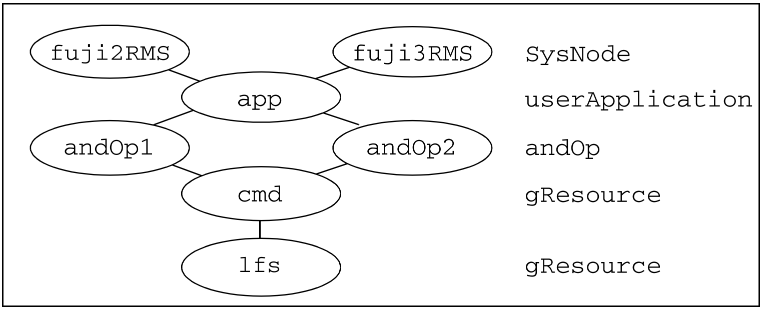


Figure 10: Object hierarchy for initializing examples

Note that the hierarchy in the figure includes the `SysNode` objects as parents of the application. While this is often done by convention, these `SysNode` objects are not dependent on the application objects in any way; however, their presence serves as a reminder of which nodes are represented by the application's child `andOp` objects. They also appear in the graph generated by the GUI, but in this case their major purpose is to indicate the node where the application is currently running.

The actual RMS graph for this configuration as produced by RMS Wizard Tools is shown in Figure 11.

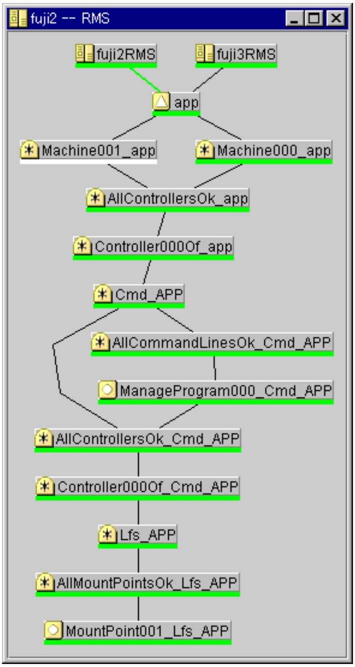
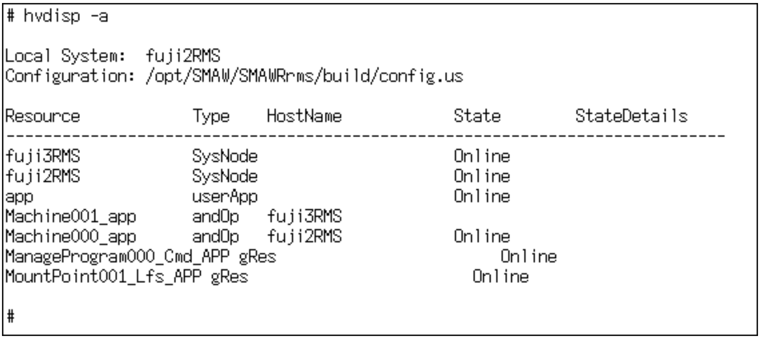


Figure 11: System graph for initializing examples—RMS Wizard Tools

The title bar contains the name of the node on which the graph was drawn, which is `fuji2RMS`. The line connecting `fuji2RMS` to `app` is green, indicating the node where the application is online.

The corresponding output from 'hvdisp -a' is shown in Figure 12.



```
# hvdisp -a

Local System:  fuji2RMS
Configuration: /opt/SMAW/SMAWRrms/build/config.us

Resource            Type    HostName            State       StateDetails
-----------------------------------------------------------------------------
fuji3RMS            SysNode                     Online
fuji2RMS            SysNode                     Online
app                 userApp                     Online
Machine001_app      andOp   fuji3RMS
Machine000_app      andOp   fuji2RMS            Online
ManageProgram000_Cmd_APP gRes                        Online
MountPoint001_Lfs_APP gRes                        Online

#
```

Figure 12: hvdisp output for initializing examples—RMS Wizard Tools

To match the `hvdisp` output, the actual graph includes resource names, which can be displayed by selecting *Preferences –> Show Resource Names in Graph* in the Cluster Admin *rms* tab view.

Note that some of the actual object names generated by the RMS Wizard Tools are more complex than the simplified, generic names shown in the abstract graph of Figure 10. Also, the graph contains additional dependencies that are automatically inserted to ensure proper operation. Selecting other items from the Cluster Admin *Preferences* menu will display further detail and reveal additional objects and dependencies.

Neither the additional objects nor the complex names in the actual graph are required for a basic understanding of RMS operation. Therefore, to simplify the discussion, the examples in this chapter will focus on the abstract graph and use the generic names.

Example 1

The following process for the configuration illustrated in Figure 10 is applicable for a monitor running on `fuji2RMS`:

1. RMS starts.
2. The base monitor determines the state of the `SysNode` objects.
3. The detectors of the `cmd` and `lfs` resources report their respective states as `Offline`.
4. Since it is a leaf object, `lfs` changes immediately to `Offline` and reports this state change to its parent.

5. After receiving the detector report and the report of its child, `cmd` possesses the necessary information for determining its own state. It then goes offline and notifies this change of state to its parent `andOp1`.

   i `andOp2` is a remote object which is ignored by the base monitor on `fuji2RMS`.

6. `andOp1` is a logical object which has no detector. It uses the message of the child to determine its own state as `Offline` and notifies this change of state to `app`.
7. `app` is also an object without a detector. When the child `andOp` that corresponds to the local node goes offline, `app` also goes offline.
8. All local child objects of `app` have exited the `Unknown` state and the initializing procedure is complete.

3.1.3 Online processing

The online processing for a `userApplication` object normally results in the `userApplication` transitioning to the `Online` state. Online processing of one `userApplication` object is independent of the online processing of any other `userApplication` objects.

The following situations can prevent successful online processing of a `userApplication`:

- The `PreCheckScript` determines that the `userApplication` should not come online.
- A fault occurs during online processing.

These situations are discussed in detail in later sections.

3.1.3.1 Online request

Generating the online request is referred to as **switching** the `userApplication`; that is, switching the `userApplication` online or switching the `userApplication` to another cluster node (refer also to the "Switch processing").

The following actions can generate an online request:

- Manual request using the GUI or CLI (`hvswitch`)

- Automatic request when RMS is started using the GUI or CLI (`hvcm`)
- Automatic requests controlled by the application's `AutoSwitchOver` attribute:
  - `AutoSwitchOver` includes `ResourceFailure` and a fault occurs
  - `AutoSwitchOver` includes `ShutDown` and a node is shut down
  - `AutoSwitchOver` includes `HostFailure` and a node is killed

Manual methods

Manual methods have two modes for switching the `userApplication`. These modes are as follows:

- Priority switch—RMS selects the `SysNode`. The `userApplication` is switched to the highest priority `SysNode`. The `SysNode` objects' priority is determined by their order in the `PriorityList` attribute of the `userApplication` object.
- Directed switch—The user selects the `SysNode`. The `userApplication` is switched to a specific `SysNode`.

In both priority and directed switches, only `SysNode` objects that are in the `Online` state may be selected.

Manual request using the GUI

To manually generate an online request, perform the following steps:

1. Using the graph, right-click on an application to display its context menu.
2. Click on a *switch* or *online* item in the context menu.

Manual request using the CLI

To generate an online request for each `userApplication`, use the `hvswitch` command. Refer to the `hvswitch` manual page for details on usage and options.

Automatic methods

All automatic methods can only invoke a priority switch.

Automatic request at RMS startup

When RMS first starts on a cluster, it switches the `userApplication` online on the highest priority node if all of the following conditions are true:

- All `SysNode` objects associated with a specific application are online.
- The `userApplication` is neither online nor inconsistent on any other cluster node.
- The `AutoStartUp` attribute of the `userApplication` is enabled.
- No object in the graph of the `userApplication` is in the faulted state.

These limitations ensure that the `userApplication` is not started on more than one cluster node at a time.

If the `userApplication` is already online after startup, an automated startup request for the `userApplication` is immediately created, even if `AutoStartUp` is not set or not all `SysNode`s are online. This is intended to ensure a consistent graph of an online `userApplication`. Otherwise objects could still be offline in an graph of an online application.

Automatic request when a fault occurs

RMS initiates a priority switchover when it detects either a fault of a `userApplication`, or a fault of a `SysNode` where a `userApplication` was online. This automatic switchover is controlled by the application's `AutoSwitchOver` attribute as follows:

- `AutoSwitchOver` includes `ResourceFailure` and a fault occurs
- `AutoSwitchOver` includes `ShutDown` and a node is shut down
- `AutoSwitchOver` includes `HostFailure` and a node is killed

No automatic switchover occurs if `AutoSwitchOver` is set to `No`.

3.1.3.2 PreCheckScript

The `PreCheckScript` is intended to verify in advance that certain prerequisites for successful online processing are fulfilled. It avoids useless attempts when those prerequisites are not (yet) met. The `PreCheckScript` is also invoked during policy-based switching.

The PreCheckScript will be forked before the original online processing begins. If the script is successful and returns with an exit code of 0, online processing proceeds as usual. If the script fails and returns with an exit code other than 0, online processing is discarded and a warning is written into the switchlog.

Resulting state

When the PreCheckScript is running, the userApplication object transits into the Wait state. If the PreCheckScript fails, the userApplication object transits back into its previous state, usually Offline or Faulted.

AutoSwitchOver

If the PreCheckScript fails and the AutoSwitchOver attribute includes ResourceFailure, then RMS automatically forwards the online request to the next priority node (except in cases of directed-switch requests).

3.1.3.3 Online processing in a logical graph of a userApplication

If the PreCheckScript is successful, the base monitor generates a **pre-online request**. Relative to the resource graph, the pre-online request process is as follows:

1. Request is sent from the parent to the child.
2. Parent object changes to the Wait state, but no script is initiated.
3. Child receives the request. The pre-online script is initiated in the leaf objects.
4. When the script terminates, confirmation is sent to the parent.
5. As soon as all children of the parent have sent their confirmation, the pre-online script is executed on the parent.

In relation to the resource graph, the above steps illustrate the **bottom-up procedure** for executing the scripts in online processing.

The userApplication object is the final object to execute its pre-online script; it then generates an online request that is passed to the leaf objects. However, there is a difference between online processing and pre-online processing.

Relative to the resource graph, the online script process is as follows:

1. RMS executes the online script.

2. The system waits until the object detector reports the `Online` state. If an object does not have a detector, the post-online script executes after the `OnlineScript` is completed successfully.
3. The post-online script executes immediately.
4. Confirmation of the success of online processing is forwarded to the parent.
5. The object exits the `Wait` state and changes to the `Online` state.

In the context of RMS, *"the userApplication is online"* means that all configured resources are online (ready to operate). In this case, the term online does not pertain to the state of the actual application. The actual application is started and monitored by the scripts configured for a `cmdline` child object.

i How a `cmdline` script influences the state of the actual application depends on the application itself. RMS has no direct control over any user application. For a more complete discussion, see the section "Relationship of RMS configurations to the real world."

Example 2

The scenario for this example is as follows:

- `AutoStartUp` attribute is set to "yes."
- None of the resource objects have `PreOnlineScript` definitions.
- All objects are in the `Offline` state at startup time.

Online processing is as follows:

1. RMS starts.
2. `userApplication` object `app` on node `fuji2RMS` generates a pre-online request because the `AutoStartUp` attribute is set to "yes."
3. This request is passed through to the `lfs` leaf object. As no `PreOnlineScript` has been configured for any of the objects in this example, `lfs` forwards a message to `app` indicating that pre-online processing has completed successfully.
4. When the pre-online success message arrives, `app` generates the online request, which is also passed through to the `lfs` leaf object.
5. The `lfs` object executes the online script and brings the disk online.

6. As soon as the detector of `lfs` reports `Online`, successful completion of online processing is notified upwards to the `cmd` object. (If the object had a post-online script, this would have been executed before the success message was forwarded.)
7. The `cmd` object starts its online script.
8. As soon as the `cmd` detector reports a success completion, the success message is forwarded to `andOp1`.
9. The `andOp1` object is an object without a detector; it does not have an online script in this example. As soon as its local child reports the `Online` state, it forwards the success message to its parent object `app`.
10. Upon receipt of the success message at `app`, RMS executes the online script and the application starts. Because `app` does not have a detector and also because no post-online script is configured, `app` changes immediately to the `Online` state after the online script has completed successfully.

3.1.3.4 Unexpected reports during online processing

Unexpected reports during `online` processing mean reports which are reported during the `online` processing but not in the `Online` state ignored by the base monitor.

Reports other than in the `Online` state ignored by the base monitor may be reported from the point where the `online` processing of the user application which an object belongs to starts until the object's `online` processing succeeds or fails.

For cases where the object's `online` processing fails, see the "Fault situations during online processing".

3.1.3.5 Fault situations during online processing

If an error situation occurs during `online` processing, the affected object commences `fault` processing and notifies its parent of the error (see also the "Fault processing"). The following can cause faults during `online` processing:

a. When the last reported state from a detector of a resource object is in the `Offline` or `Faulted` state at the point where `Online` processing finishes.

b. Script fails with an exit status other than `0`.

c. Script fails with a timeout.

d. An object's `OnlineScript` finishes and the detector does not notify the `Online` state within a specific period.

For case a, `fault` processing is initiated after `online` processing of `userApplication` finishes in direct contrast to cases b, c, and d where `fault` processing is initiated immediately once that condition is satisfied.

3.1.3.6 Initialization when an application is already online

A situation can occur in which the entire logical graph of a `userApplication` is already online when RMS is initialized. In this case, the `PreCheckScript` does not execute and the affected objects switch directly from the `Unknown` state to the `Online` state without executing any scripts.

Request while online

If a `userApplication` receives an online request when it is already online, it is forwarded to the other objects as usual. The only difference from the description in the "Online processing" is that any objects that are already online forward the request or the responses without executing their scripts and without changing to the `Wait` state. In particular, the `PreCheckScript` is not run.

A typical example of an object which is always online when RMS is initialized is a `gResource` object for a physical disk, since physical disks cannot in general be disabled through a software interface.

No request while online

If a `userApplication` does not receive an online request when it is already online and RMS is initialized, the `userApplication` carries out online processing of its graph as if it had received an explicit online request. The resulting state of the local graph is exactly the same as in the previous case.

Guarding against data loss when the application is already online

A primary objective of RMS is to ensure that no data loss occurs as a result of simultaneous activity of the same application on more than one node in the cluster. Therefore, after the online processing of the application's graph in either of the two cases described above, the base monitor on the local node reports the `userApplication` object's `Online` state to the base monitors on the other nodes to ensure that no corresponding application goes online elsewhere in the cluster.

It can be extremely damaging if a `userApplication` is online on more than one node immediately after RMS has initialized. In this case, RMS generates a `FATAL ERROR` message and blocks any further requests for the `userApplication`. This minimizes the possibility of damage caused by inconsistency in the cluster.

Caution

The situations described in this section are a result of manual intervention. If the manual intervention allowed competing instances of an application or a disk resource to run on multiple nodes, data corruption may have already occurred before RMS was initialized.

3.1.4 Offline processing

Normally, offline processing results in the `userApplication` object transitioning to the `Offline` state.

3.1.4.1 Offline request

An offline request can be generated for any of the following reasons:

- Manual offline request using the GUI or CLI (`hvutil -f`)
- Manual switch request using the GUI or CLI (`hvswitch`)
- Offline processing after a fault, either automatically or using the GUI or CLI (`hvutil -c`)
- RMS shutdown using the GUI or CLI (`hvshut`)

In normal operating mode, only the RMS command interface can generate an offline request. In the case of a fault, the `userApplication` generates its own offline request (such as if one or more necessary resources fails); this prevents an application that is no longer operating correctly from continuing to operate in an uncontrolled manner (see also the "Fault processing"). This offline request is also a primary precondition for any subsequent switchover.

Offline processing of `userApplication` objects does not occur if RMS is shut down with '`hvshut -L`' or '`hvshut -A`'.

3.1.4.2 Offline processing in a logical graph of a userApplication

Unlike online processing, the direction of offline processing is from the `userApplication` to the leaf object (top-down). Nodes without a detector execute the post-offline script immediately after the offline script. The offline process is as follows:

1. The `userApplication` changes to the `Wait` state.
2. The `userApplication` executes its pre-offline script, and sends a corresponding request to its children after the pre-offline script terminates.
3. After receiving the pre-offline request, each child object changes to the `Wait` state, executes its pre-offline script, and forwards the request.
4. As soon as the leaf objects have completed their pre-offline script, they send a corresponding message (confirmation of successful pre-offline processing) to their parents.
5. The message is forwarded without any further activity from the children to the parent until it arrives at the `userApplication`.
6. After pre-offline processing has been completed, the `userApplication` executes its offline script, immediately followed by the post-offline script (`userApplication` is an object without a detector).
7. The `userApplication` then generates the actual offline request.

Processing of the offline request in the individual objects is similar to online processing, as follows:

- The offline script is executed first.
- The post-offline script is started after the object's detector `Offline` report has arrived.
- After the post-offline script has completed, the offline request is forwarded to each of the object's children.
- When all children have returned a `PostOfflineDone` message, the object returns a `PostOfflineDone` message to its parent.

As illustrated, the `userApplication` is the final object to go offline. After the last child returns a `PostOfflineDone` message, the offline processing is complete; the `OfflineDoneScript`, if present, is fired; and the base monitor notifies the corresponding `userApplication` objects on the other nodes that the application has gone offline.

Example 3

The following further explains the offline process:

1. As none of the objects in the example has a pre-offline script, the corresponding pre-offline request is forwarded from `app` down to the leaf object.
2. The leaf object returns a success message to the `userApplication`.
3. The `userApplication` executes its offline script; in our example, this means that the application `app` is stopped. As the object `app` does not monitor the application, RMS considers the successful completion of the offline script to be a successful completion of offline processing.
4. A post-offline script is not configured, and an offline request is accordingly sent to `andOp1` immediately after the offline script has completed.
5. The `andOp1` object has no detectors and no scripts. The offline request is simply permitted to pass through.
6. The `cmd` object executes its offline script and forwards the request as soon as its own detector signals that offline processing has completed successfully.
7. The `lfs` leaf object also executes its offline script and forwards the success message after the corresponding report of its detector.
8. Offline processing completes successfully when `app` receives the success message.
9. Upon successful completion of offline processing, the `OfflineDoneScript` is fired. This script is intended for cleanup or for sending information. Its return code has no impact on the state of the `userApplication`.

3.1.4.3 Unexpected reports during offline processing

Unexpected reports during `offline` processing mean reports which are reported during the `offline` processing but not in the `Offline` state ignored by the base monitor.

Reports other than in the `Offline` state ignored by the base monitor may be reported from the point where the `offline` processing of the user application which an object belongs to starts until the object's `offline` processing succeeds or fails.

For cases where the object's `offline` processing fails, see the "Fault situations during offline processing".

3.1.4.4 Fault situations during offline processing

If an error situation occurs during offline processing, the affected object commences fault processing and notifies its parent of the error (see also the "Fault processing"). The following can cause faults during offline processing:

a. When the last reported state from a detector of a resource object is in the Online, Standby, or Faulted state at the point where Offline processing finishes.

b. Script fails with an exit status other than 0.

c. Script fails with a timeout.

d. An object's OfflineScript finishes and the detector does not notify the Offline state within a specific period.

3.1.4.5 Object is already in Offline state

An object may already be offline at the start of offline processing. This typically occurs if an offline request originates from a host where the parent userApplication is offline. (If the parent userApplication is online, then the offline object must be in the tree below an OR object.) When an offline object receives an offline request, the request is merely passed through, similar to the situation in online processing. Scripts are not executed, and the Wait state is not entered.

3.1.4.6 Object cannot be sent to Offline state

RMS covers an extremely wide range of system conditions, including monitoring resources that cannot be taken to the Offline state by a script. Physical disks are an example of such objects because they are monitored but cannot in general be physically shut down. For this purpose, RMS provides the attribute LieOffline to indicate that the resource has no true Offline state. The Wizard Tools subapplications set this attribute by default for gResource objects that represent physical disks, so it does not have to be explicitly specified.

During offline processing, an object whose LieOffline attribute is set reacts in the same way as any other object when its pre-offline, offline, and post-offline scripts are run. The reaction of the object with respect to its parent is also the same as if the object had been successfully taken offline; that is, it "lies." An object with LieOffline set does not wait for an offline report of the detector after the offline script has executed; instead, it automatically executes the post-offline script. An unexpected online report of the detector (which arrives after the offline script has executed) is not a fault condition in this case.

3.1.5 Fault processing

The handling of fault situations is a central aspect of RMS. How RMS reacts to faults differs depending on the state of an application at any particular time. For instance, the reaction to faults that occur in the resource graph of an ongoing application differs from the reaction to faults in the graph of an application that is locally offline.

3.1.5.1 Faults in the online state or request processing

When a detector indicates a fault for an online object whose corresponding `userApplication` is also online, RMS executes the fault script of the object. An equivalent fault condition occurs if the detector indicates that a previously online object is offline although no request is present.

After the fault script completes, RMS notifies the parents of the fault. The parents also execute their fault scripts and forward the fault message.

A special case is represented by `orOp` objects, which report a logical *OR* of their children's states. These react to the fault message only if no child is online. If any child of the parent `orOp` is online, RMS terminates the fault processing at this point.

If there is no intermediate `orOp` object that intercepts the fault message, it reaches the `userApplication`. The `userApplication` then executes its fault script. There are three possible cases during processing according to the following combinations of the `AutoSwitchOver` and `PreserveState` attributes:

- `AutoSwitchOver` includes `ResourceFailure`
- `AutoSwitchOver` does not include `ResourceFailure` and `PreserveState`=1
- `AutoSwitchOver` does not include `ResourceFailure` and `PreserveState`=0 or is not set

AutoSwitchOver includes ResourceFailure

When the `AutoSwitchOver` attribute includes `ResourceFailure`, RMS ignores the `PreserveState` attribute and responds as if only the `AutoSwitchOver` attribute were set. In this case, the process is as follows:

1. The `userApplication` attempts to initiate the switchover procedure. For this purpose, the application on the local node must be set to a defined `Offline` state. The procedure is the same as that described under offline processing.
2. When offline processing is successfully completed, an online request is sent to the corresponding `userApplication` of a remote node (see the "Switch processing"). However, the `userApplication` is now in the `Faulted` state—unlike the situation with a normal offline request. This prevents the possibility of an application returning to the node in the event of another switchover.

If a further fault occurs during offline processing; for example, if RMS cannot deconfigure the resource of an object that was notified of a `Faulted` state, then it does not execute a switchover procedure. RMS does not execute a switchover because it views the resources as being in an undefined state. The `userApplication` does not initiate any further actions and blocks all external, non-forced requests.

i A failure during offline processing that was initiated by a previous fault is called a double fault.
This situation cannot be resolved by RMS and requires the intervention of the system administrator. The following principle is applicable for RMS in this case: Preventing the possible destruction of data is more important than maintaining the availability of the application.
If the application is important, the `HaltFlag` attribute can be set in the `userApplication` during the configuration procedure. This attribute ensures that the local node is shut down immediately if RMS cannot resolve a double fault state, provided there is another node available for the application. The other nodes detect this as a system failure, and RMS transfers the applications running on the failed node to the available node.

AutoSwitchOver does not include ResourceFailure and PreserveState=1

In this case, the process is as follows:

1. The `userApplication` does not initiate any further activity after the fault script executes.
2. All objects remain in their current state.

Use the `PreserveState` attribute if an application can remedy faults in required resources.

AutoSwitchOver does not include ResourceFailure and PreserveState=0 or is not set

In this case, RMS carries out offline processing as a result of the fault, but it does not initiate a switchover after offline processing is complete (successful or not).

Fault during pending switch request

A special case occurs when a switch request causes a fault during offline processing. In this case, RMS carries out a switchover after completing the offline processing that the fault caused (provided that offline processing is successful), even if the `AutoSwitchOver` attribute is set to `No`. Switchover had evidently been requested at this time by the system administrator who sent the switch request online. If the ongoing switch request is a direct switch request, the target node of the switchover procedure may not be the node with the highest priority; it is the node explicitly specified in the directed switch request.

i For more information about the `AutoSwitchOver` and `PreserveState` attributes, see the "Appendix—Attributes".

3.1.5.2 Offline faults

Even if an application is not online on a node, RMS still monitors the objects configured in the application’s graph. If a detector indicates a fault in one of these objects, the fault is displayed. However, no processing takes place, the fault script is not executed, and no message is sent to the parent.

In this case, it is possible that an `andOp` object could be offline, even though one of its children is `Faulted`.

This design was chosen on the principle that mandatory dependencies between the objects in a `userApplication` graph exist only if the `userApplication` is to run.

3.1.5.3 AutoRecover attribute

An object of the type `gResource` that represents a local file system is one example of an object that can enter a `Faulted` state due to reasons that are easily and automatically remedied. A fault that occurs in the object itself (and not as a result of an input/output fault on an underlying disk) is most likely from a `umount` command that was erroneously executed. In this case, causing the entire application to be switched over probably would not be the best remedy. Therefore, fault processing would not be the best solution.

For such cases, administrators can configure an object's `AutoRecover` attribute. If a fault then occurs when the object is online, the online script is invoked before the fault script. If the object enters the `Online` state again within a specific period after the online script has been executed, fault processing does not take place.

RMS only evaluates the `AutoRecover` attribute when the object is the cause of the fault, that is, when the cause of the fault is not the fault of a child. Accordingly, RMS only evaluates `AutoRecover` for objects with a detector. The `AutoRecover` attribute is not relevant if a fault occurs during request processing or if the object is in the `Offline` state.

3.1.5.4 Fault during offline processing

A fault occurrence during offline processing does not result in an immediate halt of offline processing at that object. Instead, the fault condition at that point in the tree is stored, and offline processing continues in the normal manner down to the leaf objects. However, the fault is recalled and handled when the success/ failure message is propagated to the object on the way upstream to the `userApplication`. This design avoids race conditions that could occur if the fault were processed immediately.

3.1.5.5 Examples of fault processing

The following are examples of fault processing.

Example 4

The scenario for this example is as follows:

- The application `app` has its `AutoSwitchOver` attribute set to `No` and is online on node `fuji2RMS`.
- There is no request.

- The lfs object does not have its AutoRecover attribute set.
- An error by the system administrator unmounts the lfs file system.

Fault processing is as follows:

1. The lfs object's gResource detector indicates that its object is offline. Because the corresponding userApplication is online and because there is no offline request, RMS interprets this offline report as a fault and notifies the parent cmd.

   i Reminder: An unexpected Offline state results in a fault.

2. The cmd object in this example does not have a fault script. The cmd object goes directly to the Faulted state and reports the fault to its parent andOp1.
3. andOp1 does not have a fault script either, so it also goes directly to the Faulted state, and reports the fault to the parent app object.
4. The app object then changes to the Faulted state and starts offline processing in preparation for switchover, since its AutoSwitchOver attribute is set to a value other than No.
5. In this example, assume that the local file system lfs uses the mount point /mnt, and the offline script of lfs consists of the simple instruction umount /mnt. Because /mnt is no longer mounted, this offline script terminates with an exit status other than 0.
6. Accordingly, offline processing for RMS fails after a fault. A switchover is not possible because the local state remains unclear. RMS waits for the intervention of the system administrator.

A more complex offline script for lfs could check whether the object is still mounted and terminate with an exit status of 0. In this case, RMS could successfully complete offline processing after the fault and switch over to fuji3RMS; all local objects on fuji2RMS would then be offline following successful online processing, and only app would remain in the Faulted state.

Example 5

The scenario is the same as in the previous example, except the AutoRecover attribute is set for the lfs object.

Fault processing is as follows:

1. The lfs object's gResource detector indicates that its object is offline. Since the corresponding userApplication is online and because there is no offline request, RMS interprets this offline report as a fault (see *Example 4* above).
2. Since the AutoRecover attribute is set, RMS does not immediately report the fault to the parent cmd object. Instead, RMS starts the lfs object's online script to reverse the unmount procedure.
3. A few seconds later, the lfs object's gResource detector reports that the object is once again online. RMS returns the object to the Online state, and no further fault processing takes place.

Example 6

In this scenario, app receives an online request, but the file system represented by lfs has been corrupted.

Fault processing is as follows:

1. Online processing starts as a result of the request.
2. The lfs object starts its online script, which terminates with an exit status other than 0.
3. The lfs object then initiates fault processing: it starts its fault script (if one is configured), changes to the Faulted state, and notifies RMS of the fault.
4. The rest of the process proceeds in the same manner as described in *Example 4* above.

i Fault processing in this case would be the same even if the AutoRecover attribute were set. This attribute is only significant if the application is in a stable Online state, that is, the application is online and there is no pending request.

3.1.5.6 Fault clearing

After successful offline processing due to a fault occurrence, the resource objects will be offline, and the `userApplication` object will be faulted. If offline processing fails as a result of the fault, or if the application's `PreserveState` attribute is set, at least part of the graph may remain in a state other than `Offline`, *i.e.*, `Online`, `Standby`, or `Faulted`.

In all of the above states, the `userApplication` prevents switch requests to this host, because the base monitor assumes that at least some of the resources are not available. After the system administrator has remedied the cause of the fault, one of the following procedures can be used to notify the base monitor so that RMS can resume normal operation:

1. The following command may be used to clear the faulted state of the `userApplication` object and the objects in its graph:

   `hvutil -c` *userApplication*

   This command attempts to clear the fault by switching the parent application and its graph into a self-consistent state: if the application object is online, then online processing will be initiated; if the application object is offline, then offline processing will be initiated. (The user is notified about which type of processing will occur and given a chance to abandon the operation.) The fault clears successfully when every branch leading to the application reaches the same online or offline state. If the final state is offline, the system administrator can set the `userApplication` to the online state with a switch request.

   If the `userApplication` object is initially online, invoking '`hvutil -c`' may not affect every object in the tree. To initiate offline processing for the entire tree, use '`hvutil -f`' as described below.

2. The following command initiates an offline request to the `userApplication` object:

   `hvutil -f` *userApplication*

   This starts offline processing for the application. If the command completes successfully, the application and every object in its graph are switched to the offline state, and the fault is cleared. If required, the system administrator can set the `userApplication` to the online state with a switch request.

In summary, if the `userApplication` is in the faulted state, both '`hvutil -f`' and '`hvutil -c`' have the same effect: both result in **offline** processing.

The difference occurs when the userApplication is online and a fault occurs below an orOp: ‘hvutil -f’ would initiate **offline** processing for the userApplication; but ‘hvutil -c’ would act as if ‘hvswitch -f’ had been invoked, and **online** processing for the userApplication would begin.

3.1.5.7 SysNode faults

RMS handles a fault that occurs in a SysNode in a different manner than faults in any other type of object. A SysNode fault occurs under the following conditions:

- The local base monitor loses the heartbeat of the base monitor on a remote host.
- A CF LEFTCLUSTER event occurs

When either of these events happen, RMS must first ensure that the remote node is actually down before automatic switchover occurs. To accomplish this, RMS uses the Shutdown Facility (SF). For more information about the Shutdown Facility and shutdown agents, see "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide."

Once the shutdown of the cluster node is verified by the SF, all userApplication objects that were Online on the affected cluster node, and whose AutoSwitchOver attribute includes HostFailure, are priority switched to surviving cluster nodes.

Example 7

The scenario for this example is as follows:

- RMS is running on a cluster consisting of nodes fuji2 and fuji3, which are represented by the SysNode objects fuji2RMS and fuji3RMS, respectively.
- app is online on fuji2RMS and its AutoSwitchOver attribute includes the HostFailure setting.
- A system fault on fuji2 generates a panic message.

The reaction of RMS is as follows:

1. CF determines that a node failure has occurred and generates a LEFTCLUSTER event.
2. RMS puts the SysNode in a Wait state. RMS receives the LEFTCLUSTER event and sends a kill request to SF.

3. After SF successfully kills the node, a DOWN event is sent.
4. RMS receives the DOWN event and marks the SysNode as Faulted
5. The fuji2RMS object executes its fault script (assuming that such a script has been configured).
6. The fuji2RMS object notifies the userApplication objects that fuji2RMS has failed. Since app was online on fuji2RMS when fuji2RMS failed, and since its AutoSwitchOver attribute includes the HostFailure setting, the object app on fuji2RMS starts online processing.

Operator intervention

If the Shutdown Facility is engaged to kill a node, but the duration of the SysNode object's Wait state exceeds the object's ScriptTimeout limit, RMS records an ERROR message in the switchlog to this effect.

At this point, one cluster node is now in an undefined state, so RMS blocks all further action on all other nodes. This situation is usually resolved only by operator intervention as described in "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide." Upon successful completion of the procedure, CF sends a DOWN event, RMS resolves the blocked state, and normal operation resumes.

For more information about the ScriptTimeout attribute, see the "Appendix—Attributes".

3.1.6 Switch processing

The switch processing procedure ensures that an application switches over to another node in the cluster.

3.1.6.1 Switch request

Switch requests are divided as follows:

- Priority switch request—RMS identifies the target node according to the node priority list defined during the configuration process.
- Directed switch request—The user specifies the target node.

The types of switches are divided as follows:

- Switchover—The application running on a node is to be switched over to another node.
- Switch-online—An application that is not running on any node is started; or the node on which it has previously been running has failed.

i During switch processing, RMS notifies all the nodes in the cluster of the procedure. This prevents competing requests.

Example 8

The scenario for this example is as follows:

- `app` is online on `fuji2RMS`.
- The system administrator sends a directed switch request on `fuji3RMS` with the aim of switching `app` to `fuji3RMS`.

Switch processing is as follows:

1. RMS forwards the switch request to `fuji2RMS` because `fuji2RMS` is the online node of the `userApplication` object.
2. `app` on `fuji2RMS` notifies the corresponding nodes in the cluster (in this case, `app` on `fuji3RMS`) that switchover processing is active. This means that competing activities are blocked.
3. `app` on `fuji2RMS` sends a request to `app` on `fuji3RMS` to establish whether any faults are known in the local graph on `fuji3RMS`. In this example, there are no known faults in the local graph on `fuji3RMS`.
4. `app` on `fuji2RMS` commences offline processing.
5. As soon as RMS has successfully deconfigured `app` on `fuji2RMS`, `app` on `fuji2RMS` notifies all corresponding nodes in the cluster that the application will now be running on `fuji3RMS`. Blocking of competing requests is simultaneously cancelled.
6. `app` on `fuji2RMS` terminates its activity by sending an explicit online request to `app` on `fuji3RMS`.
7. `app` on `fuji3RMS` commences online processing.

3.1.7 Special states

3.1.7.1 Restrictions during maintenance mode

An application in maintenance mode imposes processing restrictions on other objects that appear in the same graph. These restrictions prevent all processing described in earlier sections of this chapter, and they affect the following objects:

- All child objects of the application in maintenance mode
- All ancestors up to and including the node where the application in maintenance mode resides

The restrictions may generate either an error or a timeout, depending on the type of processing request.

To illustrate how the restrictions apply, consider the situation in which two applications (`app1` and `app2`) each have a single dependent resource (`Res1` and `Res2`, respectively) and are configured to run on either of two nodes (`NodeA` and `NodeB`). Figure 13 shows the states of these objects if `app1` is put into maintenance mode.

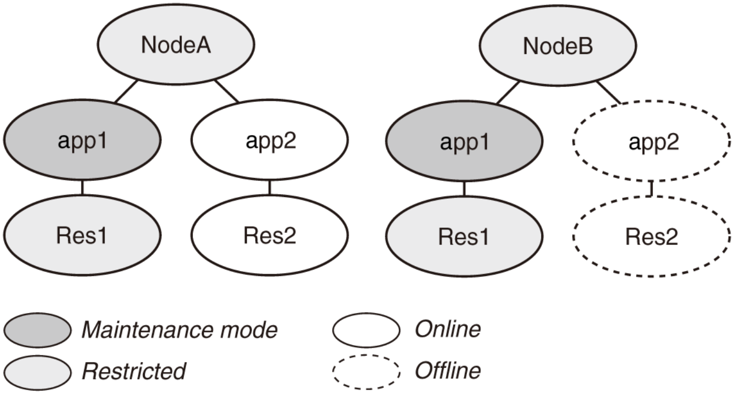


Figure 13: Example of maintenance mode restrictions

This simple example illustrates the following features:

- Maintenance mode for an application applies on every node where the application could be brought online, *i.e.*, on every node in its *PriorityList* attribute. Therefore, `app1` is in the `Maintenance` state on every node where it could run, regardless of its previous state on any of those nodes.

  Note that `app1` also has an intended status on each of its nodes. This is the status just before the start of maintenance mode. The intended status is available in the application's *StateDetails* parameter in the GUI and in the CLI `hvdisp` output.

- Since `Res1` is a child of `app1`, it is restricted everywhere.
- Since `app1` appears in the graph of both `NodeA` and `NodeB`, they are also restricted. (You can initiate RMS shutdown of either node, but you will be prompted to let RMS take `app1` out of maintenance mode first.)

- app1 does not appear in the graph of app2. Therefore, normal processing of app2 and its resource is allowed, including switching app2 offline, online, or to a different node.
- Do not stop RMS or the system while the application is in the maintenance mode. You must exit the maintenance mode of all applications before stopping them.

  If you stop RMS by using a force option before exiting the maintenance mode of all applications, the OS will shut down without the offline process being performed.
  Therefore, this could sometimes result in some resources like volume manager being in an incorrect state when RMS comes back up.

This behavior is typical if an application is put into maintenance mode with 'hvutil -m on', or if the equivalent GUI operation begins by right-clicking on the individual application. However, if 'hvutil -M on' is used, or if the GUI operation begins by right-clicking on the cluster name, then maintenance mode is clusterwide and processing is suspended everywhere.

3.1.7.2 The Inconsistent state

There are situations in which a userApplication and one or more of the resources in its graph are Offline or Faulted, while other resources in its graph are Online or Faulted. This could be the result of manual intervention by an administrator, or it could occur when a fault clearing operation fails and leaves some objects in Online or Faulted states.

It may be that some of these Online or Faulted resource objects have their ClusterExclusive attribute set, which indicates that they should not be brought Online on two or more hosts at the same time. If the userApplication were marked simply as Offline or Faulted, it could be switched Online on another node along with all its resources. This would be in direct conflict with the intention of the ClusterExclusive attribute, and the resulting resource conflict might cause data corruption. To avoid problems in these cases, RMS prevents any switch of the userApplication by marking it as Inconsistent rather than Offline or Faulted. The exact definition is as follows:

- A userApplication is marked with the Inconsistent state if its actual state is either Offline, Standby, or Faulted, and one or more resource objects in its graph are either Online or Faulted and have their ClusterExclusive attribute set to 1.

Note that while the userApplication is displayed or reported as Inconsistent, the actual state is either Offline, Standby, or Faulted. For most operations, the behavior of an Inconsistent userApplication is determined by the underlying actual state. For instance, if the actual state is Offline, and an Offline request is issued, no Offline script will be fired (see the "Object is already in Offline state").

The exception to this behavior occurs when there is a request to switch an Inconsistent userApplication to a remote node: in this case, the request is denied. This avoids possible damage by ensuring that the ClusterExclusive resources are Online only on one host at a time.

If a userApplication is Inconsistent on only one node, then it is possible to switch it Online on that node. However, if it is Inconsistent on two or more nodes, then it cannot be switched at all; in this case, the inconsistency must be resolved first, *e.g.*, by bringing all resources into an Offline state via 'hvutil -f' or 'hvutil -c'.

⚠ **Caution**

If a userApplication is Inconsistent on multiple nodes, one of its ClusterExclusive resources may be Online on multiple nodes as well. If this is the case, take appropriate action to shut down the resource gracefully on each node **before** you issue an 'hvutil' command for the userApplication. Depending on the resource type, you may also need to determine if there has been any data corruption.

3.2 RMS heartbeat operation

RMS transmits a UDP **heartbeat** signal at regular intervals. If the elapsed time since the last heartbeat from a node exceeds an adjustable connection timeout, RMS assumes the node has lost connectivity (see "HV_CONNECT_TIMEOUT"). RMS then begins a recovery period for the node. If the node heartbeat is detected during the recovery period, RMS assumes the node is functional and returns it to normal status. However, if RMS receives no heartbeats from the node before the recovery period expires, it assumes the node is down, even if other communication with the node is possible.

Once RMS marks a node as down, it takes a series of steps to ensure application and cluster integrity. First, it is necessary to ensure that the node is truly shut down. Otherwise, the node and its applications could unexpectedly recover later, causing conflicts and data corruption. To avoid these problems, RMS directs the Shutdown Facility (described later) to eliminate the node. This is often done by rebooting the node or turning off its power, but the exact action depends on which shutdown agents have been configured for the node. Only after the node has been eliminated is it safe for RMS to restart the node's applications elsewhere in the cluster. The process of automatically switching applications from a failed node to a healthy node is called application failover.

Application switchover impacts cluster performance, so it is important to choose a recovery timeout that avoids false detection of node outages. The optimum UDP recovery time depends on the conditions in the cluster. A short recovery period is the best choice to deal with failures of nodes or base monitors. However, a long recovery period allows time for overloaded nodes to respond, which avoids unnecessary shutdowns. If the UDP method is used by itself, these opposing requirements make it difficult to tune the recovery time in large or busy clusters.

Note that the UDP method can be unreliable, because it has three potential points of failure: first, an outgoing request for a response may not get through to the remote node, so it has no reason to respond; second, the remote node may be so busy that it cannot respond within the recovery period, especially if the recovery timeout is set to a low value; third, a response packet may be sent from the remote node, but it may not get through to the local node. In all three cases, the local node cannot take action until the recovery period expires.

To improve cluster response, RMS uses its Enhanced Lock Manager (ELM) as the primary method to determine machine states and connectivity. ELM is not a polling method. Instead, it relies on locks that are managed at the kernel level by the Cluster Foundation. When a node joins the cluster, it creates a lock and holds it as long as its base monitor is running. The lock is released when the node or its base monitor goes down. The state of the locks is available locally on each node, because the Cluster Foundation maintains them in the background.

ELM is designed to address the high priority issue of node or base monitor failures. The UDP heartbeat can therefore be optimized to detect slow node response, with the recovery time set to a relatively large value. This provides an important complement to ELM. A node with an overloaded CPU or network interface may respond so slowly that the underlying Cluster Foundation cannot determine the state of the node's lock. If this condition persists, the UDP heartbeat recovery period eventually expires, and RMS proceeds to shut down the node. ELM's efficiency and reliability make this a very infrequent occurrence.

Experts can manually disable ELM for rolling upgrade or debugging operations (see "HV_USE_ELM"). In this case, when RMS starts up, the expert must also manually adjust the UDP heartbeat recovery timeout to a smaller value with `'hvcm -h` *<timeout>*'. This is necessary to efficiently detect remote base monitor and node outages in the absence of ELM.

3.2.1 Operational details

The ELM mechanism is best illustrated with a few simple examples. The following discussion assumes the cluster consists of two or more nodes named A, B, C, etc.

3.2.1.1 ELM lock management

The lock name for each node has the format "RMS*<nnnnnn>*", where *<nnnnnn>* is the 6-digit CF node ID. Therefore, the correspondence of every node's name, CF node ID, and lock name is easily determined. The locks are maintained clusterwide by CF, and any node can request access to any lock.

When a node first requests access to a lock, the request is granted immediately, because the node will initially receive it in the NULL state. This is a special, neutral state that does not conflict with that lock's state on any other node. The local node can then issue a request to ELM to convert the lock to another state. Once the request is granted, the node can hold it in that state, or it can convert it to another state. Those are the only possible operations.

Besides the NULL state, ELM supports only two other states:

- concurrent read (CR)—Multiple nodes can hold the lock in this state. This will prevent other nodes from converting the lock to the exclusive state.
- exclusive (EX)—Only one node in the cluster can hold the lock in this state. This will prevent other nodes from converting the lock to the concurrent read or exclusive states.

The conversion operation is the central control mechanism for ELM. Requesting a conversion that would conflict with other nodes does not cause an error condition. Instead, the request is put into a queue until ELM can grant the request. The requesting process is put in a wait state, and when it reawakens, it knows its request has been granted.

When a node converts a lock back to the NULL state, it effectively releases the lock, and allows other nodes to convert the lock to their desired state. The requests will be granted in the order they were queued.

For example, suppose A has converted its lock to the EX state. B can request access to A’s lock and receive it immediately in the NULL state. If B then issues a request to convert it to the CR state, the request will wait until A (or ELM itself) converts the lock to the NULL or CR state, because neither of these conflict with B’s request. Therefore, when B successfully converts A’s lock, it knows that A is no longer holding the lock in the EX state.

Since a request to access another node’s lock is granted immediately and does not affect the ELM lock mechanism, that step is omitted in the following discussions.

3.2.1.2 First node startup

Assume that A is the first node to start RMS. The following sequence occurs:

1. A converts its own lock to EX mode. This happens immediately, since no other nodes have completed their startup at this point.
2. A initiates its UDP heartbeat and waits for responses from other nodes. It does not yet attempt to convert the locks of any other node at this point.

3.2.1.3 Second node startup

Assume that B is the second node to start RMS. The following sequence occurs:

1. B converts its own lock to EX mode. This happens immediately, since A has not requested access to B’s lock at this point.
2. B initiates its UDP heartbeat and waits for responses from other nodes. It does not attempt to convert the locks of any other nodes at this point.
3. A detects the first heartbeat from B. A issues a request to convert B’s lock to the CR state. Since B holds its lock in the EX state, A’s request goes to sleep while it waits in the ELM queue.
4. Since A’s request is sleeping, B must be holding its own lock. Therefore, B must be online, and A marks it accordingly. A continues to mark B as online as long as its request remains asleep.
5. B detects the heartbeat from A and executes a similar sequence. B tries to convert A’s lock to CR mode. But A holds its lock in the EX state, so B’s request goes to sleep while it waits in the ELM queue.
6. As long as B’s request remains asleep, B continues to mark A as online.

At this point, both nodes hold their own locks in the EX state, and each has issued a request to convert the other's lock to the CR state. Both requests are sleeping, but that has no effect on anything else either node is doing. However, the unfulfilled request on each node indicates the other base monitor is online.

3.2.1.4 Third and subsequent nodes

Assume C is the third node to start RMS. The sequence of operations with each of A and B are similar to the second node startup above:

1. C converts its own lock in the EX state, initiates its heartbeat, and then waits for the heartbeats from the other nodes.
2. When it first receives the heartbeat from one of the other nodes, it tries to convert that node's lock to the CR state, and the request goes to sleep.
3. As long as the request remains asleep, C marks the other node as online.

C performs steps 2 and 3 whenever it receives a heartbeat from a node for the first time.

At the same time, the other online nodes receive C's heartbeat for the first time, and they execute steps 2 and 3 with C's lock.

When the entire cluster is online, the states of the locks on each node are as follows:

- The node hold its own lock in the EX state.
- The node has issued requests to convert every other node's lock to the CR state, and all of these requests are sleeping.

3.2.1.5 Node or RMS down scenario

When CF has issued a LEFTCLUSTER event for a remote node, or when the base monitor on a remote node goes down, ELM converts that node's lock to the NULL state on every node in the cluster.

For example, suppose node B has just gone down. The sequence of events on node A is typical of every other online node:

1. A's pending request to convert B's lock to the CR state wakes up. A now holds that lock in the CR state.
2. A immediately converts the lock to the NULL state and marks B as being offline.

3. A continues to mark B as offline until it receives a heartbeat from B. At that point, A restarts the lock cycle by requesting to convert B’s lock to the CR state.

The same sequence would have occurred if node B’s base monitor went down first. The major difference would be that, if the node goes down, the LEFTCLUSTER event would precede the ELM lock release; if the base monitor went down, the ELM lock release would precede the LEFTCLUSTER event. Either condition would cause RMS to initiate a node elimination.

The ELM method proactively alerts the other base monitors when an outage occurs somewhere in the cluster. They do not have to wait for heartbeat timeouts to expire.

Note that ELM handles a graceful shutdown in much the same way, but in this case, the node itself releases the lock. Also, at the RMS level, no node elimination is necessary.

3.2.1.6 Slow response scenario

When a remote node is busy, its base monitor may respond very slowly. ELM is a state-based method and cannot detect this condition. Therefore, RMS depends on the time-based UDP heartbeat to decide when the remote response has become unacceptably slow.

For example, suppose node B is not down, but its base monitor is responding very slowly. The following sequence will occur on one of the nodes in the cluster, which we will be supposed to node A for this discussion:

1. A’s request to convert B’s lock to the CR state continues to sleep, because B is still up.
2. B’s heartbeat period expires (default: 30 seconds), and then its heartbeat recovery period expires (default: 600 seconds).
3. Based on the heartbeat loss, A directs SF to eliminate B. (Note that ELM still detects no problem.)
4. When B is eliminated, ELM releases its lock on every node.
5. A’s request to convert B’s lock is granted. A immediately releases the lock and marks B as offline.
6. A waits for B’s heartbeat, and the lock cycle starts again.

Other nodes may detect the loss of B’s heartbeat before their lock request wakes up, in which case they will also initiate a node elimination of B.

This illustrates why ELM needs the UDP heartbeat as a backup. Without UDP, the ELM lock requests could remain in the queue well beyond the point where the remote node provides no useful services.

3.2.2 Default initialization in hvenv

The `HV_USE_ELM` environment variable in `hvenv` is automatically initialized to enable or disable ELM according to the status of CF:

- If CF is not installed, `HV_USE_ELM` is set to 0 and the default UDP heartbeat recovery timeout is 45 seconds.
- If CF is installed, `HV_USE_ELM` is set to 1 and the default UDP heartbeat recovery timeout is 600 seconds.

You can override the default recovery timeout with '`hvcm -h`'.

i If the heartbeat recovery timeout is too short, premature node kills may occur even though ELM is operational.

3.2.3 Manually controlling ELM in hvenv.local

ELM may be manually disabled, but this should be done only by experts or consultants. Reasons for disabling ELM include:

- rolling upgrades
- testing or debugging

When you disable ELM, you must change the `HV_USE_ELM` variable and then start RMS with a suitable timeout:

1. In `hvenv.local`, set `HV_USE_ELM=0`

   See "`HV_USE_ELM`".

2. Start RMS with '`hvcm -h` *<timeout>* `...`'

   The recommended timeout when ELM is disabled is 45 seconds. See the `hvcm` man page. There is no way to specify the heartbeat timeout when you start RMS from the Cluster Admin GUI.

You can also set `HV_USE_ELM=1` in `hvenv.local`. However, if this setting is in effect when CF is not installed, you will not be able to start RMS. RMS indicates this with a message in the switchlog.

3.3 Scalable controllers

This chapter describes operational details of scalable controllers and scalable applications. It includes the following sections:

- "Controller overview"
- "Scalable controllers and applications"
- "Online/offline processing and state transitions"

3.3.1 Controller overview

Controllers enable an application to monitor and control other applications. The application that includes the controller sub-application is referred to as the **controlling** or **parent** application; the application(s) specified in the controller description are referred to as the **controlled** or **child** application(s). The child application(s) act like resources of the parent application. The controlling application can be thought of as the master application and the controlled applications can be thought of as slave applications.

3.3.2 Scalable controllers and applications

The scalable controller provides a single point of administration, control, and display of information for multiple applications. Applications controlled by a scalable controller are called scalable applications.

For example, by switching online a controlling application with a scalable controller, scalable applications come online in the order prescribed by the controller's ApplicationSequence attribute; by switching the controlling application offline its scalable applications come offline in the opposite order. At the same time, the state of the scalable controller reflects a combined state of the scalable applications—this state can be readily viewed via GUI or hvdisp.

Scalable controllers and scalable applications are useful for configurations that require complex control and administration for multiple configuration resources. Some such configurations have already been implemented in the past using multiple follow-type controllers. However, the scalable controller permits the construction of very complex high availability configurations that are treated as a single entity.

3.3.2.1 Scalable applications

A scalable application is any application controlled by a scalable controller. Different scalable applications can be online at the same time on the same or on different hosts. For example, parallel databases like Oracle RAC, Fujitsu Symfoware and IBM DB2 PE (Parallel Edition) are all database servers that may have separate instances running at the same time on different nodes in the cluster. A separate application is configured for each database instance. A top-level application monitors and controls all applications (or database instances). The top-level application is referred to as the “controlling” application. The “database instance” applications are referred to as “controlled” applications. By organizing such components into scalable applications controlled by a scalable controller, one can use this controller as a single point of access to the whole server across the cluster. Of course, these are the most commonly encountered scalable applications in commercial data processing. However, any application that has similar requirements can be configured similarly.

3.3.2.2 Benefits of scalable controllers

A primary benefit of the scalable controller is that it makes it allows configurations in which child applications can (or must) run on different nodes than the parent. It also simplifies administrative operations for multiple applications such as parallel databases.

For example, one method used to configure Oracle RAC is to provide a separate user application on each node. Each user application is managed independently on each node. This configuration works fine for Oracle RAC because it is a shared access database so that when a node on any instance of the cluster is available, the whole database is accessible.

However, in a non-shared database such as IBM DB2 PE, all of the instances of the database must be on-line before the entire database can be accessed. Building a configuration to support DB2 PE can be complicated using traditional follow-mode controllers because of the multiplicity of applications and relationships. However, with the scalable controller these configurations are much simpler to construct.

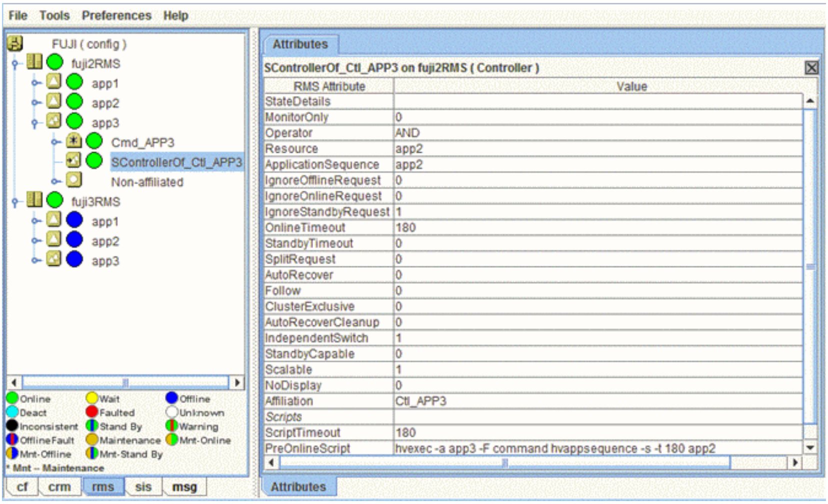
Various configuration options are available to the user to support multiple applications or parent-child application dependencies that span multiple hosts. The following sections describe the scalable controller in more detail.

3.3.2.3 Attributes for scalable controllers

The Scalable controller attribute controls support for scalable child applications: if the controller's Scalable attribute is set to 1, then all applications listed in its Resource attribute are considered to be scalable applications.

Only a single scalable controller can control a given child application—the child cannot have multiple parent controllers. A given application may contain one or more scalable controllers, and no limitations are imposed on the structure of the application that contains one or more scalable controllers. However, RMS Wizard Tools may restrict the choices available during configuration according to the template application wizard used.

The following figure shows the Cluster Admin view of a typical scalable controller's attributes.



SControllerOf_Ctl_APP3 on fuji2RMS (Controller)

RMS Attribute	Value
StateDetails	
MonitorOnly	0
Operator	AND
Resource	app2
ApplicationSequence	app2
IgnoreOfflineRequest	0
IgnoreOnlineRequest	0
IgnoreStandbyRequest	1
OnlineTimeout	180
StandbyTimeout	0
SplitRequest	0
AutoRecover	0
Follow	0
ClusterExclusive	0
AutoRecoverCleanup	0
IndependentSwitch	1
StandbyCapable	0
Scalable	1
NoDisplay	0
Affiliation	Ctl_APP3
Scripts	
ScriptTimeout	180
PreOnlineScript	hvexec -a app3 -F command hvappsequence -s -t 180 app2

Figure 14: Scalable controller attributes

Some of the scalable controller attributes shown in the figure above can be adjusted in the RMS Wizard Tools interface. These attributes in this example are set as follows (reading top-to-bottom in the figure):

- MonitorOnly=0
- Resource=<*a list of applications*>
- ApplicationSequence=<*the sequence of applications in the Resource list*>
- ScriptTimeout=180
- FaultScript=<*script definition*>
- StateChangeScript=<*script definition*>

Other attributes that affect scalable operation are set automatically by the RMS Wizard Tools when the user configures a scalable controller.

The effect of some of these attributes on switchover processing and state transitions is discussed in the following sections.

3.3.3 Online/offline processing and state transitions

3.3.3.1 How controller states depend on controlled application states

Table 4 summarizes scalable controller states according to the states of its controlled applications:

Controller state	Child application states
`Online`	At least one online on any machine
`Offline`	All offline on all machines
`Faulted`	At least one faulted on any machine, all others offline on all machines
`Standby`	At least one standby on any machine, none online on any machine
`Warning`	At least one online on any machine, others offline on all machines

Table 4: Dependence of scalable controller states on child applications

Note: Although two or more different scalable applications can be online at the same time on the same or on different hosts, each scalable application can still be online only on a single host. For example, when creating an RMS configuration for Oracle RAC, the Oracle daemon processes that must be online on multiple hosts should be represented not by a single RMS application, but by a number of separate, controlled RMS applications—one child application per daemon. The parent scalable controller for Oracle RAC becomes a single point of control, administration, and display for all these child applications.

3.3.3.2 About nodes of which application become the online state

Controlling applications and controlled applications may become the online state on different nodes. However, monitoring and controlling for applications can work normally and no action is needed.

Note

When you restart a node after it stopped abnormally because of a node failure, an application which is controlled from multiple nodes may become the online state.

However, it has no problem operating the system and no action is needed.

3.3.3.3 Request propagation to controlled applications

Priority `Online` requests from the controller are propagated to all controlled applications, each of which will attempt to come `Online` according to the sequence of hosts in their `PriorityList` attribute. `Offline` and `Standby` requests are propagated to all controlled applications on all the hosts.

The attribute `IndependentSwitch`, which must be set to 1 for a scalable controller object, assures that a parent application can be switched from host to host without affecting controlled child applications. However, the `IndependentSwitch` setting is ignored when the parent application is switched via a forced request such as '`hvswitch -f`'; in this case the controller will propagate `Offline` request to each child application as a part of its switchover processing.

When a parent application and child applications are switched over simultaneously by shutting down RMS or the operating system and restarting RMS is completed before the child applications status changed to `Online` on the secondary prior node, the child applications statuses will attempt to come `Online` according to the sequence of nodes in their `PriorityList` attributes. Therefore the child applications statuses will be `Online` again on the previous node that has not switched over.

3.3.3.4 Controller warning state

Scalable controller displays `Warning` state in GUI and `hvdisp` command if one of the following conditions is met.

This is to warn administrators that some scalable applications are not running.

- When at least one application, which is controlled by an `Online` controller, was transited to an `Offline`, `Standby`, or `Faulted` state from an `Online` state
- When at least one application, which is controlled by an `Standby` controller, was transited to an `Offline` or `Faulted` state from a `Standby` state

Note

When RMS has been stopped on all the nodes where some applications (among all applications controlled by an `Online` controller) can run, the controller will remain in the `Online` state because it cannot detect a failure.

3.3.3.5 Application warning state

An application that contains one or more scalable controllers will acquire a posted `Warning` state if at least one of its scalable controllers appears in the posted `Warning` state. It will revert to its respective posted state when all its scalable controllers go out of the posted `Warning` state. As was the case for the controller, the GUI and `hvdisp` will display this application posted `Warning` state to alert the administrator that the scalable parent application is not running in its full capacity.

The posted `Warning` state will be changed to a respective posted state when the controller transitions to offline of faulted, or when all controlled applications transition either to online or standby.

3.3.3.6 Controller state change script

The controller's `StateChangeScript` attribute specifies a script to be executed for a scalable controller whenever a controlled child application transitions into an online, offline, faulted, or standby state. The script is executed on every host where the controlling parent application can run, even if it is done on behalf of a request originated from the controller itself. The state change script will also be executed if a host where a child application is running changes its state to offline or faulted. This script has no impact on state transitions—its abnormal exit code is merely recorded in the `switchlog`.

If more than one state transition event is delivered at the same time, then a state change script will be executed for each one of them. The state change script is scheduled immediately upon receiving an event, without any delay. For multiple events arriving from the same host, it is guaranteed that the order of state change script invocation will follow the order of the received events.

Script execution environment variables

The state change script's environment contains a set of variables that can be used for decision processing at runtime. Their names and purposes are summarized below. For a complete description of their content and format, see the "Global environment variables", the "Script execution environment variables".

RMS provides two complementary variables that are set according to whether the state change script was invoked due to an application state change or a host state change:

- **`HV_APPLICATION_STATE_CHANGE_INFO`**

  Set when a state change script is invoked because a controlled application changed its state. The colon-delimited substrings are:

  - Previous state of the application on its node, as recorded on the local node
  - Current state of the application on its node, as recorded on the local node
  - Name of the node where the application has changed its state
  - Name of the application that has changed its state

  `HV_APPLICATION_STATE_CHANGE_INFO` will be empty if the state change script is invoked because a node changed its state.

- **`HV_HOST_STATE_CHANGE_INFO`**

  Set when a state change script is invoked for a scalable controller because a `SysNode` that can run a controlled child application changes its state to `Offline` or `Faulted`. The colon-delimited substrings are:

  - Previous node state
  - Current node state

- Name of the node
- Reason for the node state change: Shutdown Facility, `hvshut` command, or unknown.

`HV_HOST_STATE_CHANGE_INFO` will be empty if the state change script is invoked because a controlled child application changed its state.

Like other scripts invoked by RMS on behalf of an object, the state change script environment includes the following standard set of script variables:

- **`HV_APPLICATION`**

  Name of `userApplication` object at the top of the current sub-tree that contains the current object.

- **`HV_AUTORECOVER`**

  If set to 1, the script was initiated due to an `AutoRecover` attempt.

- **`HV_FORCED_REQUEST`**

  If set to 1, the script is currently processing a forced request.

`HV_LAST_DET_REPORT`

Last detector report for the current object.

- **`HV_OFFLINE_REASON`**

  Reason for ongoing offline processing: deact request, manual switchover, follow-up processing after a previous resource failure, or stopped application.

- **`HV_NODENAME`**

  Name of current object.

- **`HV_SCRIPT_TYPE`**

  Script type.

- **`NODE_SCRIPTS_TIME_OUT`**

  Timeout value for the current object and script type.

Script execution sequence

The state change script is executed immediately upon an event. As a result, it can run in parallel with other RMS scripts, including state change scripts for other objects or even for the current object. Since several events may be delivered nearly at the same time, the user's script is responsible to work in proper sequence. The writer of the script must assure proper access to shared resources from this and other scripts by using locks or other OS means.

3.3.3.7 Sequenced online/standby/offline and application groups

The controller’s `ApplicationSequence` attribute controls how online, offline, and standby requests are propagated to child applications. The attribute lists all the controller’s child applications that are specified in the controller `Resource` attribute, but arranged in groups that are processed in parallel or sequentially:

A space-separated group of applications is called a request group. All the applications in a request group are processed in parallel.

Request groups separated by colons (:) are processed sequentially. Online or standby requests are processed left-to-right. Offline requests are processed right-to-left.

For example, suppose the `ApplicationSequence` attribute for a controller contains the following specification:

```
A1 A2:B:C1 C2
```

The controller would issue online requests as follow:

1. A1 and A2 (the first request group) would be processed in parallel—neither would wait for the other. However, both A1 and A2 must post their respective online state before the controller proceeds to the next group.
2. B (the second request group) would be processed next. It must post its online state before the controller proceeds to the next group.
3. C1 and C2 (the third request group) would finally be processed in parallel.

Offline requests would be processed in the reverse order; that is, C1 and C2 first, then B, and finally A1 and A2.

The order is only important during a request propagated to controlled applications from the scalable controller. Applications state changes due to any other reason, including manual or automatic switchover, disregard `ApplicationSequence`.

The order of offline processing is also maintained for local `hvshut` requests such as ‘`hvshut -l`’. However, the order is disregarded for clusterwide requests such as ‘`hvshut -a`’: each host will take its applications offline independently.

Like other subapplications, scalable request groups are not processed during ‘hvshut -L’ and ‘hvshut -A’ operations.

Note that the propagation of requests from the scalable controller is also affected by the state of the hosts where the child applications may run. If no hosts are available for the applications from the same request group, then the request is not propagated. Instead, it is delayed until such a host becomes available, or until ScriptTimeOut expires.

3.3.3.8 Auto Startup on a sub-cluster

A controlling application must be able to auto-startup even when some cluster hosts are offline. This is required to allow for some controlled child applications to come online on the partial cluster, in the order defined in their parent controller’s ApplicationSequence attribute.

For example, if initially all cluster hosts are down, and some of them come up while others are in maintenance, controlled applications that are supposed to run only on the up sub-cluster must be brought online following a request from their scalable controller, regardless of the fact that other cluster hosts are currently offline or faulted. It is impossible to use 'hvswitch –f' in this case because a consultant may not be present, so the configuration must come up on its own.

The above is achieved by the attribute PartialCluster of the userApplication object. If set to 1, then the application can negotiate its online request within the currently online hosts, even if some other hosts, including the application's primary host, are offline or faulted. If set to 0, then application can negotiate its online request only when all hosts where it can possibly run are online (current behavior). The default value is 0.

For an application that contains a scalable controller (i.e. for a controlling application), PartialCluster can be set to 1 if the application graph has no cluster-exclusive resources; otherwise, PartialCluster must be set to 0. Each of its controlled applications must have its PartialCluster attribute set to 0, and its AutoStartUp attribute set to 0.

If controlling applications do not contain any objects other than the controller objects, having their PartialCluster attribute set to 1 is safe. Indeed, if two or more controlling applications auto-startup on different sub-clusters, they will not share any exclusive resources. As a part of their auto-startup, they will propagate online requests to their controlled applications that, in turn, may come online if they only require the hosts from the current sub-cluster.

However, if some controlled applications require hosts from several subclusters, then these applications will not come online, which is actually the desired effect. Note that their `PartialCluster` is 0, so the controlled applications that span subclusters refuse online processing.

Because scalable controllers delay propagation of the online request until hosts for the controlled applications from each application group come online, the order imposed by `ApplicationSequence` will be preserved even if two or more hosts simultaneously initiate online requests for the same scalable controller.

3.3.3.9 Switchover on a sub-cluster

When a controlling application has its `PartialCluster` set, it can be switched online, automatically or manually (with or without the '`-f`' forced option) between the hosts of a sub-cluster. Again, this is safe for the controlling application itself because it has no real resources other than controllers. Also, this is safe for the controlled applications because their `PartialCluster` is set to 0—they will not come online if they cross the subcluster boundary.

3.3.3.10 Manual switching of child applications

Attempting to manually take the last online child application offline with the '`hvutil -f`' command would cause the parent controller to go into the faulted state. To prevent the user from creating a faulted scenario, RMS rejects taking the last controlled online application offline with the '`hvutil -f`' command and generates the following message:

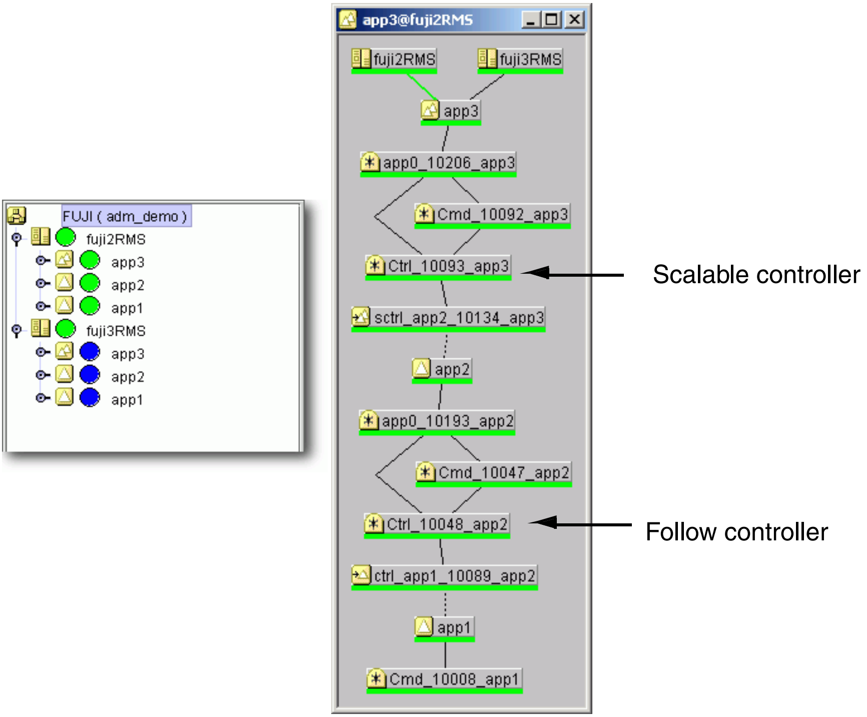
```
ERROR: Application controlled from another online application
- <application>.
```

3.3.3.11 Operation during maintenance mode

To illustrate controller behavior in maintenance mode, consider the following example:

- The configuration consists of applications `app1`, `app2`, and `app3` on nodes `shasta1` and `shasta2`.
- `app2` controls `app1` with a follow mode controller.
- `app3` controls `app2` with a scalable mode controller.

Figure 15 shows the RMS configuration tree and the corresponding graph for this scenario.



Scalable controller

Follow controller

Figure 15: Maintenance mode controller example

Switching applications between nodes

From the perspective of the graph, these may be thought of as “horizontal” switching operations.

If a scalable-mode child application is put into maintenance mode, the parent can still be switched between nodes with `hvswitch`, either manually or automatically (Figure 16). Note that putting `app2` into maintenance mode automatically puts its follow-mode child application, `app1`, into maintenance mode as well.

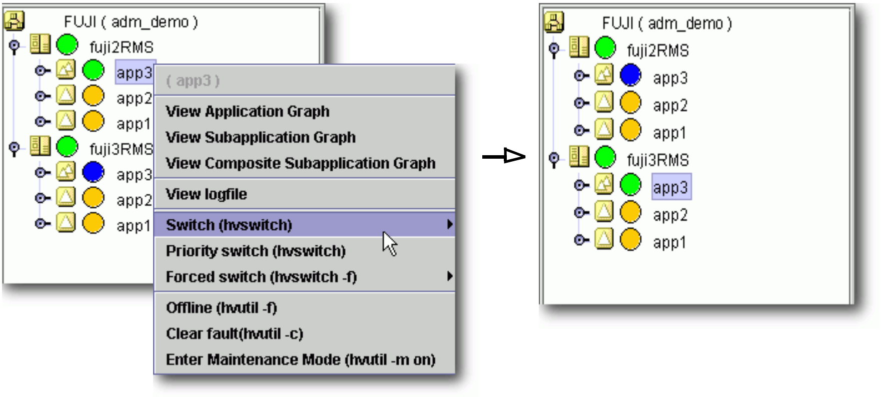


Figure 16: Switching scalable parent with child in maintenance mode

Likewise, if a scalable-mode parent application is put into maintenance mode, the child can still be switched between nodes with `hvswitch` (Figure 17). However, in actual practice, this would only occur via manual commands because the parent issues no processing requests while in maintenance mode. Note that switching `app2` to a different node automatically switches its follow-mode child application, `app1`, as well.

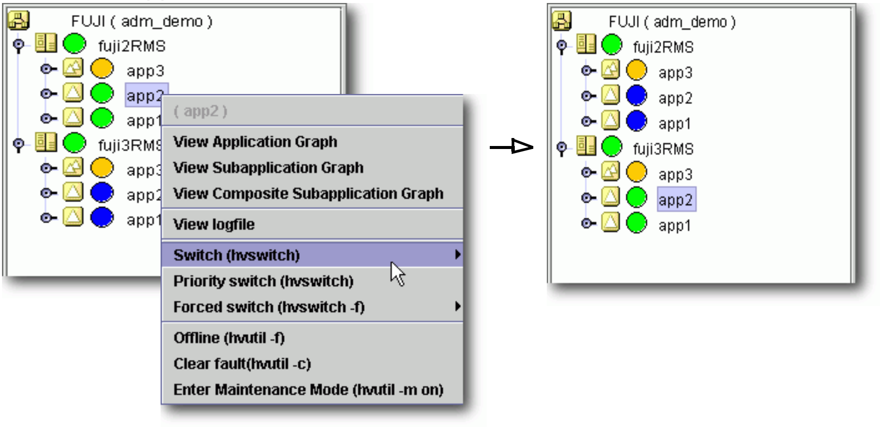


Figure 17: Switching scalable child with parent in maintenance mode

In summary, these “horizontal” `hvswitch` operations proceed normally.

Online, offline, and fault processing restrictions

From the perspective of the graph, these may be thought of as “vertical” switching operations.

Consider what happens if you attempt to take `app3` offline with `hvutil` while `app2` is in maintenance mode (Figure 18).

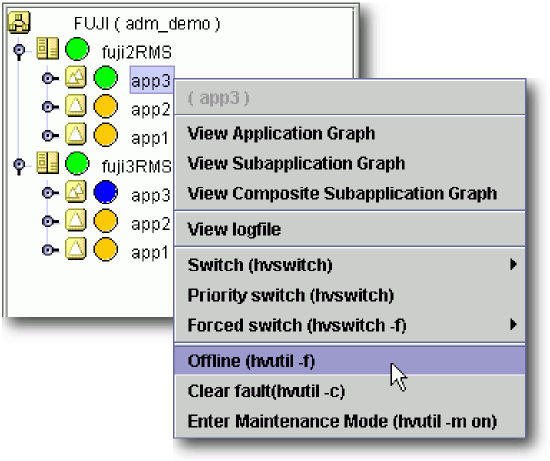


Figure 18: Attempting to take a parent offline with the child in maintenance mode

Unlike the `hvswitch` operations described previously, this ‘`hvutil -f`’ operation requires a response from its child application before it can proceed. Since maintenance mode prevents `app2` from responding to normal processing requests from its parent, the offline request will eventually time out. The same situation occurs when fault processing via ‘`hvutil -c`’ is attempted.

Attempting to take a child offline while the parent is in maintenance mode (Figure 19) also fails, but there is no long delay as in the previous case: RMS immediately generates an error because only the parent can initiate offline processing.

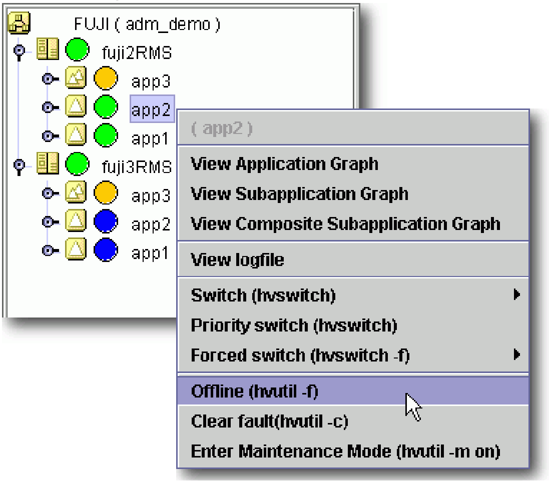


Figure 19: Attempting to take a child offline with the parent in maintenance mode

However, you can issue a fault processing ‘`hvutil -c`’ request to the child because that does not require a response from the parent.

In summary, these “vertical” `hvutil` operations will fail if the application requires a response from a child or parent application that is in maintenance mode.

Recommended approach for scalable controllers

It is highly recommended that maintenance mode requests be issued to the top-level application of a controlled hierarchy. This will help to avoid unexpected behavior:

- Child applications will receive no automatic requests from the parent to switch to other nodes. Also, no automatic online, offline, or fault processing requests will propagate from the parent.
- In case of a resource failure, a switch request from lower-level objects will fail immediately, so RMS can initiate fault processing without waiting for a timeout delay.

4 Using the Wizard Tools interface (hvw)

This chapter describes how to configure high availability for customer applications using the RMS Wizards.

- The "Overview" gives a brief overall description of the configuration process and the RMS Wizards.
- The "General configuration procedure" outlines the four major steps involved in every configuration procedure.
- The "Creating and editing a configuration" describes the wizard interface and how it is used to specify a configuration.
- The "Activating a configuration" describes how to activate a configuration after it has been created or modified.
- The "Configuration elements" provides additional details about basic RMS elements specified in every configuration.

Note

For Solaris, as a means of setting the RMS configuration, the userApplication Configuration Wizard, which is a GUI utilizing Web-Based Admin View, is provided. For this reason, use hvw only when instructed.

For details on the userApplication Configuration Wizard, see "4.4.4 userApplication Configuration Wizard Functions" in "PRIMECLUSTER Installation and Administration Guide (Oracle Solaris)."

All the following procedures assume the Cluster Foundation (CF) software has been properly installed, configured, and started. See "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide" for details.

4.1 Overview

The "Introduction" describes the components necessary for configuring applications for high availability. It is extremely important that you define applications and the resources that are used by them. Resources are entities like disks, file systems, processes, IP addresses, and so forth.

This definition also needs to include the following information:

- How the applications and their resources are related to each other
- What scripts bring resources online and offline
- Which detectors monitor the state of which resources

For example, if a node should fail to be available, the node that is to take its place must have been defined beforehand so that the applications depending on this node are able to continue operating with minimal interruption. Once the necessary information is defined, you can then set up an RMS configuration. A configuration of this magnitude, however, requires a great deal of expert knowledge.

The RMS Wizards are tools that allow you to set up an RMS configuration in a way that is simple, flexible, and quality-tested. Furthermore, these tools conform to a well-documented, standard design. To configure RMS with the wizards, you supply information about the applications using a menu-driven interface. The wizards use this information to set up a complete RMS configuration.

The following sections describe these wizards and the way they are used to configure high availability from a general point of view.

4.1.1 RMS Wizard types

The RMS Wizards are divided into two categories:

- RMS Wizard Tools—This is a general-purpose package that includes the following components:
  - The `hvw` menu-based configuration interface
  - SCALABLE application wizard, which allows configuration of scalable application.
  - STANDBY application wizard, which allows configuration of standby application.
  - The basic set of resource-oriented wizards, which provide scripts and detectors for basic resources such as file systems, volume managers, and IP addresses. They are used by the SCALABLE and STANDBY wizards as well as components in the Wizard Kit.
- RMS Wizard Kit—These application-oriented wizards are designed to cover complete applications and perform their tasks on the basis of the turnkey concept. The ORACLE wizard is this type of wizard.

For information on the availability of the RMS Wizard Kit, refer to the manual of each wizard product such as Wizard for Oracle or Wizard for Networker.

4.1.1.1 Turnkey wizards

Turnkey wizards provide predefined structures of resources to monitor almost every basic operating system object. This relieves the user of the tedious task of linking system resources according to their dependencies.

Many turnkey wizards, SCALABLE turnkey wizard, STANDBY turnkey wizard, ORACLE wizard, and so on are designed to configure a specific type of application. All characters of the turnkey wizards are in uppercase.

4.1.1.2 Resource wizards

Resource wizards (sometimes called sub-application wizards) configure lower-level resources such as file systems or IP addresses. They are invoked by turnkey wizards and are not designed to interact directly with the user. Resource wizards have names that begin with one uppercase letter followed by one or more lowercase letters. The following are some of the more important resource wizards:

- Cmdline—Configures any generic resource type by specifying `StartScript` (to bring the resource online), `StopScript` (to send the resource offline) and `CheckScript` (to check the state of a resource).
- Controller—Configures applications that control other applications.
- Fsystem—Configures local or remote file systems.
- Gds—Configures disk classes administrated by GDS.
- Gls—Configures the resource class of GLS by using RMS environment.
- Ipaddress—Configures the IP addresses that are needed for communication over a LAN interface.

4.2 General configuration procedure

RMS configuration always involves these four steps:

- ► **Stop RMS.**

  Refer to the "Stopping RMS". You can use the Cluster Admin GUI or the command line interface from any node in the cluster.

- ► **Create or edit the configuration.**

  Refer to "Creating and editing a configuration" .

- ► **Activate the configuration.**

  Activation includes generation and distribution. See the "Activating a configuration".

- ► **Start RMS.**

  Refer to the "Starting RMS". You can use the Cluster Admin GUI or the command line interface from any node in the cluster.

4.3 Creating and editing a configuration

You can bring up an existing Wizard Tools configuration that is currently activated on the host systems of a cluster. In this case, you might call up the configuration because it is to be modified using the wizards while RMS is stopped. On the other hand, you might want to use the wizards to set up a new configuration. The commands for starting the wizards are as follows:

- **`hvw`**

  Runs RMS Wizard Tools using the last activated configuration stored in the *<RELIANT_PATH>*`/etc/CONFIG.rms` startup file. If this file does not exist or activation is being done for the first time, RMS creates the default configuration, `config`.

- **`hvw -n`** *configname*

  Edits an existing configuration or creates a new configuration using the specified name. The configuration will be stored in the *<RELIANT_PATH>*`/build/`*configname*`.us` startup file.

The sample configuration used for demonstration purposes in this chapter shows how to set up a new configuration called `myconfig` using the STANDBY turnkey wizard. This example would be called up as follows:

```
hvw -n myconfig
```

The `hvw` command is documented in the online manual pages.

4.3.1 Using the wizard menus

The `hvw` command produces character-driven menus that guide you in a way designed to be self-explanatory. The following are some of the most frequently used menu operations and items:

- Selecting items—This is normally done by typing the number of the item followed by the [Enter] or [Return] key. Within the menu, a prompting line indicates the kind of input that is required. A >> prompt indicates that a string of text should be entered.
- Responding to messages—Within the menus, several kinds of messages are displayed. One type of message might be to inform the user about the activities that the wizard has performed; for example, a consistency check that ended in a positive result. Other messages may prompt the user to continue the configuration procedure with a certain activity; for example, choosing an application name.
- *HELP*—This item provides user assistance and is available at the top of every wizard menu.
- *QUIT*—This quits the wizard menu system.
- *RETURN*—This moves one level upward in the menu system; that is, from a subordinate menu to the menu it was called from.
- *SAVE+EXIT* and *NOSAVE+EXIT*—These save or discard your input and then exit. *SAVE+EXIT* will be disabled in read-only mode, and it may be disabled if the configuration is inconsistent at that point.
- *NEXT* and *PREVIOUS*—If all items cannot be listed in a single screen due to many items to be selected, some are displayed in the next screen. Press *NEXT* to go on to the next screen, and press *PREVIOUS* to go back to the previous screen.

4.3.2 Main configuration menu

The *Main configuration menu* appears immediately after a configuration has been called up. This top-level menu shows the state of the RMS cluster by indicating either one the following:

- RMS is inactive
- The list of nodes where RMS is up and running

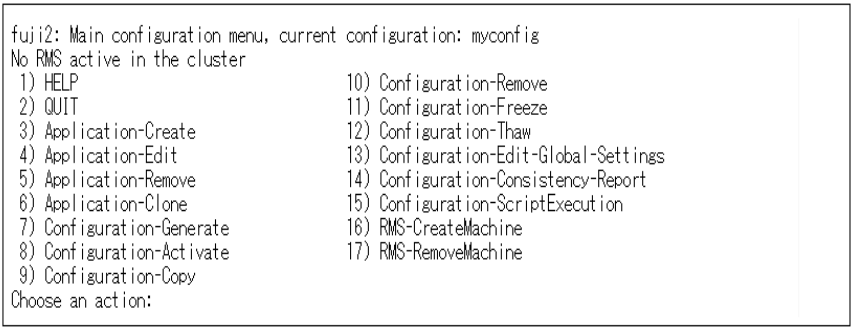
The *Main configuration menu* changes dynamically at run time depending on whether RMS is running in the cluster and whether the configuration being edited is the current configuration.

If RMS is running anywhere in the cluster, actions that could modify a running configuration are not available. Additionally, the menu items that are available are modified such that no changes can be made to the running configuration.

When RMS is running but the configuration being edited is not the same as the currently active one, the main menu is not restricted except that the *Configuration-Activate* menu option is not available.

4.3.2.1 Main configuration menu when RMS is not active

If RMS is not running anywhere, then the entire top level menu is presented without restrictions. Figure 20 shows the *Main configuration menu* window when RMS is inactive.



```
fuji2: Main configuration menu, current configuration: myconfig
No RMS active in the cluster
 1) HELP                                10) Configuration-Remove
 2) QUIT                                11) Configuration-Freeze
 3) Application-Create                  12) Configuration-Thaw
 4) Application-Edit                    13) Configuration-Edit-Global-Settings
 5) Application-Remove                  14) Configuration-Consistency-Report
 6) Application-Clone                   15) Configuration-ScriptExecution
 7) Configuration-Generate              16) RMS-CreateMachine
 8) Configuration-Activate              17) RMS-RemoveMachine
 9) Configuration-Copy
Choose an action:
```

Figure 20: Main configuration menu when RMS is not active

Menu items

The *Main configuration menu* can perform the following activities when RMS is not running anywhere in the cluster:

- *Application-Create*—Specifies which application to configure for high availability. In addition, this operation specifies all the relevant settings for the application so that it can run in a high-availability configuration monitored by RMS. Among the most important of these settings is the name of the application and the list of nodes on which the application may run.

The user application should be configured to run on multiple nodes for a high-availability configuration.

The wizard assists you by supplying menus with basic and non-basic attributes, assigns values to the attributes, and prompts you if an attribute is mandatory.

By choosing the appropriate turnkey wizard for an application, the wizard will then provide predefined elements, like scripts and detectors, for the application in question. These elements have been developed especially for the respective type of application.

The wizard will also carry out consistency checks at certain stages of the configuration procedure in order to prevent inconsistent applications from running in a high-availability configuration.

- *Application-Edit*—Modifies an existing application.

  An existing application can be modified using this menu item. The following modes are available for editing an application:

  - Turnkey mode (highly recommended)—Turnkey mode is the default mode. This mode is highly recommended because it simplifies complicated tasks like creating linkages between application and sub-applications.
  - Non-turnkey mode—Do not use this mode for creating and editing a normal RMS configuration. Use it only when you are requested from field engineers.

- *Application-Remove*—Removes an existing application from the high-availability configuration.

- *Application-Clone*—Clones an application. This feature is provided for users who want to create a new application that differs only slightly from an existing one. To do this, clone an application and modify only the parts that are necessary to create a new one.

  Note

  Application-Clone is not available in this version.

- *Configuration-Generate*—Performs the following:

  - Runs consistency checks on the configuration

  - Creates the RMS graph of the configuration and stores it in the *configname*`.us` file. The graph is a hierarchical description of objects that represent the nodes, applications, and resources used in the configuration.

  During the *Configuration-Generate* phase, the wizard indicates the progress with a series of dots on the screen. Each dot represents an application or resource that has been successfully generated.

  Normally, you would use *Configuration-Activate* (described below) to generate and distribute the configuration in one step. *Configuration-Generate* provides a way to generate and check a configuration without distributing it to the other nodes in the cluster. This may be useful for testing or debugging (see also the description for *Configuration-ScriptExecution* later in this list).

  > i *Configuration-Generate* is always available, whether RMS is running or not.

- *Configuration-Activate*—Generates and distributes a configuration.

  Selecting this item performs both the generation and distribution phases in one step. The generation phase is described above.

  The distribution phase prepares the cluster for RMS, ensuring that all the required data is put into place. The wizard copies the configuration data to every reachable node specified in the configuration and installs all necessary files.

  > i
  >
  > - *Configuration-Activate* is not available if RMS is already running on one or more nodes.
  > - Do not execute the *Configuration-Activate* menu simultaneously on multiple nodes which constitute the cluster.

- *Configuration-Copy*—Produces a copy of an existing configuration. This is often used to make a backup before an existing, tested configuration is enhanced.

- *Configuration-Remove*—Removes (deletes) any existing configuration.

- *Configuration-Freeze*—Prevents further changes to a configuration. This marks the configuration as read-only so it can be viewed, but not modified.

Configuration-Freeze is password protected: you will be prompted to create a password before the configuration is locked.

Note

Configuration-Freeze is not available in this version.

- *Configuration-Thaw*—Releases the configuration from the frozen (read-only) state so it can be modified.

Configuration-Thaw is password protected: you must enter the correct password before the configuration is unlocked.

Note

Configuration-Thaw is not available in this version.

- *Configuration-Edit-Global-Settings*—Modifies settings that affect the entire configuration. This includes settings for the detectors and the operation mode of the `hvw` command. This item is also used to specify the alternate interconnects (AlternateIps) for the cluster.
- *Configuration-Consistency-Report*—Provides a consistency check that verifies whether an application is running within a high-availability configuration and has actually been created using the configuration data provided by the respective wizard.

  Note

  Configuration-Consistency-Report is not available in this version.

  The wizard compares the currently activated wizard checksum against the wizard database checksum. One checksum is called the *Live-Info*, the other is called the *BuildInfo*. If both checksums match for an application, it is certified that its running version conforms to what was configured by the wizard.
- *Configuration-ScriptExecution*—Allows administrators to run any script independent of RMS.

  By selecting the resources configured for the application, the user can execute the scripts that are to bring the resources online or offline. To see the online scripts being executed, you can go through the resource list, which is displayed for this purpose, in ascending order. The return code indicates the proper functioning of the respective script.

  Note

Configuration-ScriptExecution is not available in this version.

- *RMS-CreateMachine*—Defines the list of machines which constitute the cluster. During the activation phase, the RMS configuration will be distributed to all the nodes in this list.

  Applications managed by RMS must each be configured to run on one or more machines in this pool. Therefore, complete this step before creating any application.

- *RMS-RemoveMachine*—Removes machines from the list of cluster nodes.

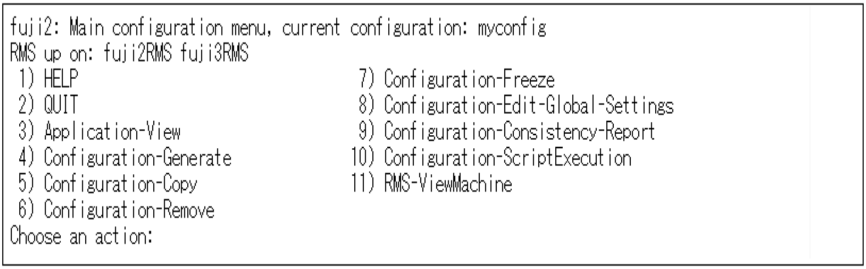
4.3.2.2 Main configuration menu when RMS is running

Wizard Tools menus change dynamically according to whether or not RMS is running in the following locations:

- anywhere in the cluster
- on the local node

If RMS is running on any of the cluster machines, any operation which could potentially modify the currently active configuration is not allowed.

In particular, when RMS is running on the local node, the *Main configuration menu* changes as shown in Figure 21.



```
fuji2: Main configuration menu, current configuration: myconfig
RMS up on: fuji2RMS fuji3RMS
 1) HELP                              7) Configuration-Freeze
 2) QUIT                              8) Configuration-Edit-Global-Settings
 3) Application-View                  9) Configuration-Consistency-Report
 4) Configuration-Generate           10) Configuration-ScriptExecution
 5) Configuration-Copy               11) RMS-ViewMachine
 6) Configuration-Remove
Choose an action:
```

Figure 21: Main configuration menu when RMS is running

When RMS is running, the following entries either appear or change their behavior:

- *Application-View*—Views an existing application in read-only mode.
- *Configuration-Generate*—Same functionality as when RMS is not running.

- *Configuration-Copy*—Produces a copy of an existing configuration. This is often used to make a backup before an existing, tested configuration is enhanced.

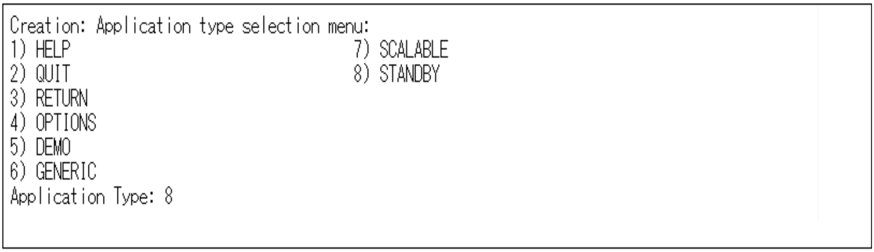
i *Configuration-Copy* cannot overwrite the configuration that is currently running.

- *Configuration-Remove*—Removes (deletes) any existing configuration except the one that is currently running.
- *RMS-ViewMachine*—Displays the list of nodes on which RMS is currently running.

4.3.3 Secondary menus

Each of the main menu items has a number of secondary menus. The secondary menus themselves can have sub-menus.

The *Creation: Application type selection menu* (Figure 22) is an example of a secondary menu. You see this menu after selecting *Application-Create* from the main menu.



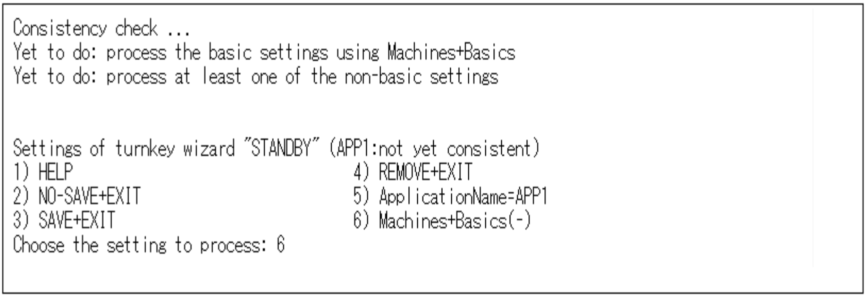
```
Creation: Application type selection menu:
1) HELP                                7) SCALABLE
2) QUIT                                8) STANDBY
3) RETURN
4) OPTIONS
5) DEMO
6) GENERIC
Application Type: 8
```

Figure 22: Application type selection

4.3.4 Basic and non-basic settings

Basic and non-basic settings are designed to guide you safely through the configuration process, ensuring that all mandatory settings are configured.

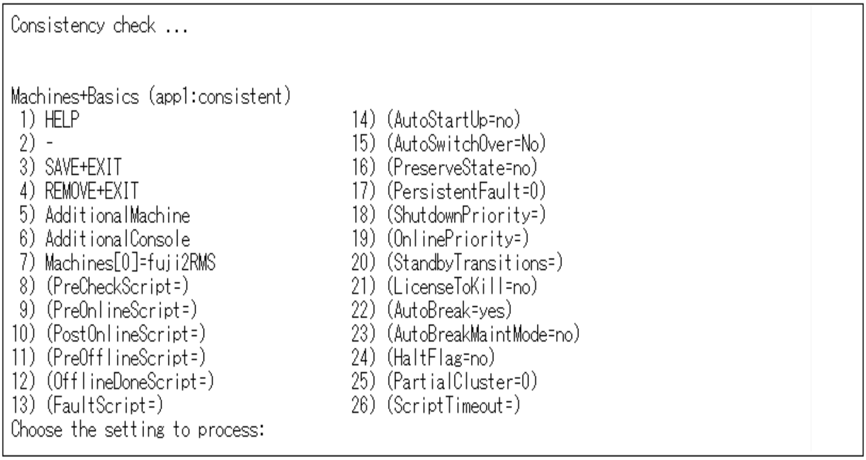
Among the basic settings are the application name and the names of the nodes where it can run. For example, at the application type selection menu shown in the previous section, selecting *8) STANDBY* produces the menu in Figure 23.



```
Consistency check ...
Yet to do: process the basic settings using Machines+Basics
Yet to do: process at least one of the non-basic settings


Settings of turnkey wizard "STANDBY" (APP1:not yet consistent)
1) HELP                               4) REMOVE+EXIT
2) NO-SAVE+EXIT                       5) ApplicationName=APP1
3) SAVE+EXIT                          6) Machines+Basics(-)
Choose the setting to process: 6
```

Figure 23: Menu leading to basic settings

If you select *6) Machines+Basics*, you can configure the basic settings using the menu in Figure 24.

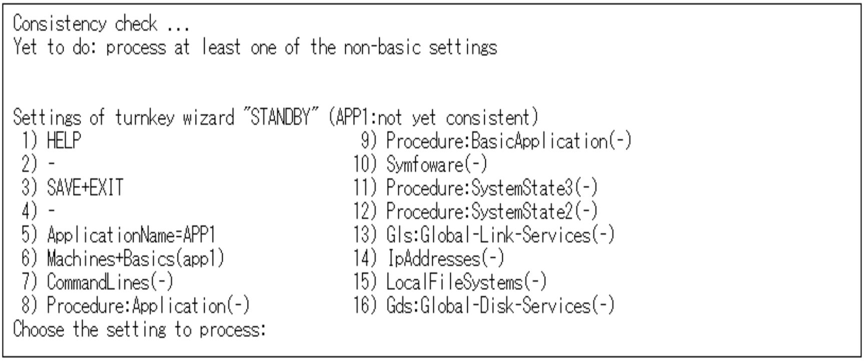


```
Consistency check ...


Machines+Basics (app1:consistent)
 1) HELP                              14) (AutoStartUp=no)
 2) -                                 15) (AutoSwitchOver=No)
 3) SAVE+EXIT                         16) (PreserveState=no)
 4) REMOVE+EXIT                       17) (PersistentFault=0)
 5) AdditionalMachine                 18) (ShutdownPriority=)
 6) AdditionalConsole                 19) (OnlinePriority=)
 7) Machines[0]=fuji2RMS              20) (StandbyTransitions=)
 8) (PreCheckScript=)                 21) (LicenseToKill=no)
 9) (PreOnlineScript=)                22) (AutoBreak=yes)
10) (PostOnlineScript=)               23) (AutoBreakMaintMode=no)
11) (PreOfflineScript=)               24) (HaltFlag=no)
12) (OfflineDoneScript=)              25) (PartialCluster=0)
13) (FaultScript=)                    26) (ScriptTimeout=)
Choose the setting to process:
```

Figure 24: Menu to configure basic settings

The menu displays the application’s current attribute settings, some of which may be set automatically by the wizards. Attributes enclosed in parentheses are optional.

After you complete the configuration of the basic settings, the non-basic settings menu appears (Figure 24). Non-basic settings include specifications for resources such as file systems, IP addresses, disks, and so forth.



```
Consistency check ...
Yet to do: process at least one of the non-basic settings


Settings of turnkey wizard "STANDBY" (APP1:not yet consistent)
 1) HELP                           9) Procedure:BasicApplication(-)
 2) -                             10) Symfoware(-)
 3) SAVE+EXIT                     11) Procedure:SystemState3(-)
 4) -                             12) Procedure:SystemState2(-)
 5) ApplicationName=APP1          13) Gls:Global-Link-Services(-)
 6) Machines+Basics(app1)         14) IpAddresses(-)
 7) CommandLines(-)               15) LocalFileSystems(-)
 8) Procedure:Application(-)      16) Gds:Global-Disk-Services(-)
Choose the setting to process:
```

Figure 25: Menu to configure non-basic settings

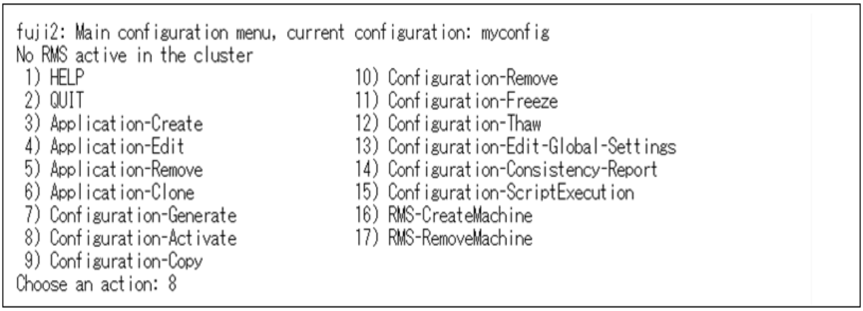
The list of available subapplications displayed in the menu depends on the packages installed on the local system. Some of the subapplications shown in this example may not be available in your market or for your platform.

4.4 Activating a configuration

As described in "General configuration procedure", activating a configuration is the third of the four fundamental steps required to set up a high-availability configuration. The activation phase comprises a number of tasks, among which are generation and distribution of a configuration.

You must stop RMS on all the nodes in the cluster before you activate a configuration.

The starting point for the activation phase is the *Main configuration menu* (see Figure 26).



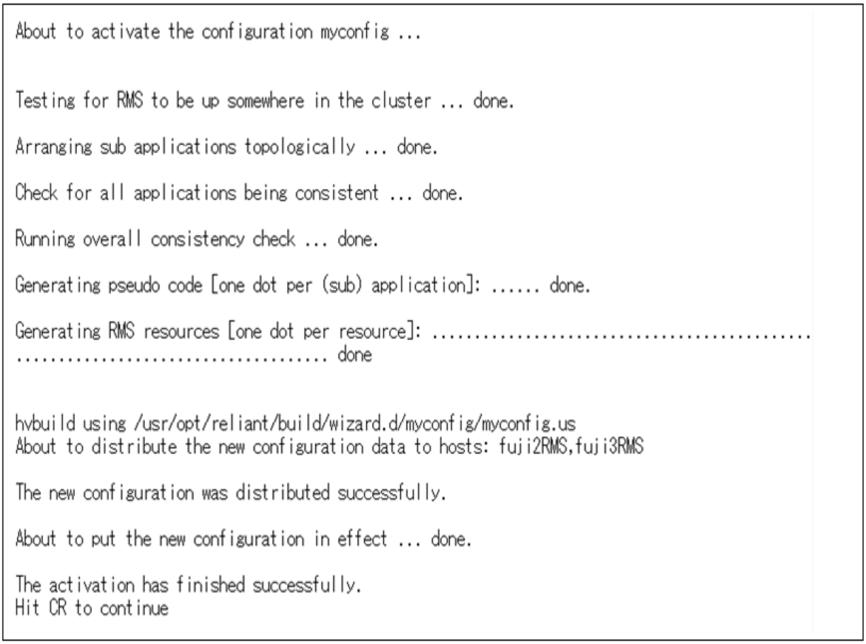
```
fuji2: Main configuration menu, current configuration: myconfig
No RMS active in the cluster
 1) HELP                               10) Configuration-Remove
 2) QUIT                               11) Configuration-Freeze
 3) Application-Create                 12) Configuration-Thaw
 4) Application-Edit                   13) Configuration-Edit-Global-Settings
 5) Application-Remove                 14) Configuration-Consistency-Report
 6) Application-Clone                  15) Configuration-ScriptExecution
 7) Configuration-Generate             16) RMS-CreateMachine
 8) Configuration-Activate             17) RMS-RemoveMachine
 9) Configuration-Copy
Choose an action: 8
```

Figure 26: Main configuration menu

► Select the *Configuration-Activate* item by entering the number 8.

The activation is performed by the wizard. No further input is required at this stage.

During the activation phase, the wizard executes a series of tasks and displays the status on the screen. The completion of a task is indicated by the word *done* or a similar expression (see Figure 27).



```
About to activate the configuration myconfig ...


Testing for RMS to be up somewhere in the cluster ... done.

Arranging sub applications topologically ... done.

Check for all applications being consistent ... done.

Running overall consistency check ... done.

Generating pseudo code [one dot per (sub) application]: ...... done.

Generating RMS resources [one dot per resource]: ...........................................
.................................... done


hvbuild using /usr/opt/reliant/build/wizard.d/myconfig/myconfig.us
About to distribute the new configuration data to hosts: fuji2RMS,fuji3RMS

The new configuration was distributed successfully.

About to put the new configuration in effect ... done.

The activation has finished successfully.
Hit CR to continue
```

Figure 27: Activating a configuration

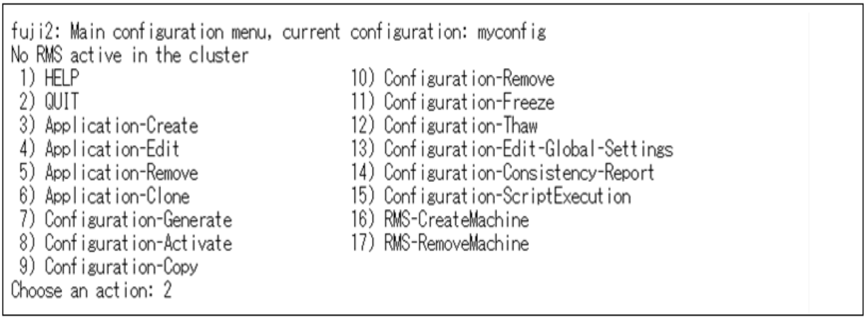
Among the tasks carried out by *Configuration-Activate* are generation and distribution of the configuration. The wizard performs a consistency check of the graph created in the generation of the configuration before distributing the configuration to all the nodes specified in the configuration.

The test to see whether RMS is up on one of the nodes in the cluster is required since activation cannot be performed if RMS is running. In this case, RMS would need to be shut down first.

i The *Configuration-Activate* process removes persistent status information on all affected nodes.

After the configuration has been activated successfully, you can return to the *Main configuration menu*. From there, you can quit the configuration procedure.

► Press Enter to return to the *Main configuration menu* (see Figure 28).



```
fuji2: Main configuration menu, current configuration: myconfig
No RMS active in the cluster
 1) HELP                                10) Configuration-Remove
 2) QUIT                                11) Configuration-Freeze
 3) Application-Create                  12) Configuration-Thaw
 4) Application-Edit                    13) Configuration-Edit-Global-Settings
 5) Application-Remove                  14) Configuration-Consistency-Report
 6) Application-Clone                   15) Configuration-ScriptExecution
 7) Configuration-Generate              16) RMS-CreateMachine
 8) Configuration-Activate              17) RMS-RemoveMachine
 9) Configuration-Copy
Choose an action: 2
```

Figure 28: Quitting the Main configuration menu

► Select *QUIT* by entering the number 2.

This ends the activation phase of the configuration process. Usually, the next step is to start RMS to monitor the newly-configured application.

► Start RMS with the GUI or with the following command:

```
hvcm -a
```

4.5 Configuration elements

This section discusses some basic elements that are part of a high-availability configuration. Most of them have been mentioned in previous sections. Additional details are provided here to assist you in understanding how they are used by the wizards.

> Users do not have to deal with any of the items listed in this section directly. RMS Wizards manage all the basic elements for a high availability configuration. This section is provided only to help users better understand the configuration elements.

4.5.1 Scripts

Scripts are used in a high-availability configuration to perform several kinds of actions. Among the most important types of actions are the following:

- Bringing a resource to an `Online` state
- Bringing a resource to an `Offline` state

As an example of a script sending a resource `Offline`, you might think of a file system that has to be unmounted on a node where a fault occurs. An offline script would use the `umount` command to unmount the file system. Another script might use the `mount` command to mount it on a different node.

Besides such online and offline scripts, there are also pre-online and pre-offline scripts for preparing transition into the respective states, as well as a number of other scripts.

> The `hvexec` command executes scripts for a high-availability configuration monitored by RMS. For more details on the command `hvexec` please refer to the `primer.htm` document.

4.5.2 Detectors

Detectors are processes that have the task of monitoring resources. If there is a change in the state of a resource (for example, of a disk group) the detector in charge notifies the RMS base monitor. The base monitor may then decide to have a script executed as a reaction to this changed state.

4.5.3 RMS objects

A high-availability configuration can be seen as a set or group of objects with interdependencies. Any application or resource that is part of the configuration is then represented by one of the objects. The interdependences of objects can be displayed as a graph called the RMS graph.

These are the most important object types used in RMS configurations:

- `userApplication`—Represents an application to be configured for high-availability.
- `SysNode`—Represents a machine that is running as a node in a cluster.
- `gResource`—Represents a generic resource that is to be defined according to the needs of a customer application.
- `Controller`—Provides a dependency linkage so that a child application can act as a resource of the parent application.

In a typical configuration, one detector can be associated with all objects of the same type.

5 Example of configuration change

This chapter provides an example procedure of configuration change to pre-built cluster applications using the RMS Wizard with Solaris version PRIMECLUSTER. The following below provides the example of configuration change.

- "Setting scripts in cluster application"
- "Changing timeout period of controller"

When editing the RMS configuration, make sure to stop RMS. Use the Cluster Admin GUI (See "Stopping RMS") or enter the following command from any machine in the cluster:

```
# hvshut -a
```

Note

When taking this procedure on Solaris, note the following things:

- Before taking this procedure, complete all the settings of the cluster application first on the userApplication Configuration Wizard.
- Use the `wgcnfclient` command to check the RMS Configuration name specified by `-n` option when executing the `hvw` command. For details on how to use the `wgcnfclient` command, see "6.7.6 Changing the RMS Configuration Name" in "PRIMECLUSTER Installation and Administration Guide (Oracle Solaris)."
- On Solaris, make sure to execute the `hvw` command with `-xj` option.

5.1 Setting scripts in cluster application

See the procedure below to set scripts in the cluster application. The settable scripts are as follows.

- `PreCheckScript`
- `PreOnlineScript`
- `PostOnlineScript`

- `PreOfflineScript`
- `PostOfflineScript`
- `OfflineDoneScript`
- `FaultScript`

Note

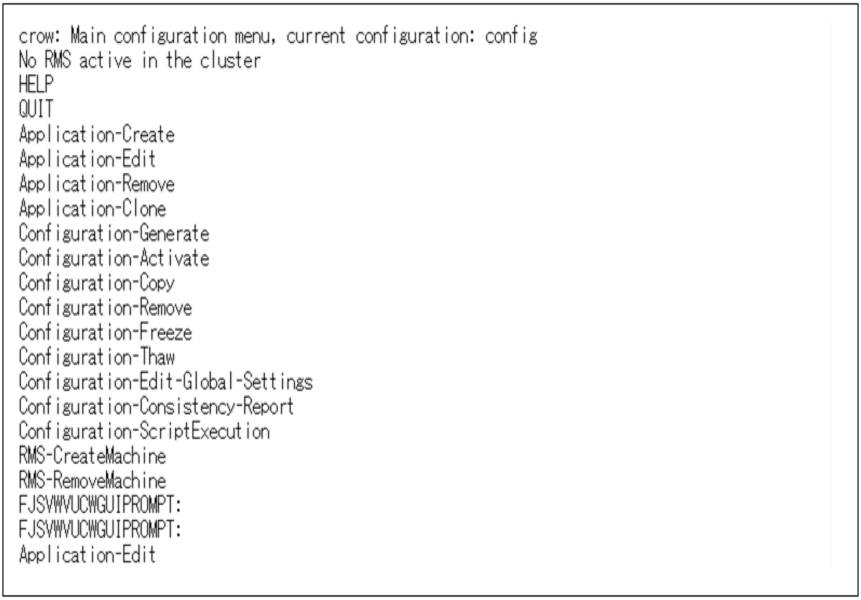
When adding/deleting a resource or changing the setting of a resource in the cluster application, delete the `userApplication` once as a setting procedure. In this case, follow this procedure to set the scripts again.

► Enter the following command to display the wizard menu for configuring RMS.

```
# hvw -xj -n configname
```

► RMS Wizard is started and the Main configuration menu is displayed.

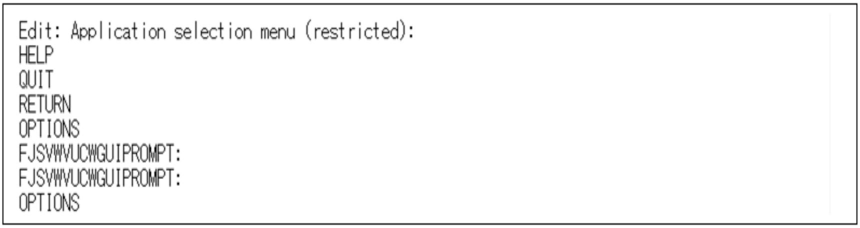
Enter "Application-Edit" and then select *Application-Edit*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
Application-Edit
```

Figure 29: Main configuration menu

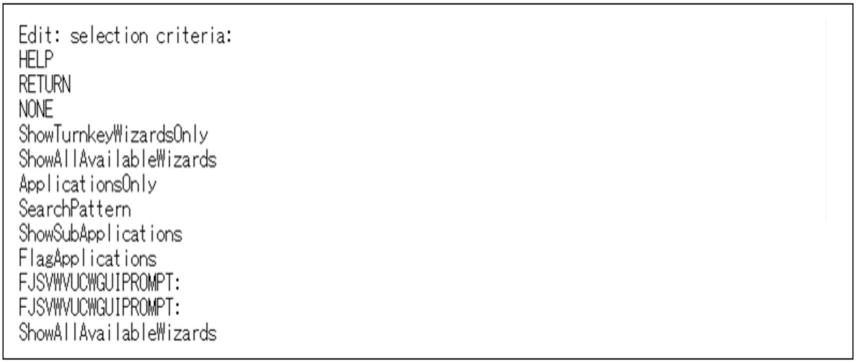
► Enter "OPTIONS" and then select *OPTIONS*.



```
Edit: Application selection menu (restricted):
HELP
QUIT
RETURN
OPTIONS
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
OPTIONS
```

Figure 30: Application selection menu

► Enter "ShowAllAvailableWizards" and then select *ShowAllAvailableWizards*.

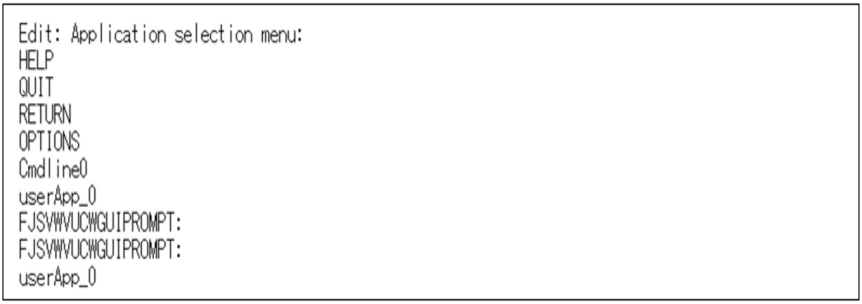


```
Edit: selection criteria:
HELP
RETURN
NONE
ShowTurnkeyWizardsOnly
ShowAllAvailableWizards
ApplicationsOnly
SearchPattern
ShowSubApplications
FlagApplications
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
ShowAllAvailableWizards
```

Figure 31: Option menu of the application setting

► In the screen below, enter the application name that sets the script, and enter the return key.

In the example below, "userApp_0" is entered to set the `PreCheckScript` of userApp_0.

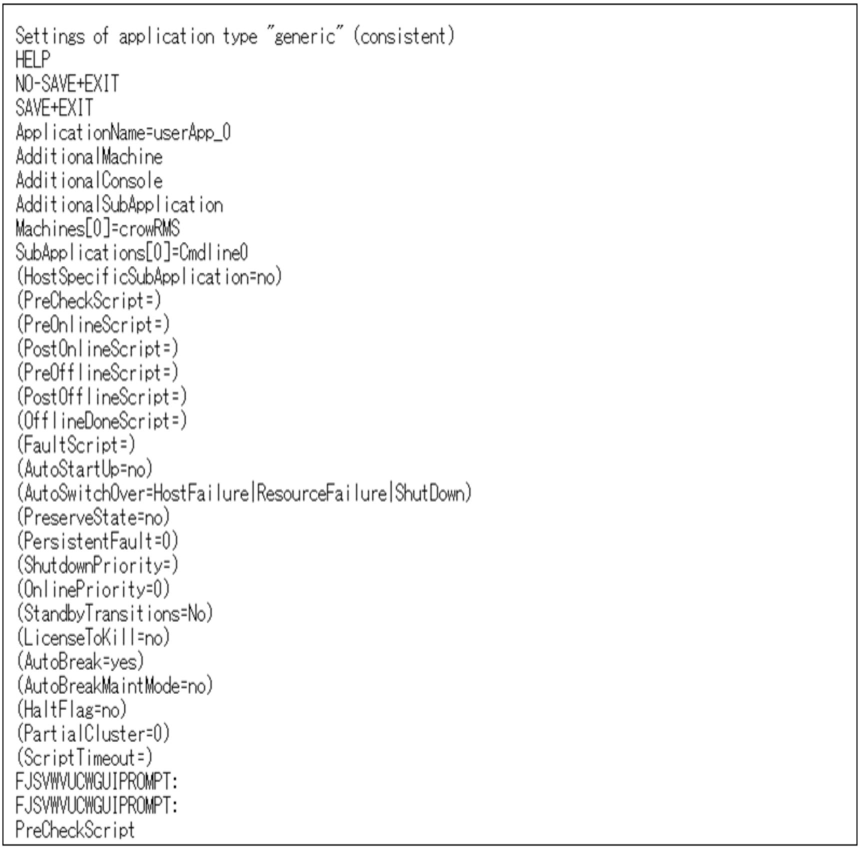


```
Edit: Application selection menu:
HELP
QUIT
RETURN
OPTIONS
Cmdline0
userApp_0
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
userApp_0
```

Figure 32: Application selection menu

Enter the script name to be set, and press the return key.

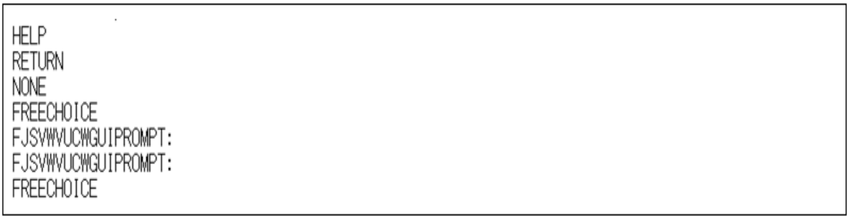
In the example below, "PreCheckScript" is entered to set the PreCheckScript.



```
Settings of application type "generic" (consistent)
HELP
NO-SAVE+EXIT
SAVE+EXIT
ApplicationName=userApp_0
AdditionalMachine
AdditionalConsole
AdditionalSubApplication
Machines[0]=crowRMS
SubApplications[0]=Cmdline0
(HostSpecificSubApplication=no)
(PreCheckScript=)
(PreOnlineScript=)
(PostOnlineScript=)
(PreOfflineScript=)
(PostOfflineScript=)
(OfflineDoneScript=)
(FaultScript=)
(AutoStartUp=no)
(AutoSwitchOver=HostFailure|ResourceFailure|ShutDown)
(PreserveState=no)
(PersistentFault=0)
(ShutdownPriority=)
(OnlinePriority=0)
(StandbyTransitions=No)
(LicenseToKill=no)
(AutoBreak=yes)
(AutoBreakMaintMode=no)
(HaltFlag=no)
(PartialCluster=0)
(ScriptTimeout=)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
PreCheckScript
```

Figure 33: Application setting menu

- ► Enter "FREECHOICE" and then select [FREECHOICE].

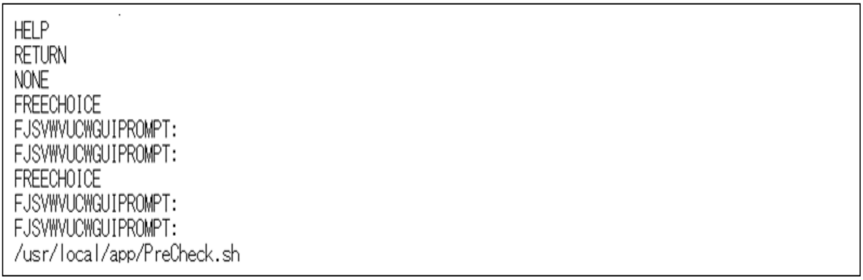


```
HELP
RETURN
NONE
FREECHOICE
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
FREECHOICE
```

Figure 34: Selection menu of the scripts

- ► Enter the file path of the script, and press the return key.

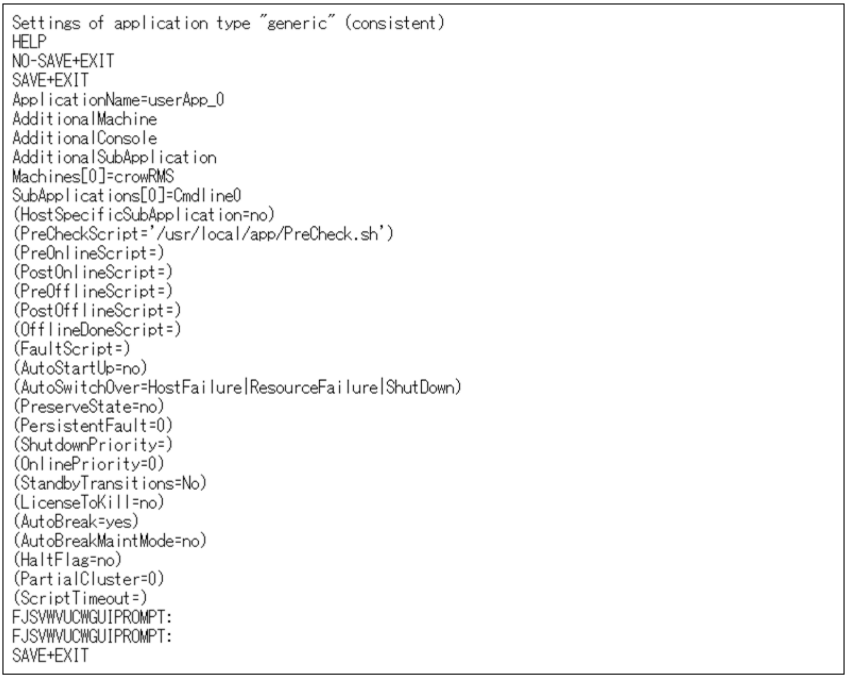
In the example below, /usr/local/app/PreCheck.sh is specified for the `PreCheckScript`.



```
HELP
RETURN
NONE
FREECHOICE
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
FREECHOICE
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
/usr/local/app/PreCheck.sh
```

Figure 35: Entering the file path of the script

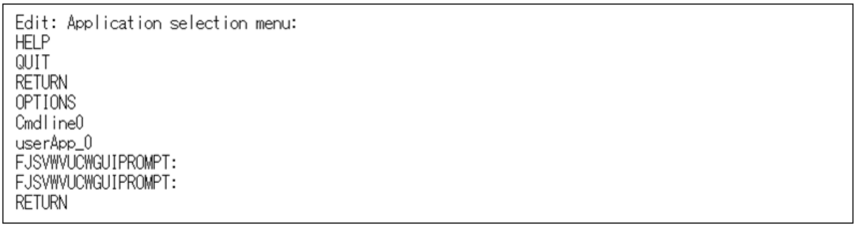
► Enter "SAVE+EXIT" and then select [SAVE+EXIT].



```
Settings of application type "generic" (consistent)
HELP
NO-SAVE+EXIT
SAVE+EXIT
ApplicationName=userApp_0
AdditionalMachine
AdditionalConsole
AdditionalSubApplication
Machines[0]=crowRMS
SubApplications[0]=Cmdline0
(HostSpecificSubApplication=no)
(PreCheckScript='/usr/local/app/PreCheck.sh')
(PreOnlineScript=)
(PostOnlineScript=)
(PreOfflineScript=)
(PostOfflineScript=)
(OfflineDoneScript=)
(FaultScript=)
(AutoStartUp=no)
(AutoSwitchOver=HostFailure|ResourceFailure|ShutDown)
(PreserveState=no)
(PersistentFault=0)
(ShutdownPriority=)
(OnlinePriority=0)
(StandbyTransitions=No)
(LicenseToKill=no)
(AutoBreak=yes)
(AutoBreakMaintMode=no)
(HaltFlag=no)
(PartialCluster=0)
(ScriptTimeout=)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
SAVE+EXIT
```

Figure 36: Application setting menu

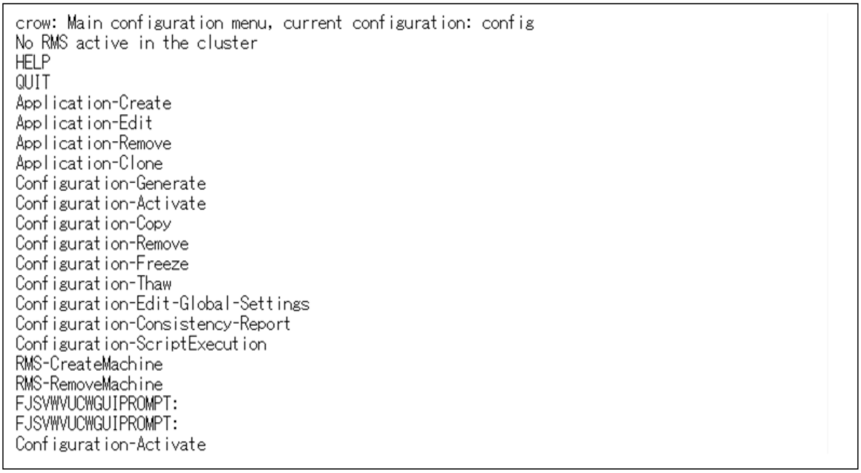
► Enter "RETURN" and then select *RETURN*.



```
Edit: Application selection menu:
HELP
QUIT
RETURN
OPTIONS
Cmdline0
userApp_0
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
RETURN
```

Figure 37: Application selection menu

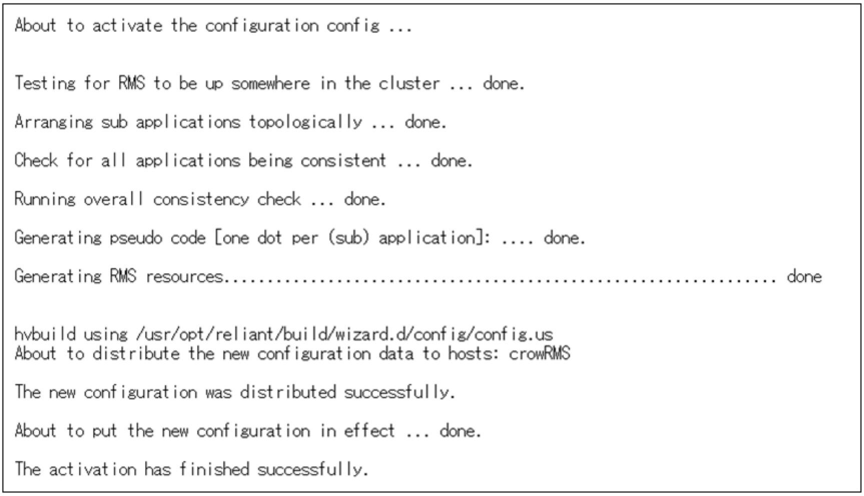
► Enter "Configuration-Activate" and then select *Configuration-Activate*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
Configuration-Activate
```

Figure 38: Main configuration menu

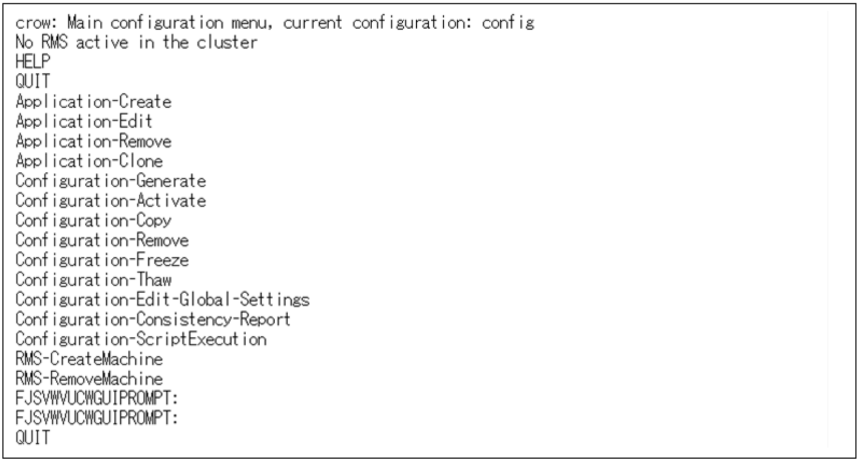
► RMS configuration is generated and distributed.



```
About to activate the configuration config ...


Testing for RMS to be up somewhere in the cluster ... done.

Arranging sub applications topologically ... done.

Check for all applications being consistent ... done.

Running overall consistency check ... done.

Generating pseudo code [one dot per (sub) application]: .... done.

Generating RMS resources................................................................ done


hvbuild using /usr/opt/reliant/build/wizard.d/config/config.us
About to distribute the new configuration data to hosts: crowRMS

The new configuration was distributed successfully.

About to put the new configuration in effect ... done.

The activation has finished successfully.
```

Figure 39: Generation and distribution of the RMS configuration file

- ► Enter "QUIT" and then select *QUIT*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
QUIT
```

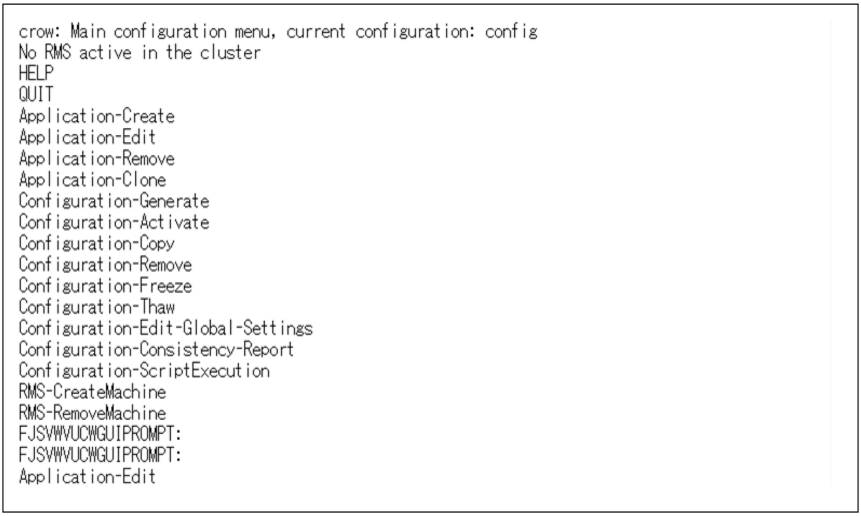
Figure 40: Quitting main configuration menu

5.2 Changing timeout period of controller

- ► Enter the following command to display the wizard menu for configuring RMS.

```
# hvw -xj -n configname
```

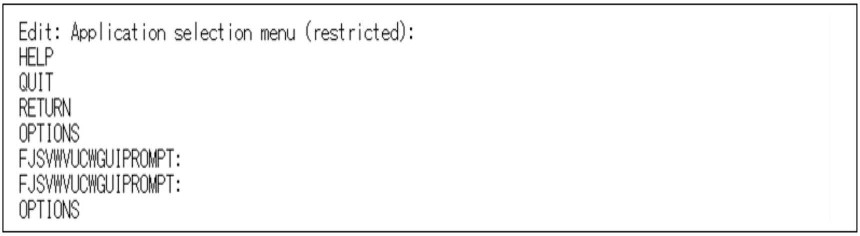
► Enter "Application-Edit" and the select *Application-Edit*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
Application-Edit
```

Figure 41: Main configuration menu

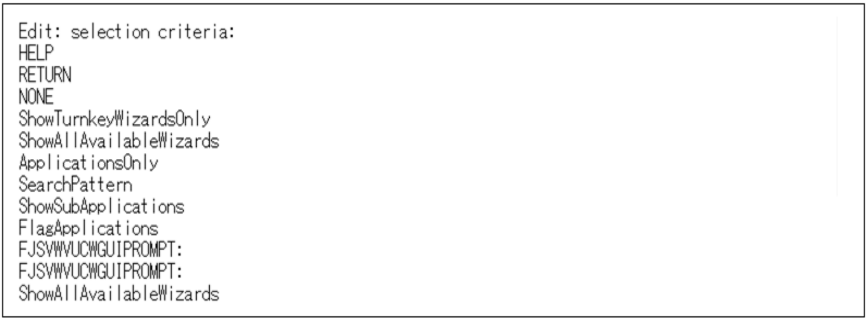
► Enter "OPTIONS" and then select *OPTIONS*.



```
Edit: Application selection menu (restricted):
HELP
QUIT
RETURN
OPTIONS
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
OPTIONS
```

Figure 42: Application selection menu

► Enter "ShowAllAvailableWizards" and then select *ShowAllAvailableWizards*.

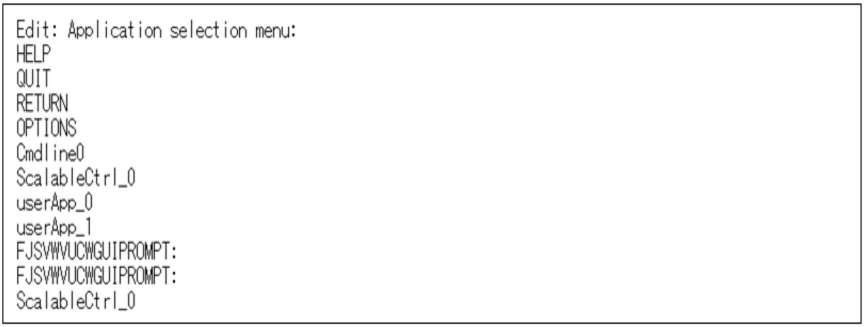


```
Edit: selection criteria:
HELP
RETURN
NONE
ShowTurnkeyWizardsOnly
ShowAllAvailableWizards
ApplicationsOnly
SearchPattern
ShowSubApplications
FlagApplications
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
ShowAllAvailableWizards
```

Figure 43: Option menu of application setting

- ► In the screen below, enter the resource name fo the *Controller* resource that you want to change the timeout period and then press the return key.

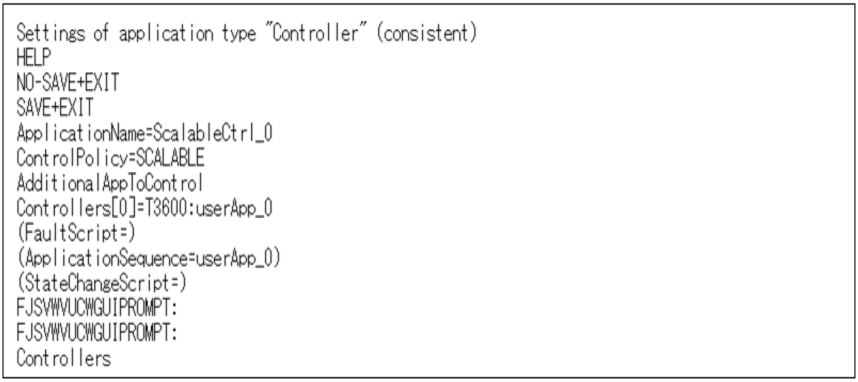
Enter "ScalableCtrl_0" to change the timeout period of *ScalableCtrl_0*.



```
Edit: Application selection menu:
HELP
QUIT
RETURN
OPTIONS
Cmdline0
ScalableCtrl_0
userApp_0
userApp_1
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
ScalableCtrl_0
```

Figure 44: Application selection menu

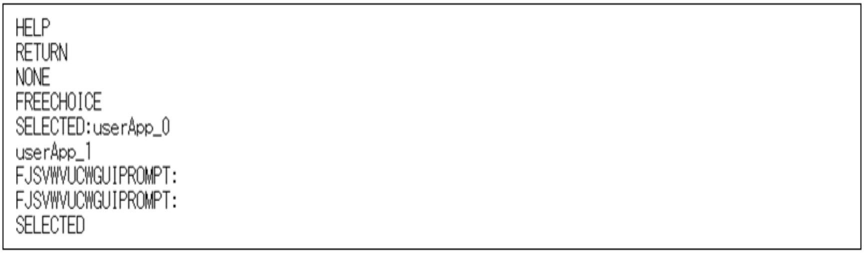
- ► Enter "Controllers" and then select *Controllers*.



```
Settings of application type "Controller" (consistent)
HELP
NO-SAVE+EXIT
SAVE+EXIT
ApplicationName=ScalableCtrl_0
ControlPolicy=SCALABLE
AdditionalAppToControl
Controllers[0]=T3600:userApp_0
(FaultScript=)
(ApplicationSequence=userApp_0)
(StateChangeScript=)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
Controllers
```

Figure 45: Settings menu of controller

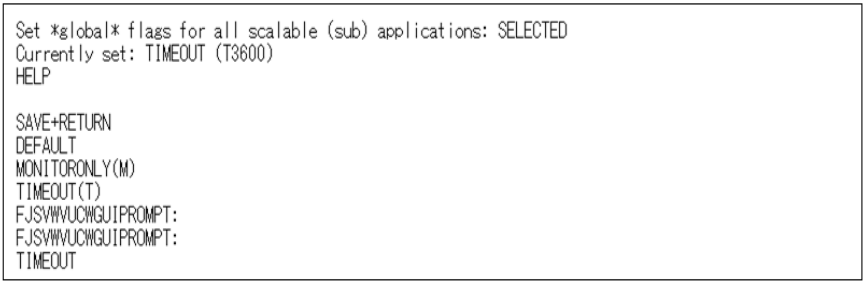
► Enter "SELECTED:<*userApplication name*> and then select *SELECTED.*



```
HELP
RETURN
NONE
FREECHOICE
SELECTED:userApp_0
userApp_1
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
SELECTED
```

Figure 46: Selection menu of controlled target application

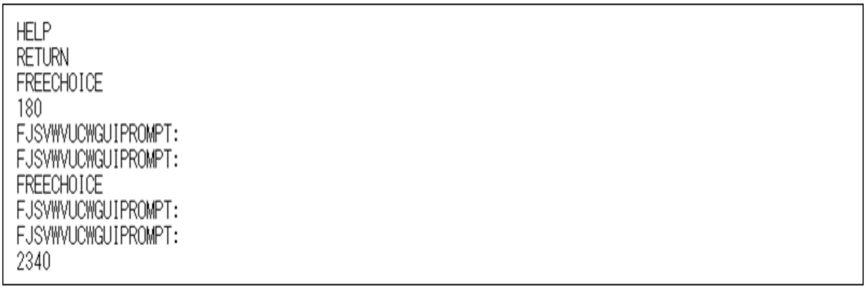
► Enter "TIMEOUT" and then select *TIMEOUT(T)*.



```
Set *global* flags for all scalable (sub) applications: SELECTED
Currently set: TIMEOUT (T3600)
HELP

SAVE+RETURN
DEFAULT
MONITORONLY(M)
TIMEOUT(T)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
TIMEOUT
```

Figure 47: Attribution setting menu of the controller

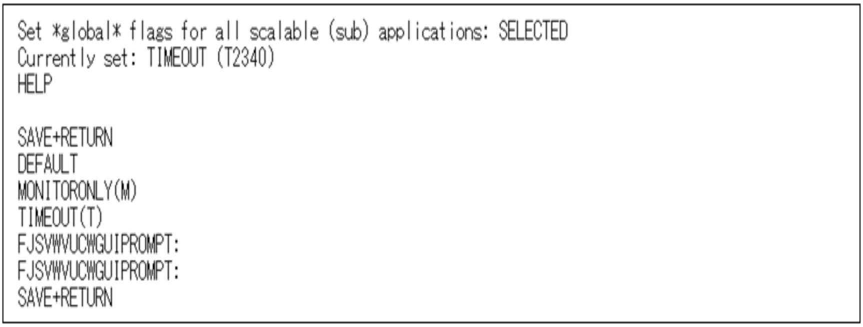
► Enter "FREECHOICE" then select *FREECHOICE* and then enter the timeout period. Here, enter "2340" to set the timeout period to *2340* seconds.



```
HELP
RETURN
FREECHOICE
180
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
FREECHOICE
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
2340
```

Figure 48: TIMEOUT input

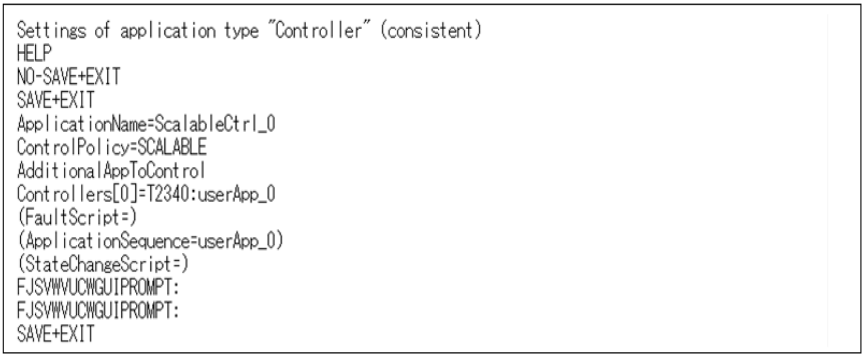
- ► Enter "SAVE+RETURN" and then select *SAVE+RETURN*.



```
Set *global* flags for all scalable (sub) applications: SELECTED
Currently set: TIMEOUT (T2340)
HELP

SAVE+RETURN
DEFAULT
MONITORONLY(M)
TIMEOUT(T)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
SAVE+RETURN
```

Figure 49: Attribution setting menu of the controller

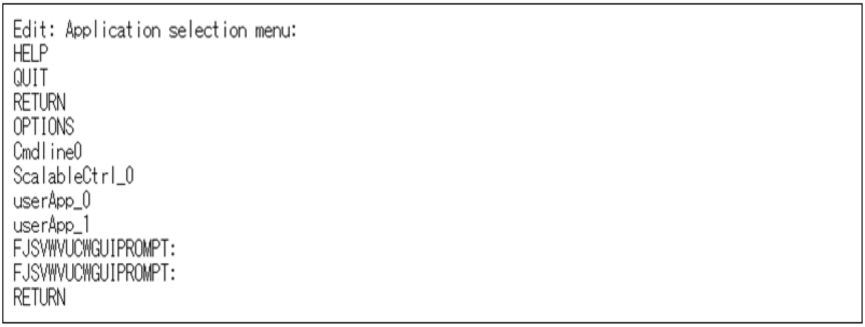
- ► Enter "SAVE+EXIT" and then select *SAVE+EXIT*.



```
Settings of application type "Controller" (consistent)
HELP
NO-SAVE+EXIT
SAVE+EXIT
ApplicationName=ScalableCtrl_0
ControlPolicy=SCALABLE
AdditionalAppToControl
Controllers[0]=T2340:userApp_0
(FaultScript=)
(ApplicationSequence=userApp_0)
(StateChangeScript=)
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
SAVE+EXIT
```

Figure 50: Menu settings of the controller

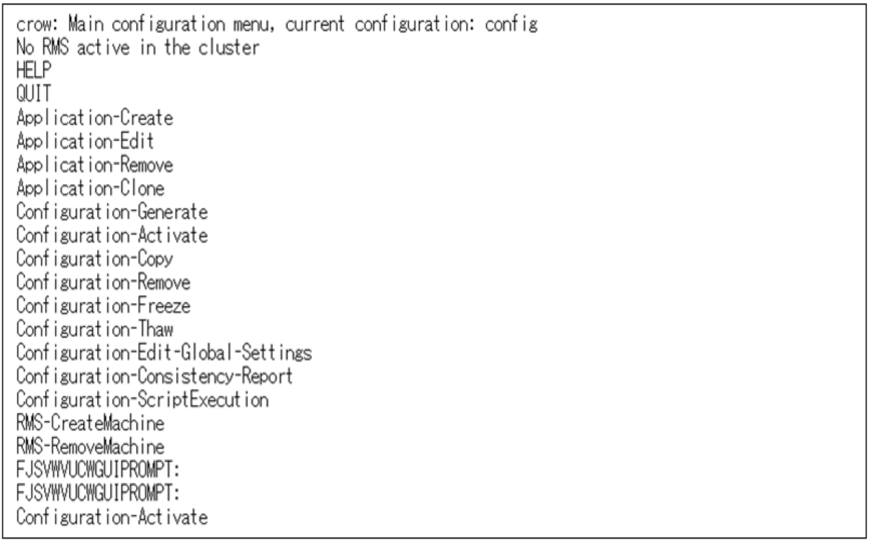
► Enter "RETURN" and then select *RETURN*.



```
Edit: Application selection menu:
HELP
QUIT
RETURN
OPTIONS
Cmdline0
ScalableCtrl_0
userApp_0
userApp_1
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
RETURN
```

Figure 51: Application selection menu

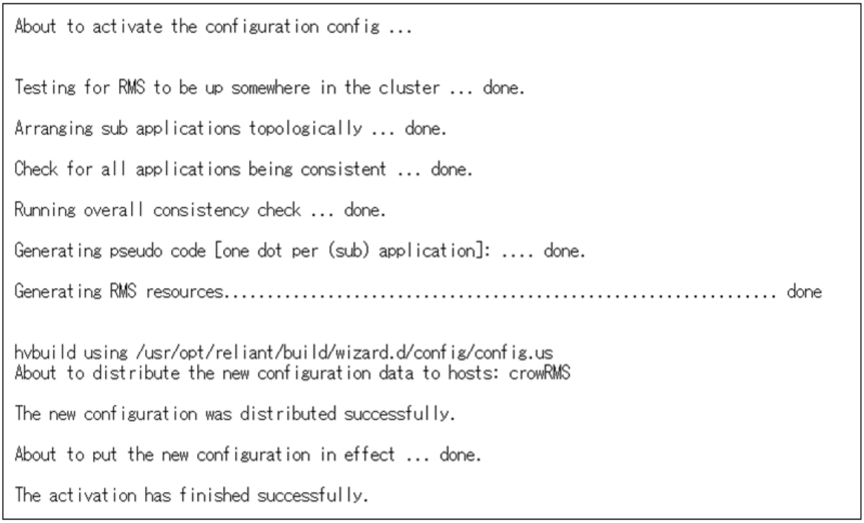
► Enter "Configuration-Activate" and then select *Configuration-Activate*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
Configuration-Activate
```

Figure 52: Main configuration menu

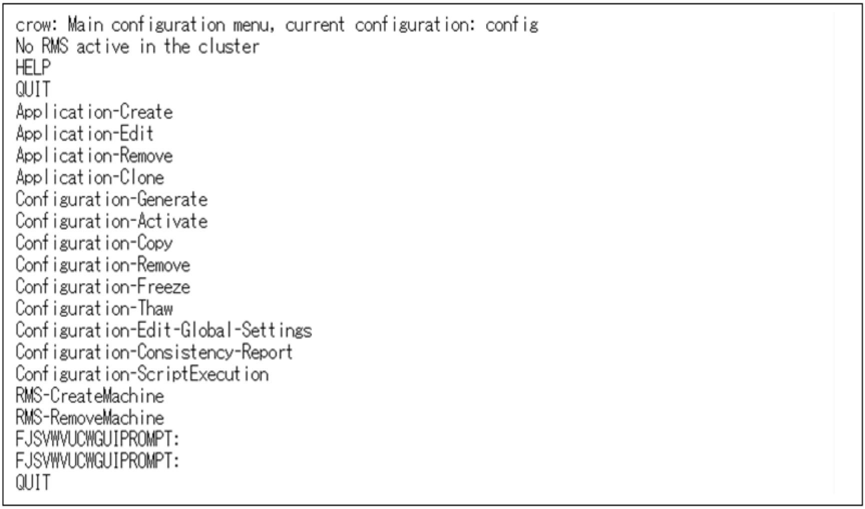
► RMS configuration is generated and distributed.



```
About to activate the configuration config ...


Testing for RMS to be up somewhere in the cluster ... done.

Arranging sub applications topologically ... done.

Check for all applications being consistent ... done.

Running overall consistency check ... done.

Generating pseudo code [one dot per (sub) application]: .... done.

Generating RMS resources............................................................... done


hvbuild using /usr/opt/reliant/build/wizard.d/config/config.us
About to distribute the new configuration data to hosts: crowRMS

The new configuration was distributed successfully.

About to put the new configuration in effect ... done.

The activation has finished successfully.
```

Figure 53: Creation and distribution of designated file of RMS configuration

► Enter "QUIT" and then select *QUIT*.



```
crow: Main configuration menu, current configuration: config
No RMS active in the cluster
HELP
QUIT
Application-Create
Application-Edit
Application-Remove
Application-Clone
Configuration-Generate
Configuration-Activate
Configuration-Copy
Configuration-Remove
Configuration-Freeze
Configuration-Thaw
Configuration-Edit-Global-Settings
Configuration-Consistency-Report
Configuration-ScriptExecution
RMS-CreateMachine
RMS-RemoveMachine
FJSVWVUCWGUIPROMPT:
FJSVWVUCWGUIPROMPT:
QUIT
```

Figure 54: Quitting main configuration menu

6 Using the Cluster Admin GUI

This chapter describes PRIMECLUSTER administration using the Cluster Admin graphical user interface (GUI). In addition, some command-line interface (CLI) commands are discussed.

Chapter contents:

- "Overview"
- "Starting the Cluster Admin GUI"
- "Monitoring RMS with Cluster Admin"

6.1 Overview

RMS administration can be done by means of the Cluster Admin GUI or by the CLI. The procedures in this chapter focus on the Cluster Admin GUI.

CLI procedures

Some of the operations described in this chapter describe the equivalent CLI procedure. However, we recommend that the CLI be used only by expert system administrators, or in those cases where a browser is not available. If you decide to use a CLI procedure, please note the following:

- The commands are located in the <*RELIANT_PATH*>`/bin` directory.
- All RMS CLI commands accept both CF node names and RMS node names for `SysNode` objects when the RMS naming convention has been followed (that is, when the names are of the form <*CF-name*>`RMS`).
- RMS CLI commands accept case-insensitive application names.
- The CLI procedures presented here are not intended to be a complete description of the commands that are used. Other options may be available. For more information about any CLI command, see its online manual pages. For the complete list of online documentation related to RMS operation, see "Appendix—Release information".

CLI status codes

In general, RMS `hv*` commands send a request to the base monitor and then return immediately without waiting for this request to be processed. They exit with a status code of 0 (success), which indicates a request has been **sent** to the base monitor successfully. However, this does not guarantee that the request was **processed** successfully.

Important exceptions include the '`hvshut`' and '`hvutil -[mM]`' commands, which remove nodes and applications from RMS control. These commands may return status codes that indicate failure. This type of command also provides an option for "forced" operation, but this should be used with great care and only when absolutely necessary.

6.2 Starting the Cluster Admin GUI

The following sections discuss how to use the RMS portion of the GUI.

ℹ Windows desktop systems require the Java plugin as specified in "PRIMECLUSTER Web-Based Admin View Operation Guide" for your operating system.

6.2.1 Web-Based Admin View

▶ Open a Java-enabled browser and enter the following URL in the *Address* location:

`http://`*<hostname>*`:8081/Plugin.cgi`

The *hostname* should be the name or IP address of the primary or secondary management server. For example, if a cluster has `shasta1` and `shasta2` as its primary and secondary management servers, the URL would be either one of the following:

- `http://shasta1:8081/Plugin.cgi`
- `http://shasta2:8081/Plugin.cgi`

The `Plugin.cgi` URL always attempts to contact the primary management server; after contacting the host, the browser changes the URL suffix from '`.cgi`' to '`.html`'. If you instead use the `Plugin.html` form, Cluster Admin will attempt to make direct contact with the server specified in the URL.

For details on the primary and secondary management servers, refer to "PRIMECLUSTER Web-Based Admin View Operation Guide" for your operating system.

6.2.2 Login

Before logging in, make sure you have a user name and password with the appropriate privilege level. Cluster Admin has the following privilege levels:

- Root privileges—Can perform all actions including configuration, administration, and viewing tasks.
- Administrative privileges—Can view and execute commands, but cannot make configuration changes.
- Operator privileges—Can only perform viewing tasks.

For more details on privilege levels, refer to "4.2.1 Assigning Users to Manage the Cluster" in "PRIMECLUSTER Installation and Administration Guide (Oracle Solaris)" or "4.3.1 Assigning Users to Manage the Cluster" in "PRIMECLUSTER Installation and Administration Guide (Linux)."

After the Web-Based Admin View login window appears (Figure 55), log in as follows:

► Enter the user name and password for a user with the appropriate privilege level.

► Click the *OK* button.

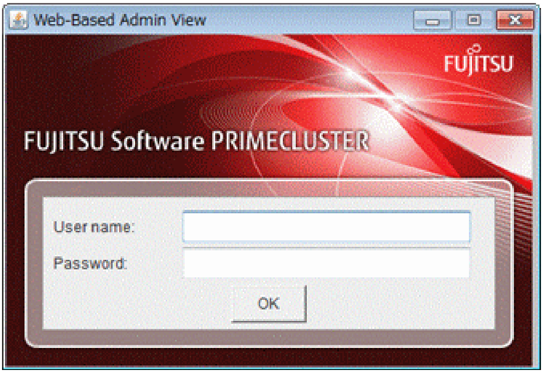


Figure 55: Web-Based Admin View login

After you log in, the Web-Based Admin View window appears (Figure 56).

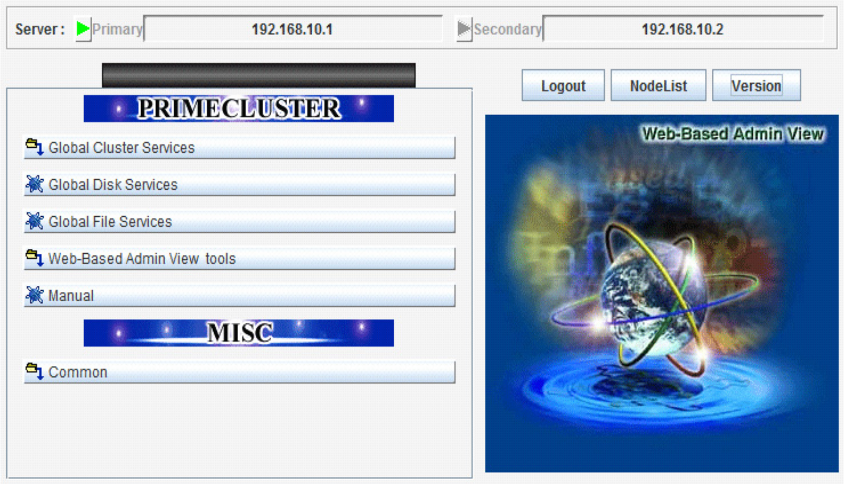


Figure 56: Invoking the Cluster Services GUI

► Click the *Global Cluster Services* button to advance to the next view (Figure 57).

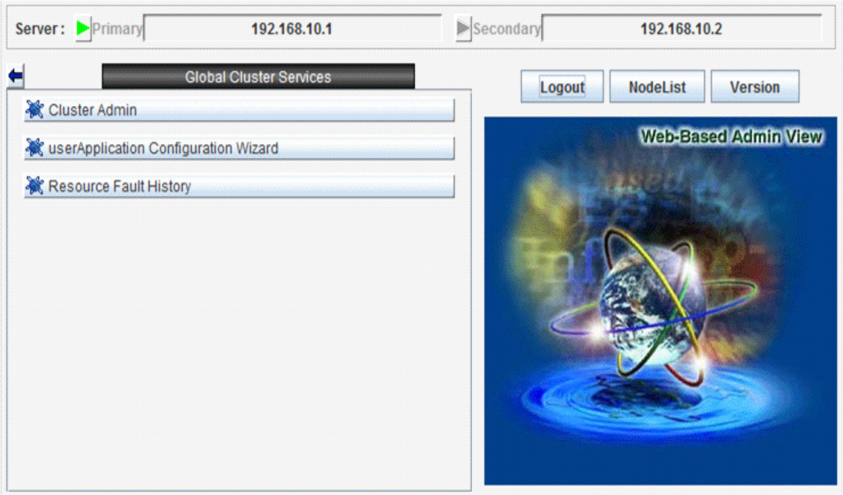


Figure 57: Invoking Cluster Admin

► Click the *Cluster Admin* button.

The *Choose a node for initial connection* window appears (Figure 58).

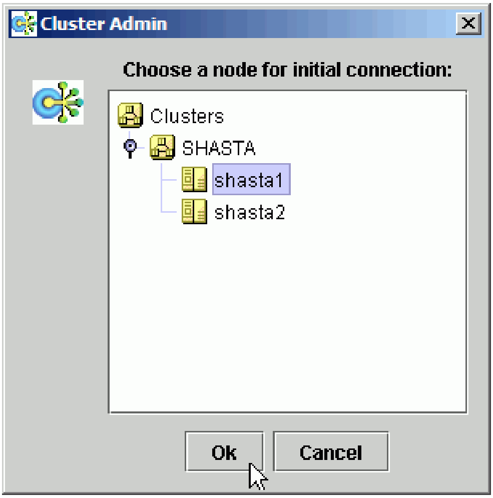


Figure 58: Cluster Admin initial connection menu

The nodes are displayed in alphabetical order, and the first one is selected by default. In most cases, the node you choose is immaterial for administrative tasks.

► Select the desired node for the connection, and click *OK*.

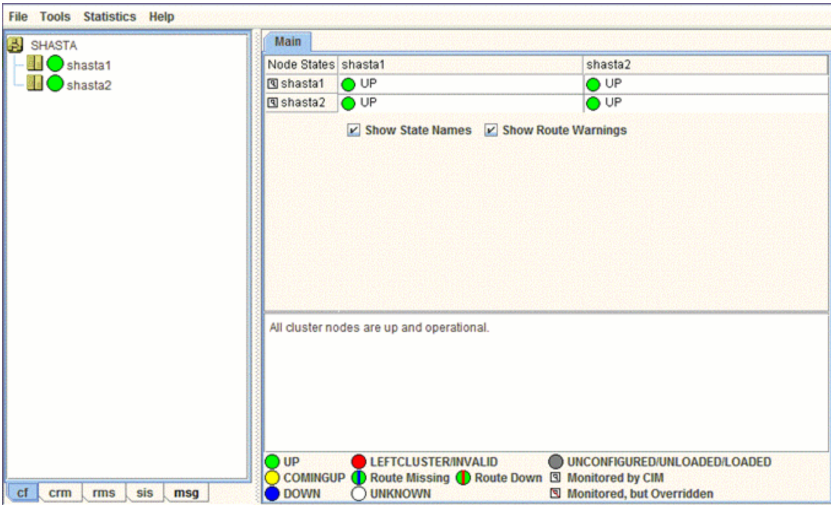
The next window that appears depends on how you have set the trust levels for the Cluster Admin Java applets. If you have already chosen to use trusted applets for all sessions, you can skip the following description.

Trusted applets

For platform independence and security, the Cluster Admin GUI uses Java applets. When the Java applets run in trusted mode, they are allowed to use some client system resources, such as the clipboard. If you intend to copy and paste text between the Java window and other applications on your workstation, you must run the applets in trusted mode.

6.2.3 Main Cluster Admin window

When Cluster Admin opens, the initial view is similar to Figure 59.



Node States	shasta1	shasta2
shasta1	● UP	● UP
shasta2	● UP	● UP

☑ Show State Names ☑ Show Route Warnings

All cluster nodes are up and operational.

Figure 59: Main Cluster Admin window—Initial view

The following tabs appear at the bottom of the left pane:

- *cf*
- *rms*
- *sis*
- *msg* (message window)

Clicking a tab switches the view to the corresponding product. Initially, the CF view is selected. All views have the following common features:

- **Menu bar**—The pull-down menus contain generic administrative functions as well as items specific to the PRIMECLUSTER products. Some entries may be disabled (grayed out) according to the item selected in the current view.
- **Configuration tree**—The left pane contains product-specific configuration information in a hierarchical display. Clicking on an item in the tree will display the item's properties and, in some views, allow you to change them. Right-clicking on an item generally brings up a context menu specific to that item.
- **Input and message area**—The large pane on the right is the main work and information area. The content varies according to the product being administered and the functions selected from the menus or tree.

This chapter focuses on RMS administration. For information about operations available on the other tabs, refer to the corresponding product documentation.

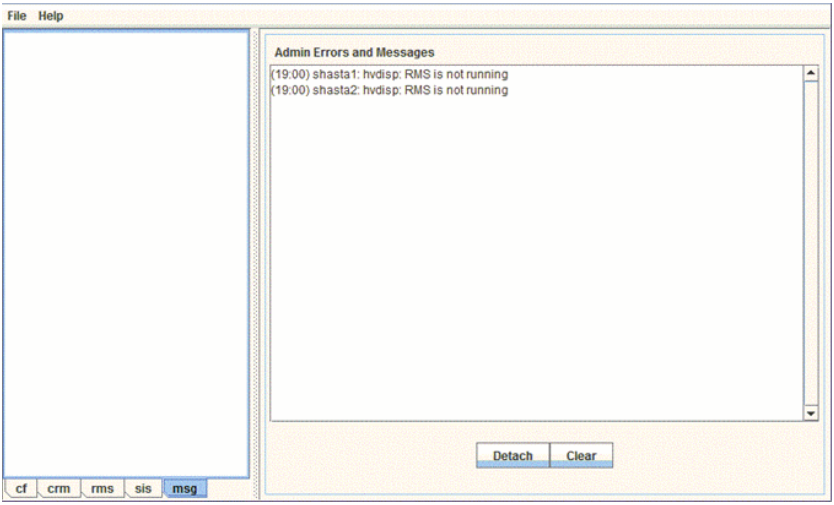
Note

SIS is not available in PRIMECLUSTER 4.5.

6.2.4 Cluster Admin message view

Error and debug messages related to Cluster Admin can be displayed at any time:

► Click the *msg* tab on the bottom of the RMS tree pane. (The tab label is red if a new message has been added to the text area since it was last viewed.) The *Admin Errors and Messages* view appears (Figure 60).



Admin Errors and Messages

```
(19:00) shasta1: hvdisp: RMS is not running
(19:00) shasta2: hvdisp: RMS is not running
```

Figure 60: Main Cluster Admin window—message view

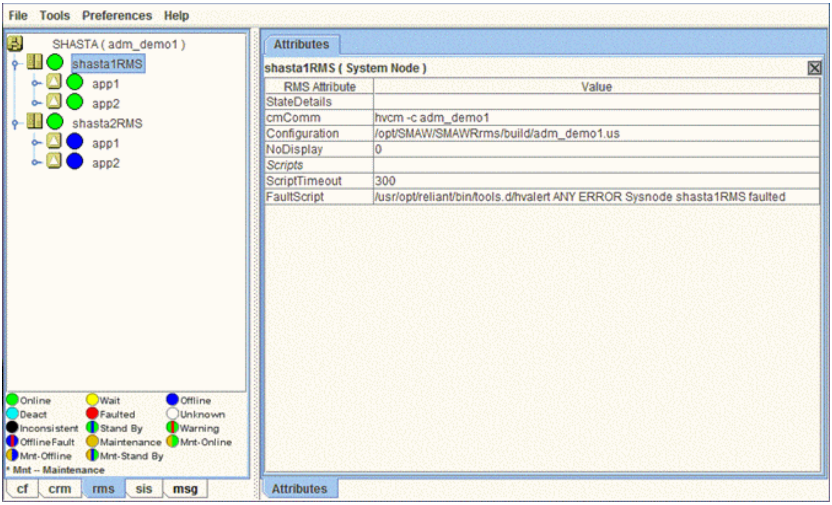
The message pane can be detached or re-attached using the buttons at the bottom of the display. Use the *Clear* button to delete all messages in the display.

6.3 Monitoring RMS with Cluster Admin

The procedures in this section allow you to view information about the RMS cluster as well as individual nodes, applications, and resources. These procedures are passive: they display data, but they do not change the operation of the configuration.

► To enter the RMS portion of the Cluster Admin GUI, click on the *rms* tab.

A typical RMS view is shown in Figure 61.



shasta1RMS (System Node)

RMS Attribute	Value
StateDetails	
cmComm	hvcm -c adm_demo1
Configuration	/opt/SMAW/SMAWRrms/build/adm_demo1.us
NoDisplay	0
Scripts	
ScriptTimeout	300
FaultScript	/usr/opt/reliant/bin/tools.d/hvalert ANY ERROR Sysnode shasta1RMS faulted

Figure 61: Main Cluster Admin window—RMS view

The main window area is split into two major areas: the left pane contains the RMS tree; the right pane displays configuration information, properties of nodes and objects, RMS logs, or other items. The information displayed depends on what has been selected RMS tree and which operation, if any, has been invoked.

6.3.1 RMS tree

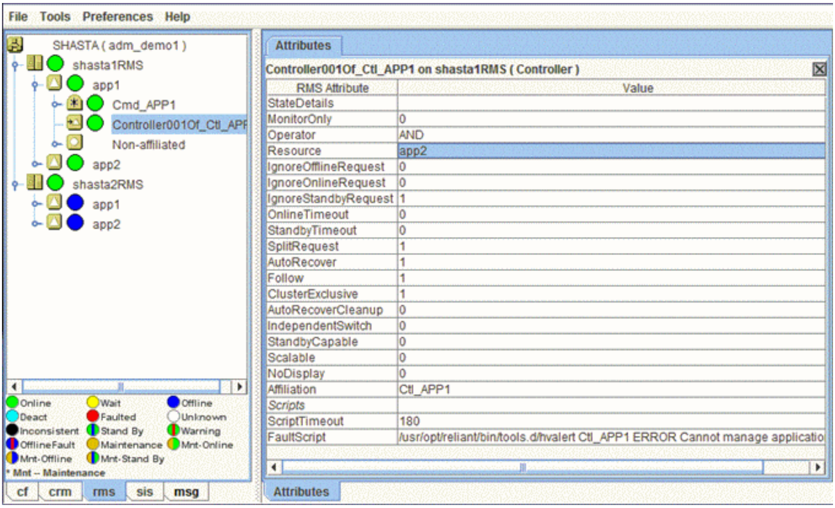
The Cluster Admin RMS tree displays the configuration information for the cluster in a simple hierarchical format. The tree has the following levels:

- Root of the tree—Represents the cluster. The root is labeled with the cluster name, followed by the RMS configuration name in parentheses. The cluster name is determined by your CF configuration.
- First level—Represents the system nodes forming the cluster.
- Second level—Represents the `userApplication` objects running on each of the system nodes.
- Third level—Represents subapplications, if any. Also contains non-affiliated groups of objects (see fourth level description).
- Fourth level—Represents the resources necessary for each of the subapplications. Also contains non-affiliated objects.

i Non-affiliated objects (`andOP`, `orOP`) provide logical dependencies and group connectivity between nodes, applications, and subapplications.

If an application has subapplications, the fourth level represents resources used by that subapplication. If an application does not have subapplications, then the third level represents all the resources used by the `userApplication`.

Applications always appear at the second level of the tree, even if some of them are controlled by others. Dependencies between applications are depicted in the RMS tree by the presence of controller objects. An example of an RMS tree with a controller object is shown in Figure 62.



Controller001Of_Ctl_APP1 on shasta1RMS (Controller)

RMS Attribute	Value
StateDetails	
MonitorOnly	0
Operator	AND
Resource	app2
IgnoreOfflineRequest	0
IgnoreOnlineRequest	0
IgnoreStandbyRequest	1
OnlineTimeout	0
StandbyTimeout	0
SplitRequest	1
AutoRecover	1
Follow	1
ClusterExclusive	1
AutoRecoverCleanup	0
IndependentSwitch	0
StandbyCapable	0
Scalable	0
NoDisplay	0
Affiliation	Ctl_APP1
Scripts	
ScriptTimeout	180
FaultScript	/usr/opt/reliant/bin/tools.d/hvalert Ctl_APP1 ERROR Cannot manage applicatio

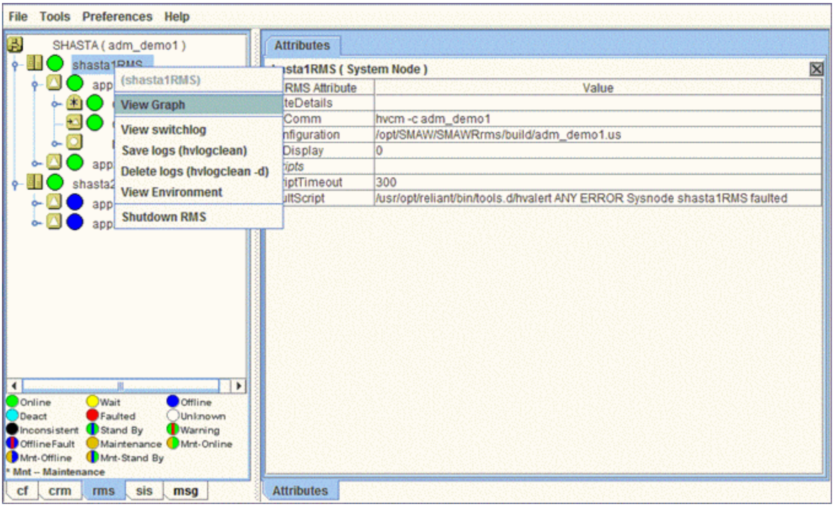
Figure 62: RMS tree with a controller object

In the example shown in the figure, the *Resource* attribute of the highlighted controller object in *app1* contains the name of the *app2* application: this indicates the dependence of *app1* on *app2*.

A complete visual display of object dependence is available from the RMS graph. See the "Using RMS graphs" for a description of the procedure.

6.3.2 Pop-up context menus

Each object in the Cluster Admin RMS configuration tree has a pop-up context menu that provides quick access to commonly-used operations. Invoke the context menu by right-clicking on any object. The first item on the menu displays the selected object's name in grayed-out text. The remaining items list the available operations, which vary according to the object's type and current state (Figure 63).



sta1RMS (System Node)

RMS Attribute	Value
teDetails	
Comm	hvcm -c adm_demo1
nfiguration	/opt/SMAW/SMAWRrms/build/adm_demo1.us
Display	0
ripts	
iptTimeout	300
ultScript	/usr/opt/reliant/bin/tools.d/hvalert ANY ERROR Sysnode shasta1RMS faulted

Figure 63: Pop-up context menu for a node

Items that affect object states, node states, or the entire RMS configuration appear toward the bottom of the menu. These actions are described in the final sections of this chapter.

> **i** To close the context menu without performing an operation, click the grayed-out object name in the menu or press the [Esc] key.

The menu offers different operations for a node object compared to an application object. It also offers different options for an application object in the online state (Figure 64) compared to the offline state (Figure 65).

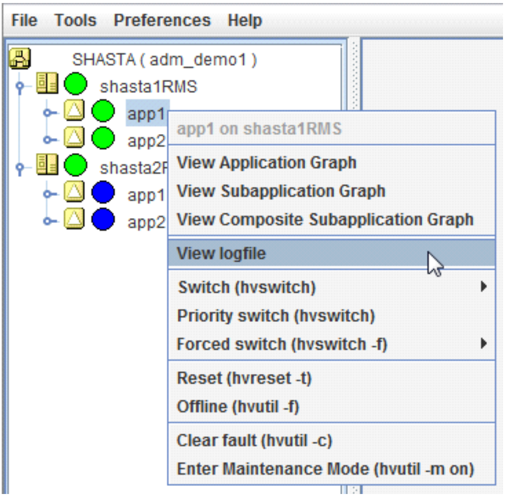


Figure 64: Pop-up context menu for an online application

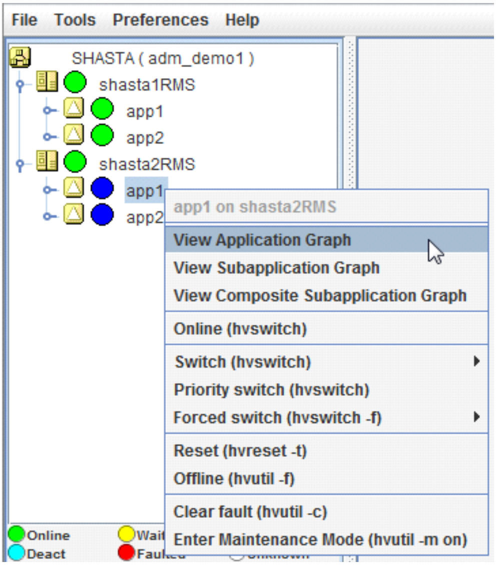
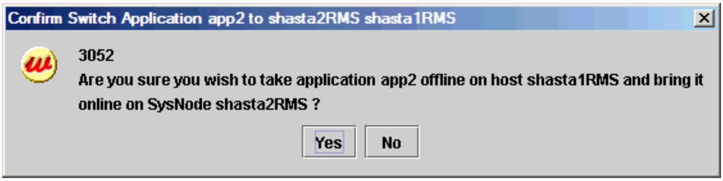


Figure 65: Pop-up context menu for an offline application

6.3.3 Pop-up confirmation dialogs

When you select an item in an object's context menu that can cause state changes to that object, a pop-up confirmation dialog appears (Figure 66). To proceed with the action described in the warning message, click *Yes*; to cancel the action, click *No*.



Confirm Switch Application app2 to shasta2RMS shasta1RMS

3052

Are you sure you wish to take application app2 offline on host shasta1RMS and bring it online on SysNode shasta2RMS ?

Figure 66: Pop-up confirmation dialog

6.3.4 Displaying environment variables

Display the global (clusterwide) environment variables as follows:

- ► Right-click on a cluster in the RMS tree window and select *View Environment* from the context menu (Figure 67).

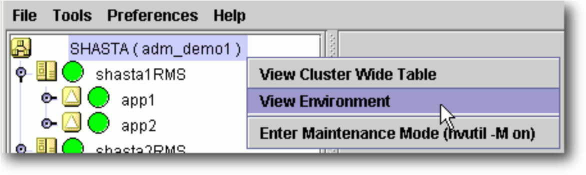
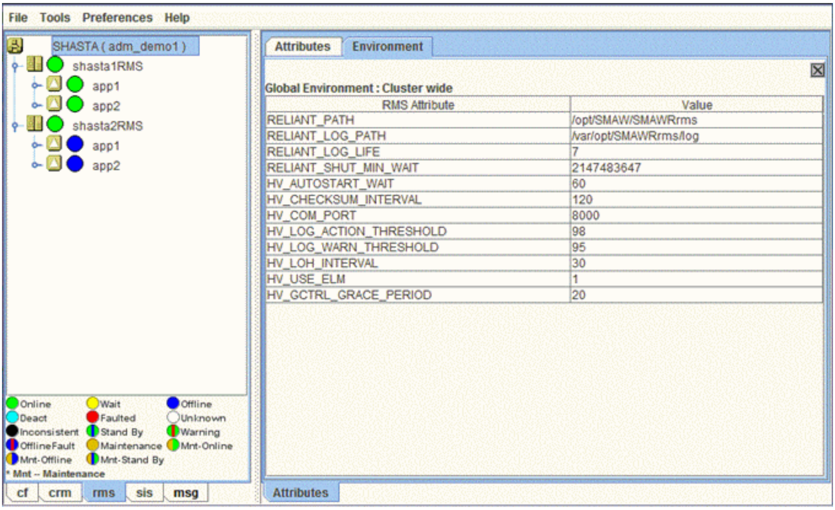


Figure 67: Displaying global environment variables

The global variables will appear under a separate tab in the right pane (Figure 68).



Global Environment : Cluster wide

RMS Attribute	Value
RELIANT_PATH	/opt/SMAW/SMAWRrms
RELIANT_LOG_PATH	/var/opt/SMAWRrms/log
RELIANT_LOG_LIFE	7
RELIANT_SHUT_MIN_WAIT	2147483647
HV_AUTOSTART_WAIT	60
HV_CHECKSUM_INTERVAL	120
HV_COM_PORT	8000
HV_LOG_ACTION_THRESHOLD	98
HV_LOG_WARN_THRESHOLD	95
HV_LOH_INTERVAL	30
HV_USE_ELM	1
HV_GCTRL_GRACE_PERIOD	20

Figure 68: Global environment variable view

> i To close a tab view, use the button in the upper-right corner of the view.

Display local environment variables as follows:

- ► Right-click on a node in the RMS tree window and select *View Environment* from the context menu (Figure 69).

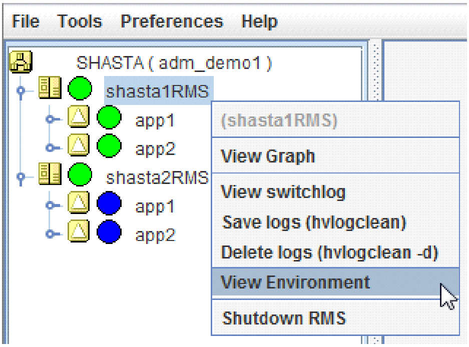
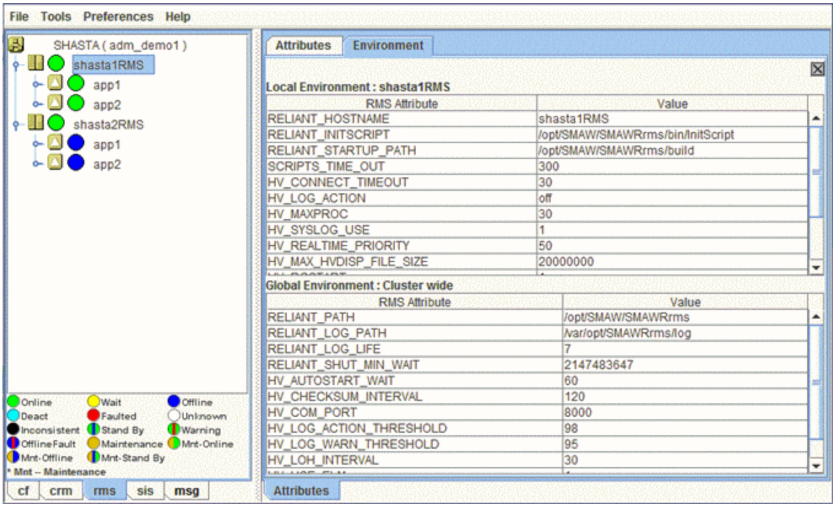


Figure 69: Displaying local environment variables

Both local and global variables appear on the same tab in the right pane (Figure 70).



Local Environment : shasta1RMS

RMS Attribute	Value
RELIANT_HOSTNAME	shasta1RMS
RELIANT_INITSCRIPT	/opt/SMAW/SMAWRrms/bin/InitScript
RELIANT_STARTUP_PATH	/opt/SMAW/SMAWRrms/build
SCRIPTS_TIME_OUT	300
HV_CONNECT_TIMEOUT	30
HV_LOG_ACTION	off
HV_MAXPROC	30
HV_SYSLOG_USE	1
HV_REALTIME_PRIORITY	50
HV_MAX_HVDISP_FILE_SIZE	20000000

Global Environment : Cluster wide

RMS Attribute	Value
RELIANT_PATH	/opt/SMAW/SMAWRrms
RELIANT_LOG_PATH	/var/opt/SMAWRrms/log
RELIANT_LOG_LIFE	7
RELIANT_SHUT_MIN_WAIT	2147483647
HV_AUTOSTART_WAIT	60
HV_CHECKSUM_INTERVAL	120
HV_COM_PORT	8000
HV_LOG_ACTION_THRESHOLD	98
HV_LOG_WARN_THRESHOLD	95
HV_LOH_INTERVAL	30

Figure 70: Local environment variables view

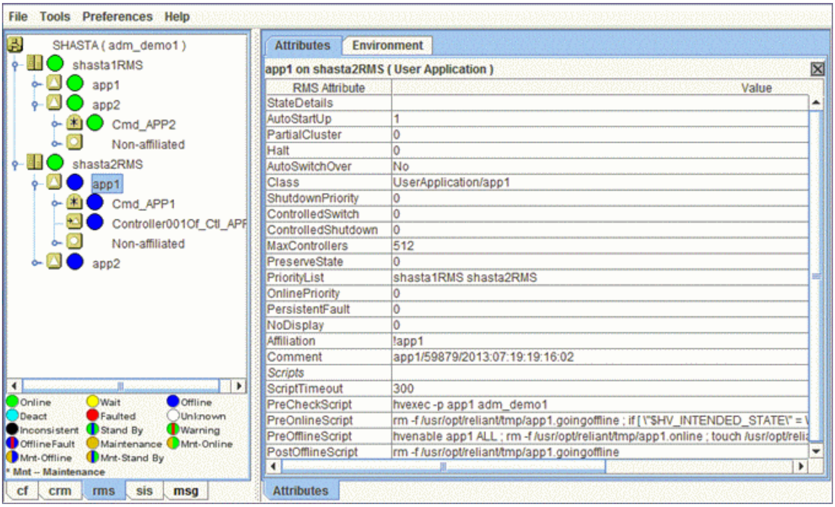
CLI: hvdisp

Display the environment variables with the `hvdisp` command, which does not require root privilege:

```
hvdisp ENV

hvdisp ENVL
```

6.3.5 Displaying object states

The state of each RMS object is indicated by the color of its circular status icon, located immediately to the left of the object's name in the configuration tree. The legend for the object states appears below the RMS tree in the left pane of the RMS view (Figure 71).



app1 on shasta2RMS (User Application)

RMS Attribute	Value
StateDetails	
AutoStartUp	1
PartialCluster	0
Halt	0
AutoSwitchOver	No
Class	UserApplication/app1
ShutdownPriority	0
ControlledSwitch	0
ControlledShutdown	0
MaxControllers	512
PreserveState	0
PriorityList	shasta1RMS shasta2RMS
OnlinePriority	0
PersistentFault	0
NoDisplay	0
Affiliation	!app1
Comment	app1/59879/2013:07:19:19:16:02
Scripts	
ScriptTimeout	300
PreCheckScript	hvexec -p app1 adm_demo1
PreOnlineScript	rm -f /usr/opt/reliant/tmp/app1.goingoffline ; if [\"$HV_INTENDED_STATE\" = \
PreOfflineScript	hvenable app1 ALL ; rm -f /usr/opt/reliant/tmp/app1.online ; touch /usr/opt/reli
PostOfflineScript	rm -f /usr/opt/reliant/tmp/app1.goingoffline

Figure 71: Displaying application and object states

In the example above, the application `app2` is online (green status icon) on node `shasta1RMS`, but offline (blue status icon) on node `shasta2RMS`.

See "Appendix—States" for a description of RMS object states.

CLI: hvdisp

The syntax for the CLI is as follows:

```
hvdisp {-a | -c} [-o out_file]
```

Options:

`-a` Displays the object name, the object type, the object's `SysNode` name, and the object state for each object in the configuration (automatically generated connectors are not shown)

`-c` Displays information in compact format

`-o` Sends the output to the designated file

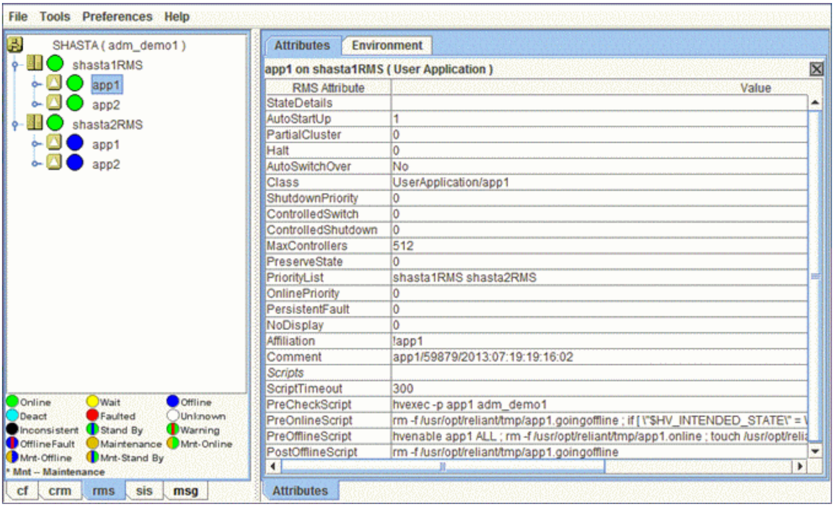
The `hvdisp` command only works when RMS is running, and the root privilege is not required.

Note

For an object that does not operate on the command execution node, the object name is displayed, but the object state is not displayed.

6.3.6 Configuration information or object attributes

View configuration information for individual objects by left-clicking with the mouse on the object in the tree. The properties are displayed in a tabular format on the right pane of the RMS main window (Figure 72).



app1 on shasta1RMS (User Application)

RMS Attribute	Value
StateDetails	
AutoStartUp	1
PartialCluster	0
Halt	0
AutoSwitchOver	No
Class	UserApplication/app1
ShutdownPriority	0
ControlledSwitch	0
ControlledShutdown	0
MaxControllers	512
PreserveState	0
PriorityList	shasta1RMS shasta2RMS
OnlinePriority	0
PersistentFault	0
NoDisplay	0
Affiliation	!app1
Comment	app1/59879/2013:07:19:19:16:02
Scripts	
ScriptTimeout	300
PreCheckScript	hvexec -p app1 adm_demo1
PreOnlineScript	rm -f /usr/opt/reliant/tmp/app1.goingoffline ; if [\"$HV_INTENDED_STATE\" = \
PreOfflineScript	hvenable app1 ALL ; rm -f /usr/opt/reliant/tmp/app1.online ; touch /usr/opt/relia
PostOfflineScript	rm -f /usr/opt/reliant/tmp/app1.goingoffline

Figure 72: Configuration information or object attributes

7 Additional administrative tools

The Cluster Admin GUI provides several additional tools to help you manage RMS operation.

Chapter contents:

- "Using the RMS clusterwide table"
- "Using RMS graphs"
- "Interpreting display changes"
- "Viewing RMS log messages"

7.1 Using the RMS clusterwide table

The RMS clusterwide table displays the state of each application on each of the system nodes in a concise table.

► To open the clusterwide table, right-click the cluster name (the root of the RMS tree in the left pane) and then select *View Cluster Wide table* from the context menu (Figure 73).

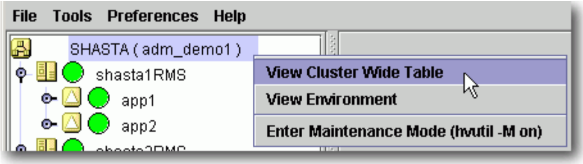
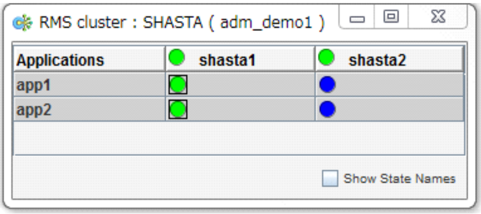


Figure 73: Opening the clusterwide table

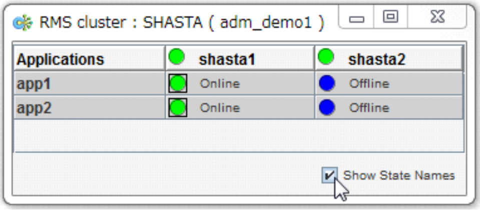
The clusterwide table appears in a separate window (Figure 74).



Applications	● shasta1	● shasta2
app1	🟩	●
app2	🟩	●

Figure 74: Clusterwide table

► To display the corresponding state name next to each status icon, click the *Show State Names* checkbox at the lower-right corner of the window (Figure 75).



RMS cluster : SHASTA (adm_demo1)

Applications	● shasta1	● shasta2
app1	● Online	● Offline
app2	● Online	● Offline

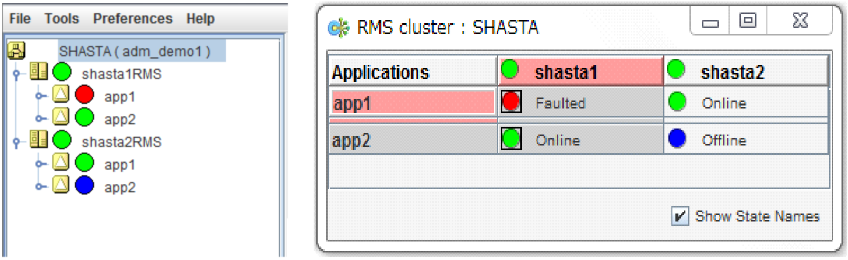
☑ Show State Names

Figure 75: Clusterwide table with state names

You can increase or decrease the size of the clusterwide table window and the size of the columns by using the mouse. If the window is already large enough to fully display all of the table elements, then you will not be allowed to further increase its size.

A square surrounding the colored state circle indicates the primary node for the application. Figure 75 above shows that shasta1 is the primary node for all of the applications.

Normally, the clusterwide table displays applications in alphabetical order from top to bottom. However, Faulted applications are handled specially. If an application is in the Faulted state on any node in the cluster, then it is displayed at the top of the table, and the application's name is highlighted by a pink background (Figure 76). This allows the System Administrator to easily spot any Faulted applications.



SHASTA (adm_demo1)
- ● shasta1RMS
  - ● app1
  - ● app2
- ● shasta2RMS
  - ● app1
  - ● app2

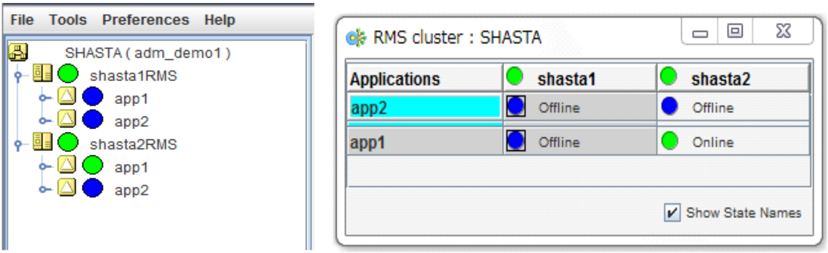
RMS cluster : SHASTA

Applications	● shasta1	● shasta2
app1	● Faulted	● Online
app2	● Online	● Offline

☑ Show State Names

Figure 76: Faulted applications in the clusterwide table

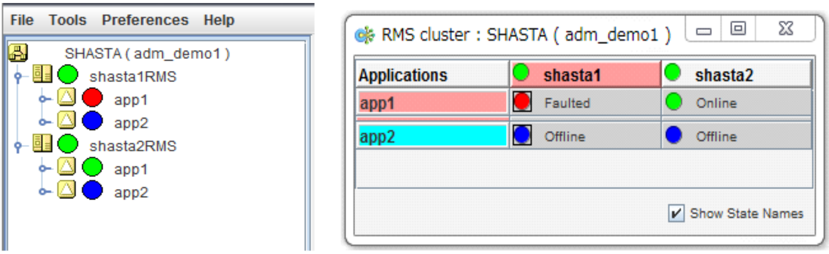
The clusterwide table also makes special provisions for applications that are not online anywhere in the cluster. These applications are also displayed at the top of the table, with the application's name highlighted in light blue (Figure 77). This alerts the system administrator that some applications are not running anywhere and should probably be brought online on some node.



Applications	● shasta1	● shasta2
app2	● Offline	● Offline
app1	● Offline	● Online

Figure 77: Offline applications in the clusterwide table

If there are both faulted applications and applications that are not online anywhere, then the faulted applications are listed first (Figure 78).

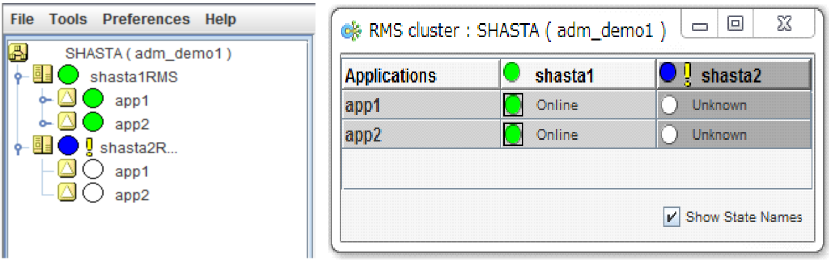


Applications	● shasta1	● shasta2
app1	● Faulted	● Online
app2	● Offline	● Offline

Figure 78: Faulted and offline applications in the clusterwide table

If there is a split-brain condition in the cluster on both the clusterwide table and the RMS tree, then colored exclamation marks will appear after the status icons (colored circles) of the nodes. A colored exclamation mark indicates that the state of that `SysNode` is different from what another `SysNode` views it as being. The color of the exclamation mark indicates the state that the other node thinks that the `SysNode` is in. If there are multiple nodes that see a `SysNode` in different states, you will see multiple exclamation marks after the colored circle. Exclamation marks are sorted according to the severity of the states.

Figure 79 shows a clusterwide table with an application of a split-brain condition. Note the yellow exclamation mark before the second node name.


File Tools Preferences Help
SHASTA (adm_demo1)
shasta1RMS
app1
app2
shasta2R...
app1
app2
RMS cluster : SHASTA (adm_demo1)

Applications	● shasta1	● ! shasta2
app1	● Online	○ Unknown
app2	● Online	○ Unknown

☑ Show State Names

Figure 79: Split-brain conditions in the clusterwide table

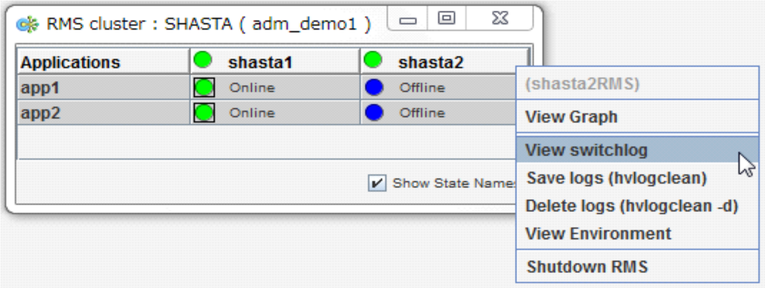
> Momentary split-brain conditions may be indicated while a node starts up or shuts down.

7.1.1 Using context menus from the clusterwide table

Each object in the clusterwide table has a pop-up context menu that provides quick access to commonly-used operations.

- ► To display a context menu, right-click on any object with a status icon, where column headers represent hosts and cells represent applications.

The first item on the menu displays the selected object’s name in grayed-out text. The remaining items list the available operations, which vary according to the object’s type and current state (Figure 80).



Applications	● shasta1	● shasta2
app1	● Online	● Offline
app2	● Online	● Offline

☑ Show State Name

Figure 80: Using context menus in the clusterwide table

Items that affect object states, node states, or the entire RMS configuration appear toward the bottom of the menu. These actions are described in the final sections of this chapter.

▶ To close the context menu without performing an operation, click the grayed-out object name in the menu or press the [Esc] key.

7.2 Using RMS graphs

Cluster Admin provides an alternate way of viewing the RMS configuration hierarchy called **graphs**. A graph represents the configuration in a true tree structure, where the branches indicate the dependencies that are not generally visible in the RMS configuration tree described earlier. The following types of graphs are available:

- Full graph—Displays the complete cluster configuration.
- Application graph—Shows all of the resources used by an application and can be used to look at specific resource properties.
- Subapplication graph—Lists all of the subapplications used by a given application, and it shows the connections between the subapplications.
- Composite subapplications graph—Shows all the subapplications that the application depends on directly or indirectly.

The following sections describe each type in more detail, as well as these graph-related features:

- Obtaining configuration information
- Using command context (pop-up) menus
- Displaying various levels of detail
- Interpreting display changes in the clusterwide table and graphs

7.2.1 RMS full graph

▶ To display the RMS full graph, right-click on any system node and select *View Graph* from the context menu (Figure 81).

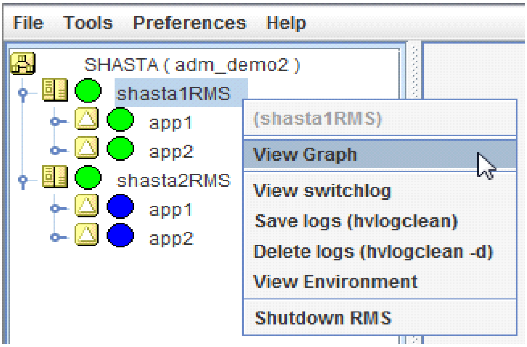


Figure 81: Viewing the RMS full graph on a node

The *View Graph* menu item is not available if a graph is already open for that node.

By default, each graph appears as a separate tab in the right pane of the Cluster Admin view (Figure 82).

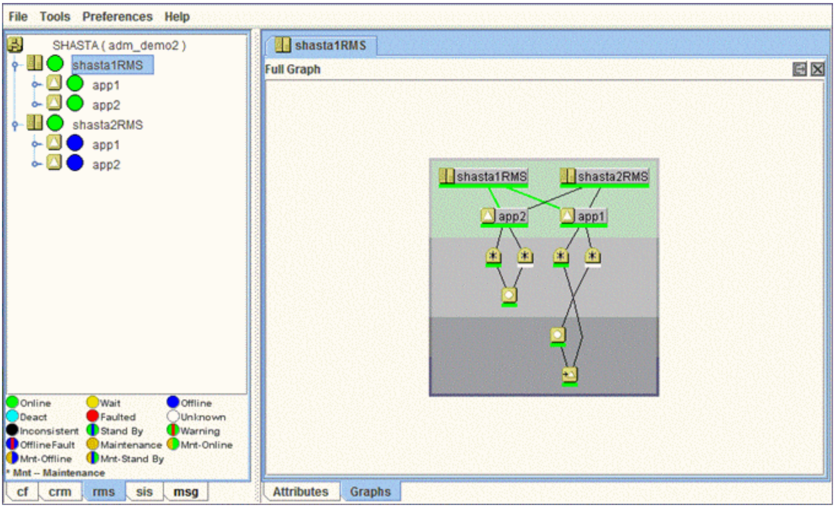


Figure 82: RMS full graph on a node—tab view

► To view any tab in a separate window, click the **detach** control button. The detach button is located next to the **close** control button in the upper-right corner of the view (Figure 83).

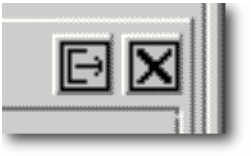


Figure 83: Detail of tab view showing detach button

The detached view contains the same information as the tabbed view (Figure 84).

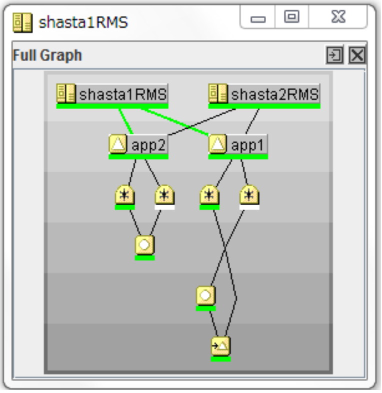


Figure 84: RMS full graph on a node—separate window view

- ► To rejoin the detached window to the Cluster Admin view, click the **attach** control button. The attach button is located next to the view's **close** control button in the upper-right corner, just below the standard window control buttons (Figure 85).

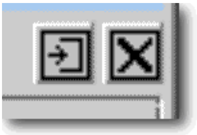


Figure 85: Detail of separate window view showing attach button

The RMS full graph displays the complete RMS configuration of the cluster and represents the following items:

- Node where each application is currently online, indicated by green lines between the node and application objects
- Object types, indicated by the object's icon
- Current object state, indicated by the colored bar beneath each icon
- Relationships between objects
- Dependencies of objects

The RMS graph is drawn from the perspective of the selected node; that is, the state information of all other objects is displayed according to the reports received by that node. The node name in the title bar of the graph identifies the node that is supplying the state information. You can create an RMS graph from the perspective of any node in the cluster.

The background of the graph is shaded from top to bottom with progressively darker gray bands. In large, complicated graphs, this can help to locate objects and identify their dependency level.

If you position the mouse cursor over an object in the graph, the cursor changes to a crosshair and the object's name appears as a tool tip. Also, the connector lines radiating from the object are highlighted with yellow to indicate its parent and child dependencies (Figure 86).

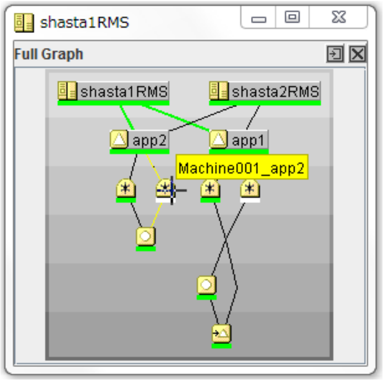
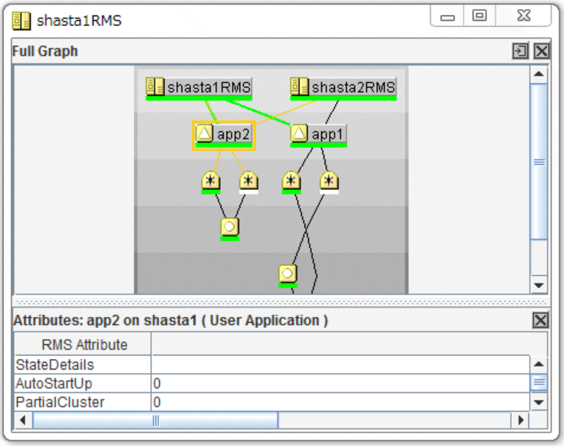


Figure 86: RMS full graph—object tooltip

Clicking on the object brings up a window with further details such as the object's attributes (Figure 87).



shasta1RMS

Full Graph

Attributes: app2 on shasta1 (User Application)

RMS Attribute	
StateDetails	
AutoStartUp	0
PartialCluster	0

Figure 87: RMS full graph—object details

7.2.2 Application graph

- ► To display the graph for a single application, right-click on the application object and select *View Application Graph* from the context menu (Figure 88).

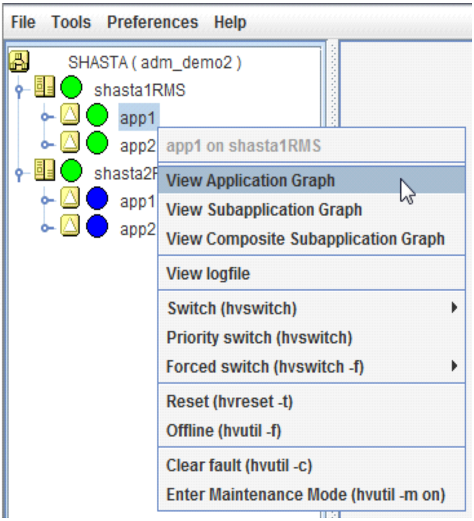


Figure 88: Viewing an RMS application graph

The application graph shares the same features as the full graph, except that it shows only the selected application and its resources (Figure 89). Like the full graph, the application graph is shown from the perspective of the selected node, and tooltips and details are available for every object.

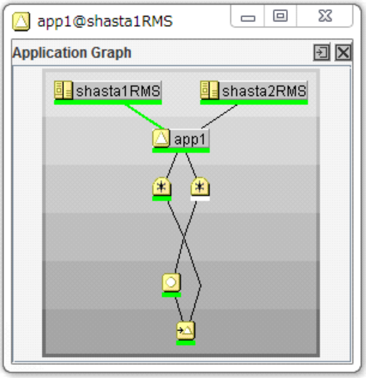


Figure 89: Typical RMS application graph

7.2.3 Subapplication graph

- ► To display a subapplication graph, right-click on the parent application and select *View Subapplication Graph* from the context menu (Figure 90).

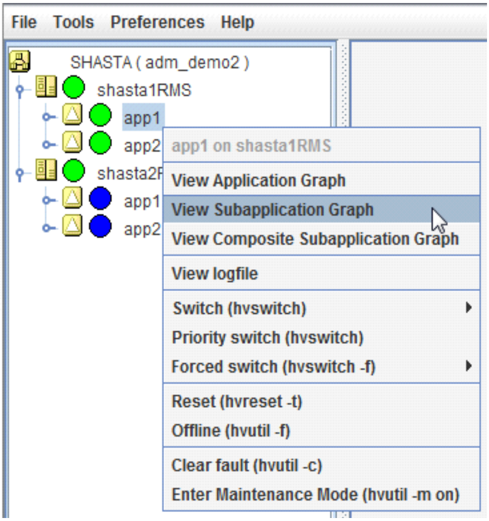


Figure 90: Viewing an RMS subapplication graph

This graph displays all the subapplications used by the selected application, showing the connections between the subapplications (Figure 91).

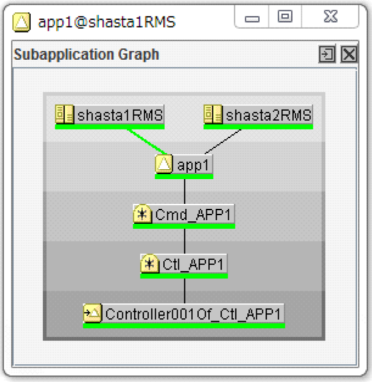


Figure 91: Typical RMS subapplication graph

For clarity, names of the subapplication objects are shown as labels rather than tooltips, and various abstractions such as non-affiliated objects are not included. Like other graphs, clicking on an object brings up a window that displays its attributes.

7.2.4 Composite subapplication graph

> The composite subapplication graph is available only for applications with controller objects.

When the configuration includes a controller object, the full graph of the node (or of either application) shows the parent and child applications in separate branches (Figure 92).

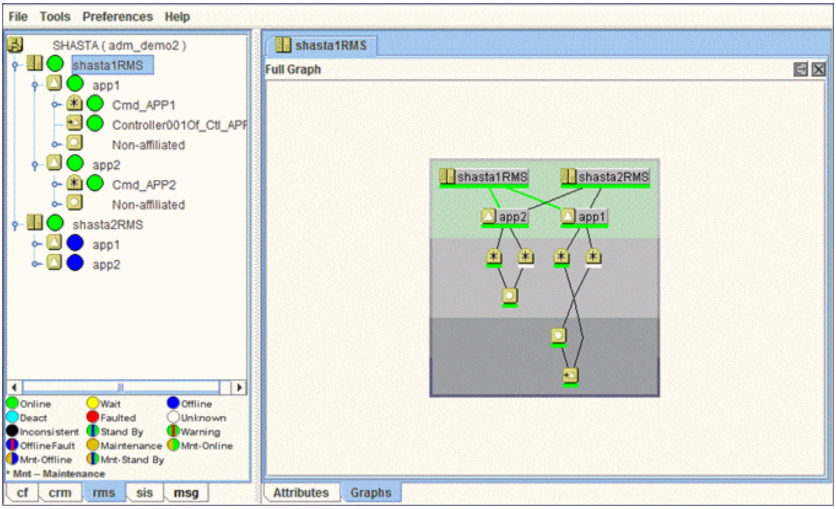


Figure 92: Standard view of configuration with controlled application

In some cases, it is convenient to view the child application as a resource of the parent so they both appear in the same branch. This is called a **composite subapplication graph**.

- ► To view a composite subapplication graph, right-click on the parent application and select *View Composite Subapplication Graph* from the context menu (Figure 93).

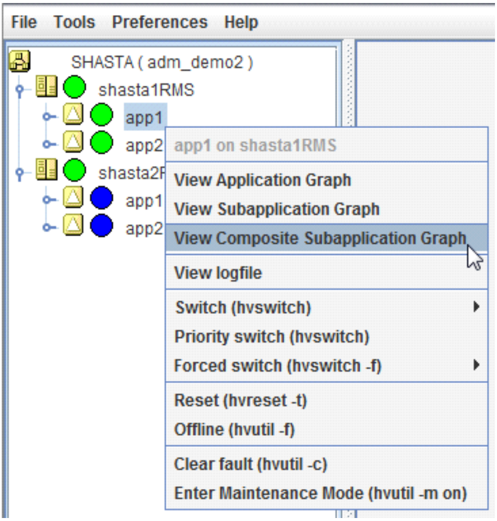


Figure 93: Viewing an RMS composite subapplication graph

For every controller object in the subapplication graph, the graph of its controlled application is inserted with a dotted line connection to the parent controller. For example, note where *app2* appears in the composite subapplication graph in Figure 94 below, and compare this to the standard graph shown earlier in Figure 92.

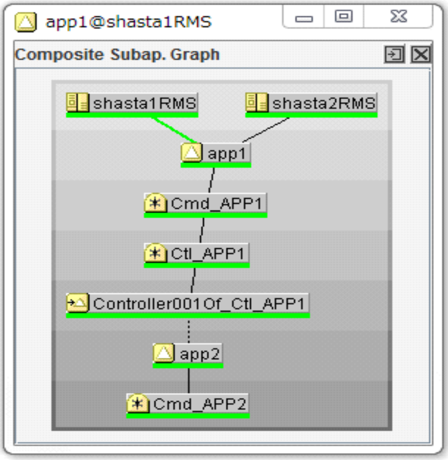


Figure 94: Typical composite subapplication graph

If the controlled application has its own controller objects, then the process is recursively repeated. This gives a composite view of all the subapplications that the selected parent application depends on, whether directly or indirectly.

7.2.5 Using pop-up context menus from the graph

Each object in the RMS graph has a pop-up context menu that provides quick access to commonly-used operations.

► To display a context menu, right-click on any object in a graph.

The first item on the menu displays the selected object's name in grayed-out text. The remaining items list the available operations, which vary according to the object's type and current state (Figure 95).

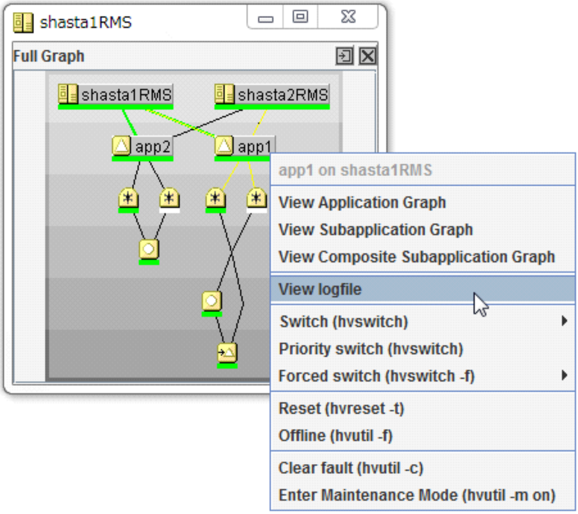


Figure 95: Using a pop-up context menu from the RMS graph

Items that affect object states, node states, or the entire RMS configuration appear toward the bottom of the menu. These actions are described in the final sections of this chapter.

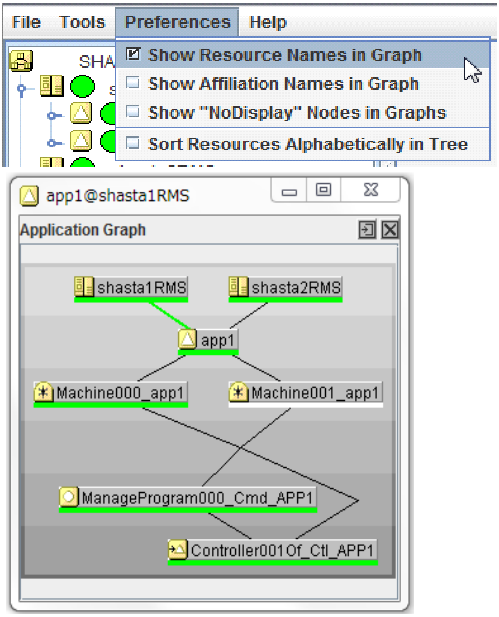
► To close the context menu without performing an operation, click the grayed-out object name in the menu or press the Esc key.

7.2.6 Changing the displayed detail level

By default, the RMS graph does not display the resource (object) names on the graphs. These are available as tool tips and can be seen by placing the mouse over a particular object.

► To add any combination of resource names, affiliation names, “NoDisplay” nodes to the graphs, use the checkboxes on the *Preferences* menu.

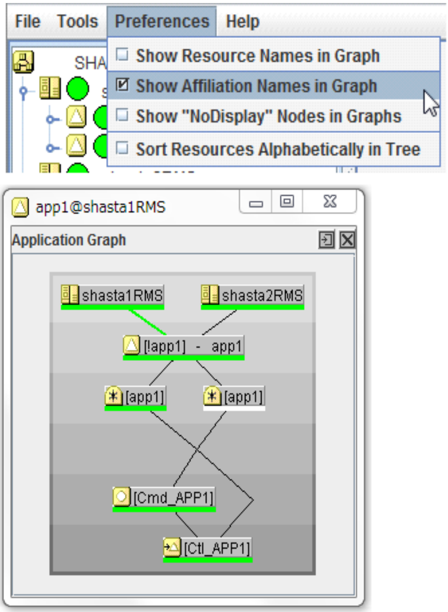
Figure 96 shows the preference setting and a corresponding graph that displays resource names.



☑ Show Resource Names in Graph
☐ Show Affiliation Names in Graph
☐ Show "NoDisplay" Nodes in Graphs
☐ Sort Resources Alphabetically in Tree

Figure 96: Displaying an RMS graph with affiliation names

Figure 97 shows the preference setting and a corresponding graph that displays affiliation names.



□ Show Resource Names in Graph

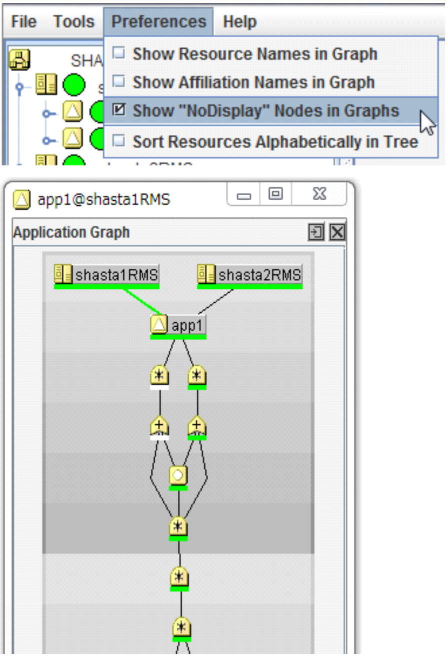
☑ Show Affiliation Names in Graph

□ Show "NoDisplay" Nodes in Graphs

□ Sort Resources Alphabetically in Tree

Figure 97: RMS graph with resource names

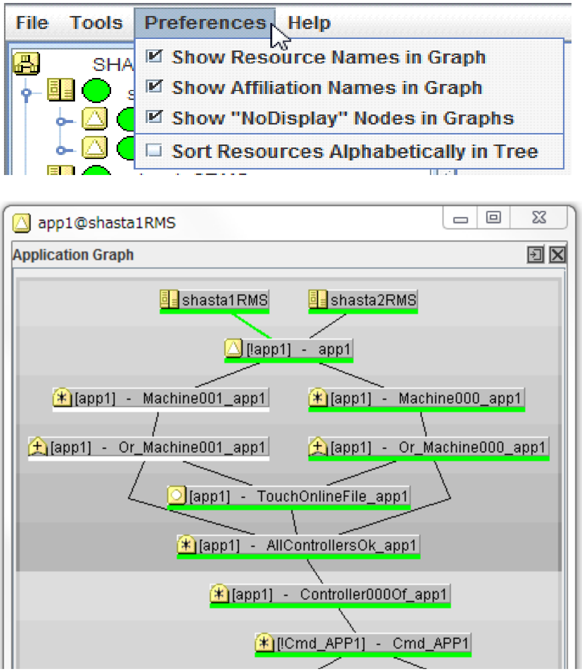
Figure 98 shows the preference setting and a corresponding graph that displays “NoDisplay” objects. These are typically logical AND/OR objects that are automatically generated by the configuration tool.



□ Show Resource Names in Graph
□ Show Affiliation Names in Graph
☑ Show "NoDisplay" Nodes in Graphs
□ Sort Resources Alphabetically in Tree

Figure 98: RMS graph with resource names

If two or more display options are selected, some of the object and resource names will consume more on-screen space (Figure 99). Horizontal scrollbars will appear when the graph is larger than the width of the screen, but the graph may still be difficult to read.



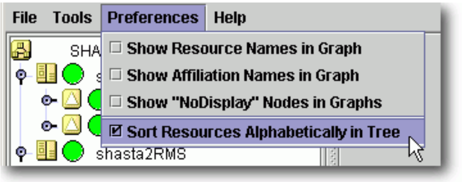
File Tools Preferences Help

- ☑ Show Resource Names in Graph
- ☑ Show Affiliation Names in Graph
- ☑ Show "NoDisplay" Nodes in Graphs
- ☐ Sort Resources Alphabetically in Tree

SHA
app1@shasta1RMS
Application Graph
shasta1RMS
shasta2RMS
[!app1] - app1
[app1] - Machine001_app1
[app1] - Machine000_app1
[app1] - Or_Machine001_app1
[app1] - Or_Machine000_app1
[app1] - TouchOnlineFile_app1
[app1] - AllControllersOk_app1
[app1] - Controller000Of_app1
[!Cmd_APP1] - Cmd_APP1

Figure 99: RMS graph with resource and affiliation names

In a complicated graph, it may help to sort the resource names alphabetically (Figure 100).



File Tools Preferences Help

- ☐ Show Resource Names in Graph
- ☐ Show Affiliation Names in Graph
- ☐ Show "NoDisplay" Nodes in Graphs
- ☑ Sort Resources Alphabetically in Tree

Figure 100: Sorting object names in the graph

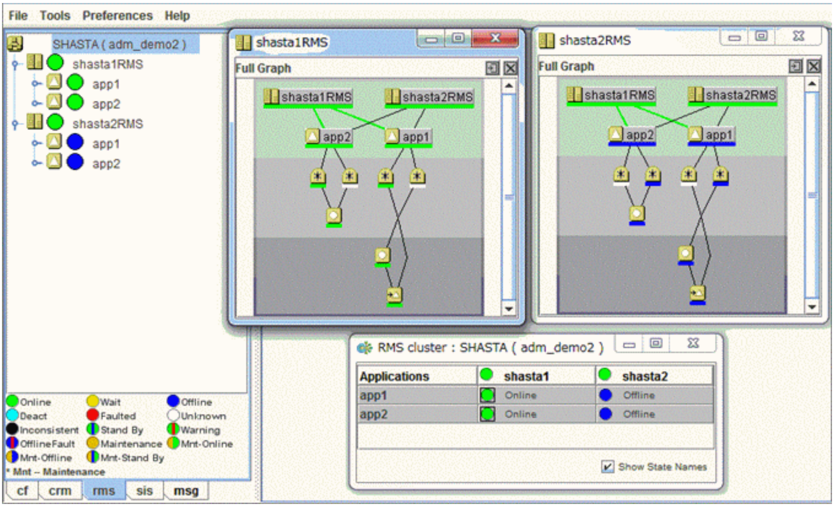
7.3 Interpreting display changes

The Cluster Admin view, the graphs, and the clusterwide table all have methods to denote the state of individual nodes as well as the overall configuration.

7.3.1 Display during RMS configuration changes

When you stop and restart RMS with a different configuration, the RMS tree, the clusterwide table, and the node graphs are redrawn in the same windows.

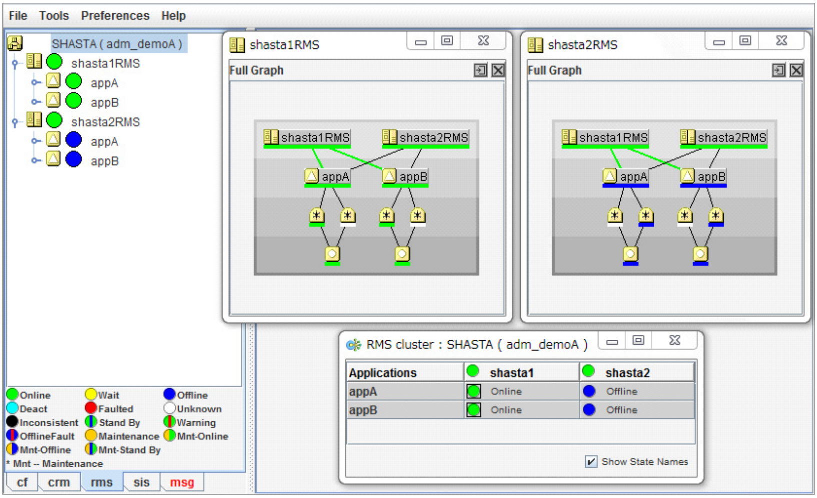
Figure 101 illustrates a Cluster Admin view overlaid by two individual node graphs and the clusterwide table, all displaying the state of a running configuration that monitors `app1` and `app2`.



Applications	● shasta1	● shasta2
app1	Online	Offline
app2	Online	Offline

Figure 101: Cluster state before RMS is shut down

Figure 102 shows the same windows after RMS has been restarted, this time with a different configuration that monitors `appA` and `appB`.



Applications	● shasta1	● shasta2
appA	🟩 Online	● Offline
appB	🟩 Online	● Offline

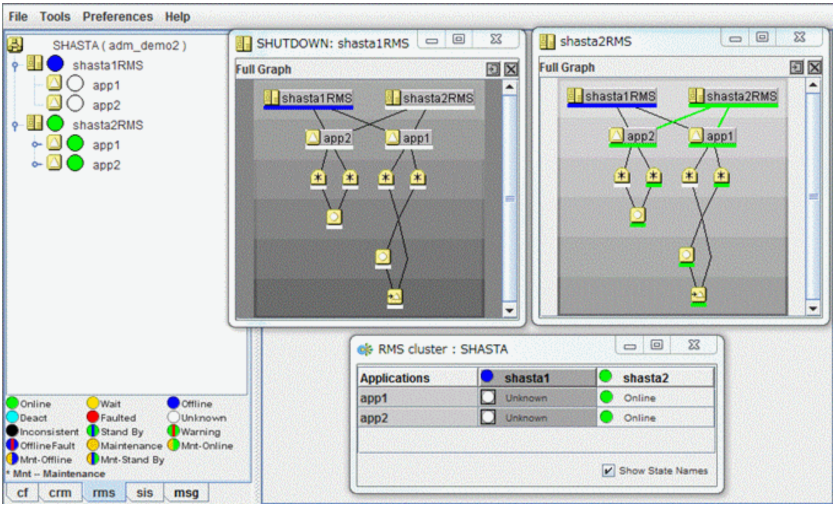
Figure 102: Cluster state after RMS restart with different configuration

The graphs and clusterwide table display the status of the same `SysNode` objects (`shasta1` and `shasta2`) before and after the restart, so the windows remain open.

7.3.2 Display after RMS shutdown

After RMS is shut down, the background of RMS graph windows become dark gray on the node from which they are getting their information. In this condition, all the states are white, indicating that the states are unknown. Once the node on which RMS is activated is connected, the GUI starts to display the information again.

For example, suppose RMS is shut down only on one node (`shasta1`) of our example cluster. The graph on that node and the corresponding column of the clusterwide table will be shaded with a dark gray background (Figure 103).



Applications	● shasta1	● shasta2
app1	□ Unknown	● Online
app2	□ Unknown	● Online

☑ Show State Names

Figure 103: RMS main view, graphs, and clusterwide table after shutdown on one node

However, as long as RMS continues to run on the remaining node, `shasta2`, the RMS main view, the `shasta2RMS` graph, and the `shasta2` column in the clusterwide table will indicate the online objects.

Application and subapplication graphs

When a node shuts down, any application or subapplication graph on that node would also change to the shutdown state (Figure 104).

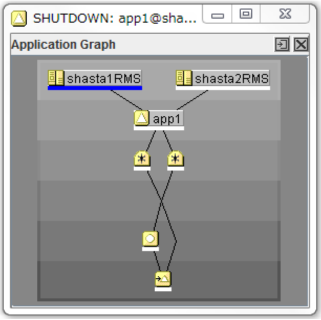
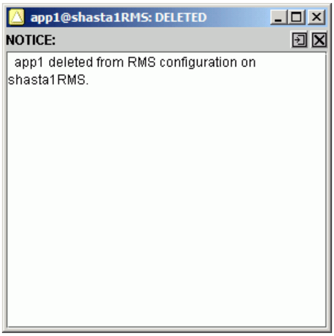


Figure 104: Application graph on shutdown node

The graph retains this appearance until the node restarts with the same configuration, at which point it returns to its normal display.

If the node restarts with a different configuration, the graph contents are deleted, because the object(s) no longer exist in the new configuration. However, the empty graph window remain opens until explicitly closed (Figure 105).



app1 deleted from RMS configuration on shasta1RMS.

Figure 105: Graph window for deleted object

7.4 Viewing RMS log messages

The Cluster Admin interface provides a log viewer that lets you view and filter entries in the RMS switchlog and individual application logs on any node.

All RMS log files, which normally reside in `/var/opt/SMAWRrms/log/`, can be viewed directly using a standard UNIX editor like `vi`.

For meanings of error messages and possible corrective actions, refer to "PRIMECLUSTER Messages."

Note

If you have built a cluster system in the following environments, these logs cannot be displayed from the Cluster Admin.

- FUJITSU Cloud Service K5 environment

- Environment that uses Firewall

- Red Hat OpenStack Platform environment

View the switchlog for a system node as follows:

- Right-click on the system node and select *View Switchlog* from the pop-up context menu (Figure 106). Alternatively, select a node and use *Tools –> View switchlog* (Figure 107).

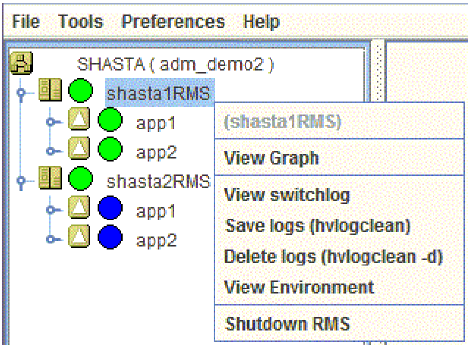


Figure 106: Viewing the RMS switchlog file using a context menu

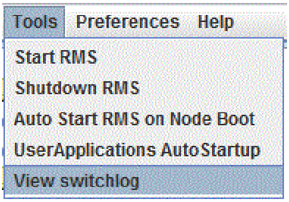


Figure 107: Viewing the RMS switchlog file using the Tools menu

View an application log as follows:

► Right-click on an application on the RMS tree and choose *View logfile* from the pop-up context menu (Figure 108).

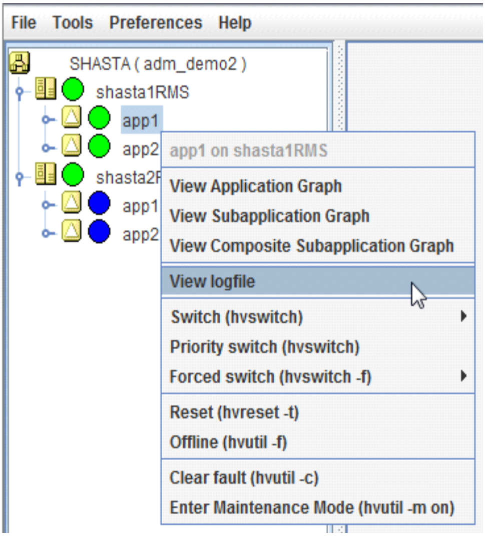
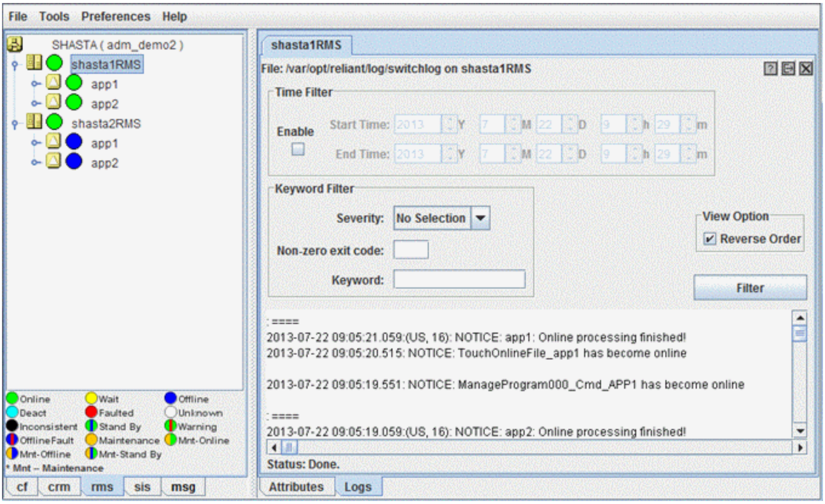


Figure 108: Viewing an application log using a context menu

i You can invoke equivalent context menus for an object from the Cluster Admin view, from the clusterwide table, or from any RMS graph containing that object.

By default, each log file is displayed in a separate tab in the right pane (Figure 109).



File: /var/opt/reliant/log/switchlog on shasta1RMS

Enable □

Start Time: 2013 Y 7 M 22 D 9 h 29 m

End Time: 2013 Y 7 M 22 D 9 h 29 m

Severity: No Selection

Non-zero exit code:

Keyword:

☑ Reverse Order

```
: ====
2013-07-22 09:05:21.059:(US, 16): NOTICE: app1: Online processing finished!
2013-07-22 09:05:20.515: NOTICE: TouchOnlineFile_app1 has become online

2013-07-22 09:05:19.551: NOTICE: ManageProgram000_Cmd_APP1 has become online

: ====
2013-07-22 09:05:19.059:(US, 16): NOTICE: app2: Online processing finished!
```

Status: Done.

Figure 109: RMS switchlog in tab view

- ► To view any tab in a separate window, click the **detach** control button. The detach button is located between the **help** and **close** control buttons in the upper-right corner of the view (Figure 110).

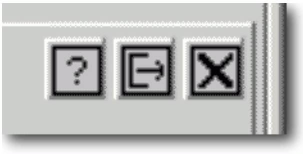
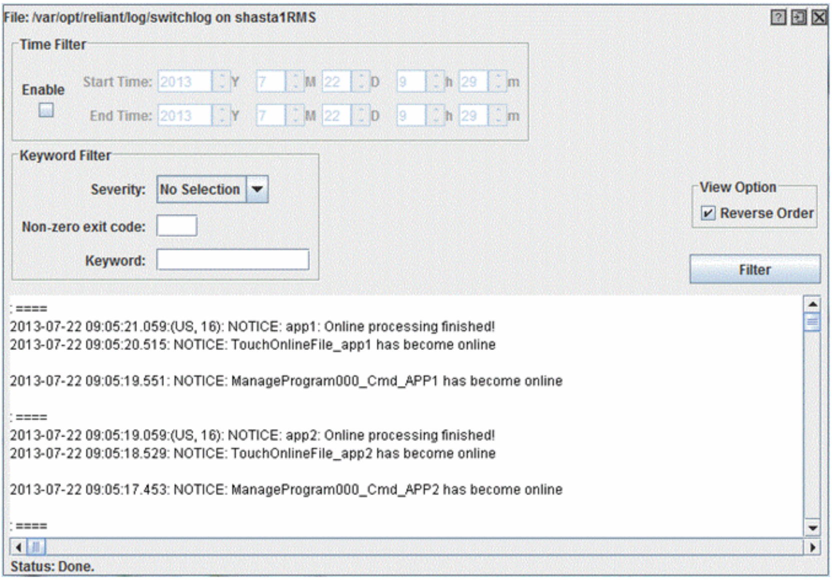


Figure 110: Detail of tab view showing detach button

The detached view contains the same information as the tabbed view (Figure 111).



File: /var/opt/reliant/log/switchlog on shasta1RMS

Time Filter

Enable □

Start Time: 2013 Y 7 M 22 D 9 h 29 m

End Time: 2013 Y 7 M 22 D 9 h 29 m

Keyword Filter

Severity: No Selection

Non-zero exit code:

Keyword:

View Option

☑ Reverse Order

```
:====
2013-07-22 09:05:21.059:(US, 16): NOTICE: app1: Online processing finished!
2013-07-22 09:05:20.515: NOTICE: TouchOnlineFile_app1 has become online

2013-07-22 09:05:19.551: NOTICE: ManageProgram000_Cmd_APP1 has become online

:====
2013-07-22 09:05:19.059:(US, 16): NOTICE: app2: Online processing finished!
2013-07-22 09:05:18.529: NOTICE: TouchOnlineFile_app2 has become online

2013-07-22 09:05:17.453: NOTICE: ManageProgram000_Cmd_APP2 has become online

:====
```

Status: Done.

Figure 111: RMS switchlog in detached view

► To rejoin the detached window to the Cluster Admin view, click the **attach** control button. The attach button is located between the view’s **help** and **close** control buttons in the upper-right corner, just below the standard window control buttons (Figure 112).

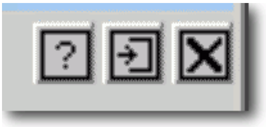


Figure 112: Detail of detached window view showing attach button

i While in detached mode, the view’s close button and the standard window **close** button serve the same purpose: they both close the detached window.

In attached mode, the tabbed view’s **close** button closes only the visible tab. All other tabs remain open.

7.4.1 Common procedures for switchlog and application log

By default, the entire log is available in the scrolled area at the bottom of the window. You can restrict the entries displayed with the following filters, which are described in subsections below:

- *Time Filter*—defines the time period of interest.
- *Keyword Filter*—selects a particular resource name (for an application only), error message severity level, non-zero exit code, or keyword.

> **i** For details on severity levels, see the section "Severity", and on exit codes, see "PRIMECLUSTER Messages."

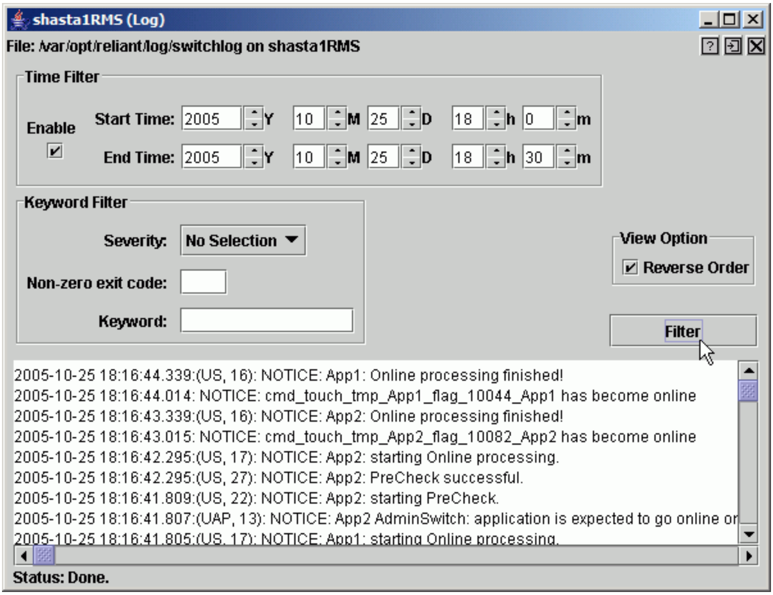
► After you enter your filter criteria, click the *Filter* button to display the filtered log entries.

> **i** All the selected and non-blank *Time Filter* and *Keyword Filter* controls are combined with a logical `AND` operation.

At any time, you can sort the displayed switchlog entries according to increasing or decreasing time by checking or unchecking the *Reverse Order* checkbox in the log viewer window.

7.4.2 Time filter

The controls in the *Time Filter* panel allow you to limit the entries displayed in the log pane according to their date and time (Figure 113).



shasta1RMS (Log)

File: /var/opt/reliant/log/switchlog on shasta1RMS

Time Filter

Enable ☑

Start Time: 2005 Y 10 M 25 D 18 h 0 m

End Time: 2005 Y 10 M 25 D 18 h 30 m

Keyword Filter

Severity: No Selection

Non-zero exit code:

Keyword:

View Option

☑ Reverse Order

```
2005-10-25 18:16:44.339:(US, 16): NOTICE: App1: Online processing finished!
2005-10-25 18:16:44.014: NOTICE: cmd_touch_tmp_App1_flag_10044_App1 has become online
2005-10-25 18:16:43.339:(US, 16): NOTICE: App2: Online processing finished!
2005-10-25 18:16:43.015: NOTICE: cmd_touch_tmp_App2_flag_10082_App2 has become online
2005-10-25 18:16:42.295:(US, 17): NOTICE: App2: starting Online processing.
2005-10-25 18:16:42.295:(US, 27): NOTICE: App2: PreCheck successful.
2005-10-25 18:16:41.809:(US, 22): NOTICE: App2: starting PreCheck.
2005-10-25 18:16:41.807:(UAP, 13): NOTICE: App2 AdminSwitch: application is expected to go online or
2005-10-25 18:16:41.805:(US, 17): NOTICE: App1: starting Online processing.
```

Status: Done.

Figure 113: Search based on date and time range

- ► Select the *Start Time* and *End Time* using the scrolling input boxes (you can also type in the values directly) and then check the *Enable* checkbox.

The controls take effect the next time you click the *Filter* button.

- ► To remove the time filter, uncheck *Enable* and then click *Filter*.

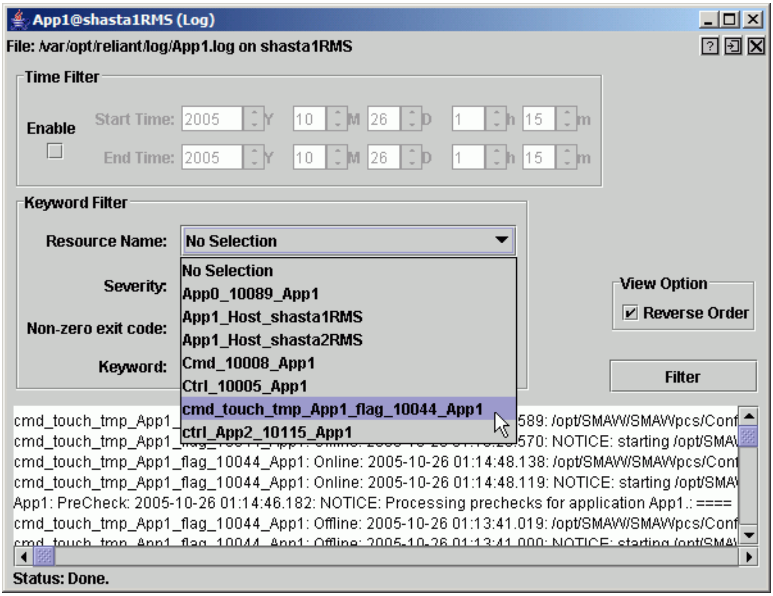
7.4.3 Keyword filters

The following items are available in the *Keyword Filter* panel.

7.4.3.1 Resource Name

The *Resource Name* control is available only for application logs.

► Select a resource name from the dropdown list (Figure 114) and then click *Filter*.



App1@shasta1RMS (Log)

File: /var/opt/reliant/log/App1.log on shasta1RMS

Time Filter

Enable □

Start Time: 2005 Y 10 M 26 D 1 h 15 m

End Time: 2005 Y 10 M 26 D 1 h 15 m

Keyword Filter

Resource Name: No Selection

View Option

☑ Reverse Order

```
cmd_touch_tmp_App1_                                          589: /opt/SMAW/SMAWpcs/Conf
cmd_touch_tmp_App1_                                          570: NOTICE: starting /opt/SMAW
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-26 01:14:48.138: /opt/SMAW/SMAWpcs/Conf
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-26 01:14:48.119: NOTICE: starting /opt/SMAW
App1: PreCheck: 2005-10-26 01:14:46.182: NOTICE: Processing prechecks for application App1.: ====
cmd_touch_tmp_App1_flag_10044_App1: Offline: 2005-10-26 01:13:41.019: /opt/SMAW/SMAWpcs/Conf
cmd_touch_tmp_App1_flag_10044_App1: Offline: 2005-10-26 01:13:41.000: NOTICE: starting /opt/SMAW
```

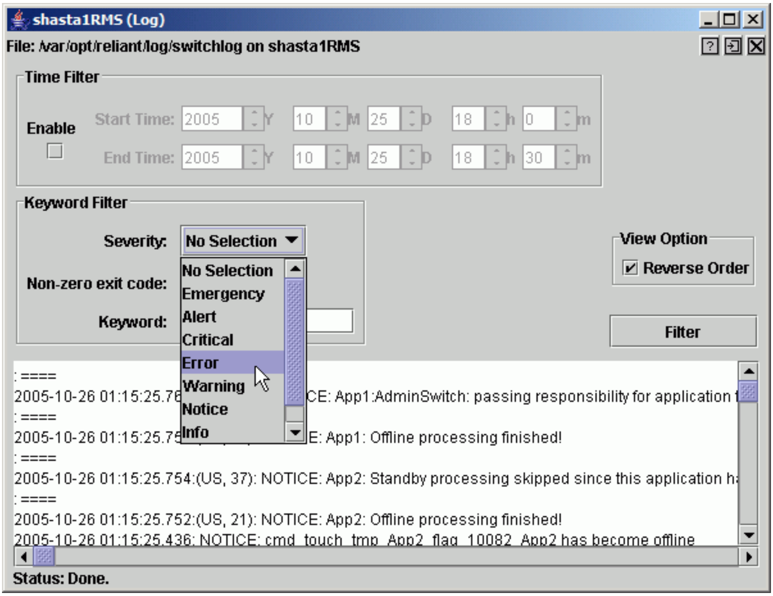
Status: Done.

Figure 114: Search based on resource name

► To remove the resource name filter, select *No Selection* from the dropdown list and then click *Filter*.

7.4.3.2 Severity

- ► Select an message severity level from the dropdown list (Figure 115) and then click *Filter*.



shasta1RMS (Log)

File: /var/opt/reliant/log/switchlog on shasta1RMS

Time Filter

Enable ☐

Start Time: 2005 Y 10 M 25 D 18 h 0 m

End Time: 2005 Y 10 M 25 D 18 h 30 m

Keyword Filter

Severity: No Selection

Non-zero exit code:

Keyword:

View Option

☑ Reverse Order

```
: ====
2005-10-26 01:15:25.76                CE: App1:AdminSwitch: passing responsibility for application t
: ====
2005-10-26 01:15:25.75                E: App1: Offline processing finished!
: ====
2005-10-26 01:15:25.754:(US, 37): NOTICE: App2: Standby processing skipped since this application h
: ====
2005-10-26 01:15:25.752:(US, 21): NOTICE: App2: Offline processing finished!
2005-10-26 01:15:25.436: NOTICE: cmd  touch  tmp  App2  flag  10082  App2 has become offline
```

Status: Done.

Figure 115: Search based on severity level

Table 5 summarizes the RMS message log viewer severity levels.

Severity level	Description
Emergency	Systems cannot be used
Alert	Immediate action is necessary
Critical	Critical condition (fatal error)
Error	Error condition (non-fatal error)
Warning	Warning condition
Notice	Normal but important condition
Info	Miscellaneous information
Debug	Debug messages

Table 5: RMS severity level description

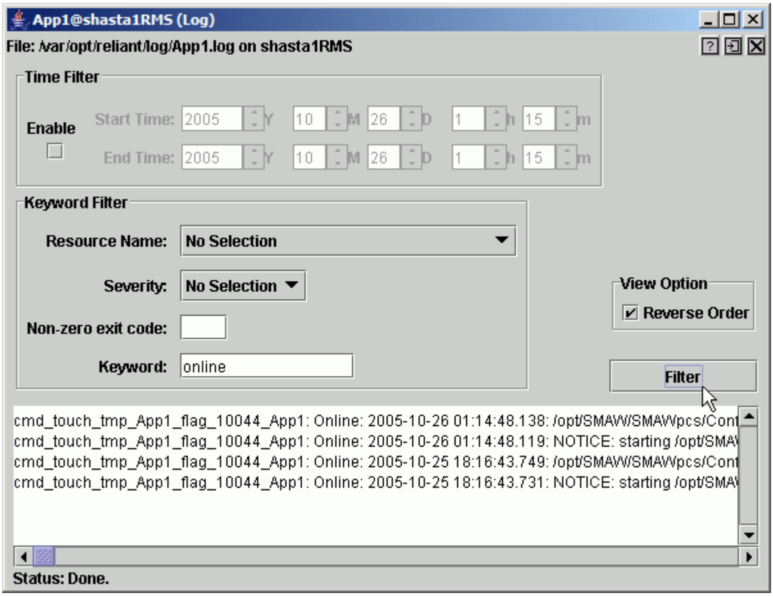
- To remove the severity level filter, select *No Selection* from the dropdown list and then click *Filter*.

7.4.3.3 Non-zero exit code

- Enter a numeric exit code in the *Non-zero exit code* input box and then click *Filter*.

7.4.3.4 Keyword

- Enter a string in the *Keyword* box (Figure 116) and then click *Filter*.



App1@shasta1RMS (Log)

File: /var/opt/reliant/log/App1.log on shasta1RMS

Time Filter

Enable ☐

Start Time: 2005 Y 10 M 26 D 1 h 15 m

End Time: 2005 Y 10 M 26 D 1 h 15 m

Keyword Filter

Resource Name: No Selection

Severity: No Selection

Non-zero exit code:

Keyword: online

View Option

☑ Reverse Order

```
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-26 01:14:48.138: /opt/SMAW/SMAWpcs/Cont
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-26 01:14:48.119: NOTICE: starting /opt/SMAW
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-25 18:16:43.749: /opt/SMAW/SMAWpcs/Cont
cmd_touch_tmp_App1_flag_10044_App1: Online: 2005-10-25 18:16:43.731: NOTICE: starting /opt/SMAW
```

Status: Done.

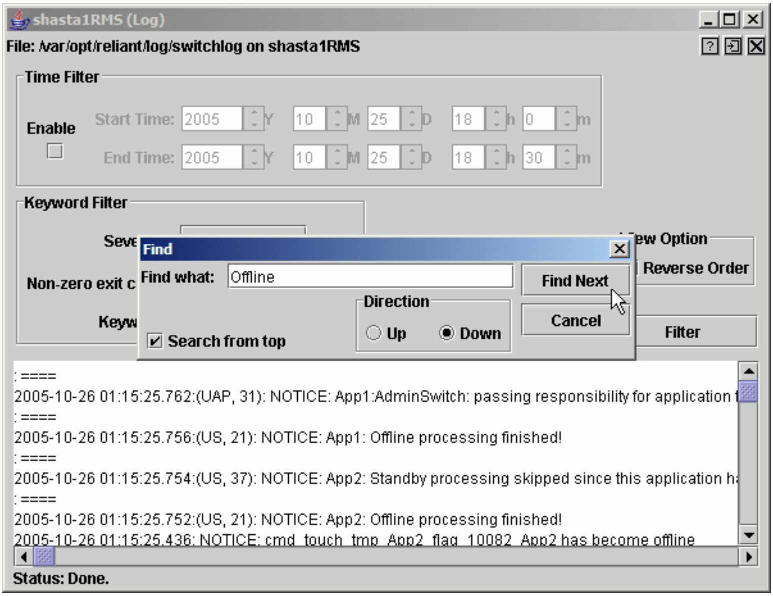
Figure 116: Search based on keyword

Special characters and spaces are valid, but wildcards are not interpreted. This search is **not case-sensitive**.

- To remove the keyword filter, clear the text in the *Keyword* box and then click *Filter*.

7.4.4 Text search

You can search the text in the application log by right-clicking on the displayed text. A pop-up dialog with a *Find* entry allows you to perform a **case-sensitive** search in the direction you specify (Figure 117).



shasta1RMS (Log)

File: /var/opt/reliant/log/switchlog on shasta1RMS

Time Filter

Enable □

Start Time: 2005 Y 10 M 25 D 18 h 0 m

End Time: 2005 Y 10 M 25 D 18 h 30 m

Keyword Filter

Find

Find what: Offline

☑ Search from top

Direction: ○ Up ● Down

```
: ====
2005-10-26 01:15:25.762:(UAP, 31): NOTICE: App1:AdminSwitch: passing responsibility for application t
: ====
2005-10-26 01:15:25.756:(US, 21): NOTICE: App1: Offline processing finished!
: ====
2005-10-26 01:15:25.754:(US, 37): NOTICE: App2: Standby processing skipped since this application h
: ====
2005-10-26 01:15:25.752:(US, 21): NOTICE: App2: Offline processing finished!
2005-10-26 01:15:25.436: NOTICE: cmd_touch_tmp_App2_flag_10082_App2 has become offline
```

Status: Done.

Figure 117: Using the pop-up Find dialog in log viewer

> **i** The *Find* search string is processed literally. You can include spaces and special characters, but wildcards are not interpreted.

7.4.5 Removing filters

To remove all filters, take the following steps:

- Uncheck the time filter *Enable* box.
- Set drop-down lists to *No Selection*
- Clear text from input boxes
- Click the *Filter* button

The unfiltered view will be restored.

8 Controlling RMS operation

Chapter contents:

- " Managing RMS nodes"
- "Managing RMS applications"
- "Managing resources"
- "Using maintenance mode"

8.1 Managing RMS nodes

This section describes basic procedures to control the operation of RMS, including how to start and stop individual nodes or the entire cluster. Procedures in this section are active: they change the state of the RMS cluster and may have a direct effect on the disposition of data.

As stated in the overview of this chapter, the primary means of administration is through the Cluster Admin GUI. This method should be used whenever possible. However, each procedure in this section includes a CLI alternative.

- The command is stored in <*RELIANT_PATH*>/bin directory.
- If CF code names and RMS node names follow the naming convention (if the structure of the name is <*CFname*>RMS), both are operated as Sysnode object in all of the commands of RMS CLI.
- In the description of commands, only the most frequently used options are stated. Available options may exist other than these. For command details, see the manual pages of each command.

8.1.1 Starting RMS

When you use the GUI, you can only start the most recently activated configuration. To start a different configuration, you must first use the Wizard Tools to activate that configuration.

By default, the GUI will start RMS on all the nodes in the cluster. Alternatively, you can start RMS only on a single node that you select.

► From the Cluster Admin *rms* tab, select *Tools –> Start RMS* (Figure 118).

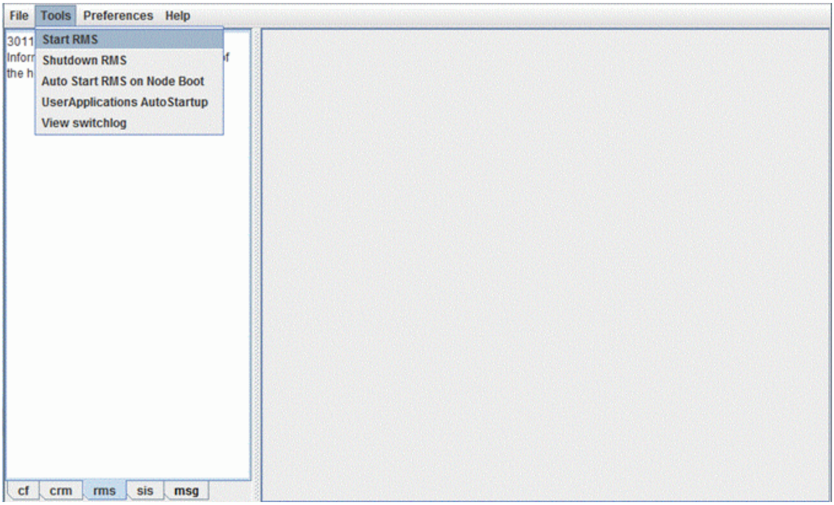
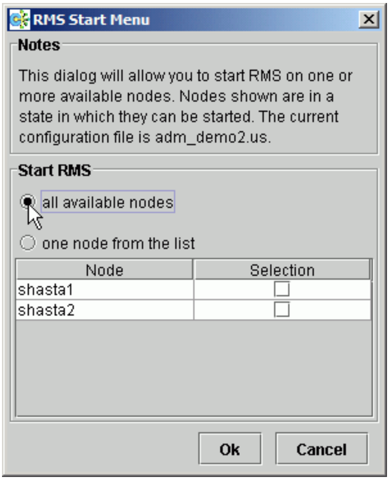


Figure 118: Starting RMS from the main menu

The *RMS Start Menu* window opens.

► To start RMS on all the nodes, click the *all available nodes* radio button and then click *OK* (Figure 119).



Notes

This dialog will allow you to start RMS on one or more available nodes. Nodes shown are in a state in which they can be started. The current configuration file is adm_demo2.us.

Start RMS

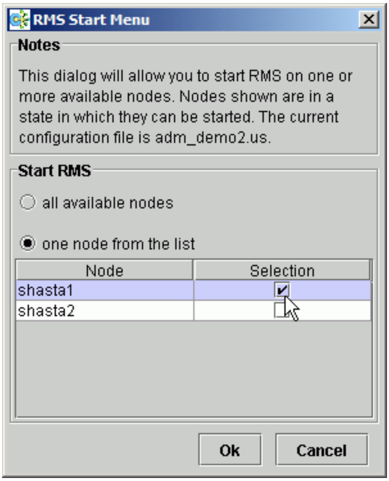
● all available nodes

○ one node from the list

Node	Selection
shasta1	□
shasta2	□

Figure 119: RMS Start Menu for all the nodes

► To start RMS only on a single node, click the *one node from the list* radio button, and then choose the node using a checkbox in the *Selection* column. After making your selections, click *OK* (Figure 120).


RMS Start Menu

Notes

This dialog will allow you to start RMS on one or more available nodes. Nodes shown are in a state in which they can be started. The current configuration file is adm_demo2.us.

Start RMS

○ all available nodes

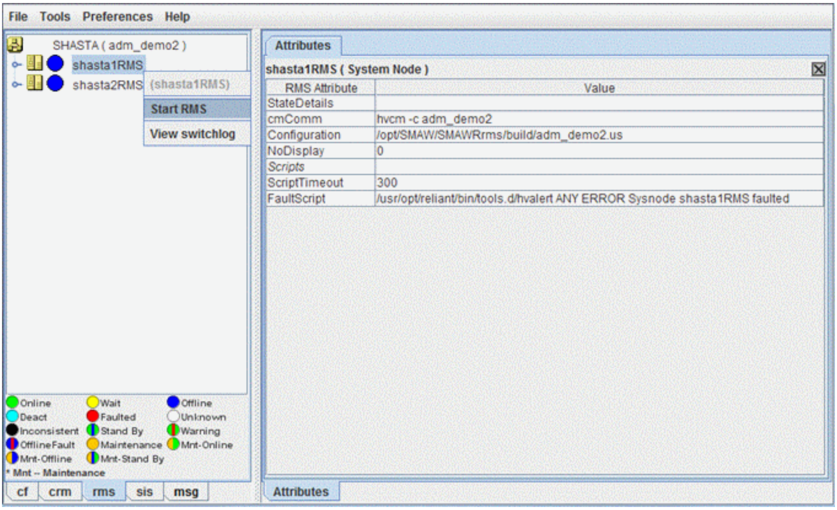
● one node from the list

Node	Selection
shasta1	☑
shasta2	□

Figure 120: RMS Start Menu for individual nodes

Alternatively, you can start RMS on individual nodes directly from the *Cluster Admin* window:

1. In the left pane, click the *rms* tab to view the cluster tree.
2. Right-click on the node and select *Start RMS* from the pop-up menu (Figure 121).



shasta1RMS (System Node)

RMS Attribute	Value
StateDetails	
cmComm	hvcm -c adm_demo2
Configuration	/opt/SMAW/SMAWRrms/build/adm_demo2.us
NoDisplay	0
Scripts	
ScriptTimeout	300
FaultScript	/usr/opt/reliant/bin/tools.d/hvalert ANY ERROR Sysnode shasta1RMS faulted

Figure 121: Starting RMS on individual nodes

CLI: hvcm

The `hvcm` command starts the base monitor and the detectors for all monitored resources. The CLI syntax for `hvcm` has two possible formats:

Format 1

`hvcm [-a | -s` *SysNode*`]`

Format 2

`hvcm -c` *config_name* `[-a | -s` *SysNode*`] [-h` *timeout*`] [-l` *loglevels*`]`

The options valid for both formats are:

- `-a` Start RMS on all the nodes in the configuration
- `-s` Start RMS only on the specified node

If neither '`-a`' nor '`-s`' is specified, `hvcm` starts RMS only on the local node.

The options valid only for *Format 2* are:

- `-c` Use the specified configuration file
- `-h` Use the specified heartbeat recovery timeout
- `-l` Activate diagnostic output according to the specified level(s)

> i To start a configuration other than the one most recently activated, change the heartbeat recovery timeout, or set the diagnostic level, you must use the CLI. These parameters cannot be adjusted from the Cluster Admin GUI.

Notes for Format 1

When the '`-c`' option is not present, `hvcm` reads the default `CONFIG.rms` startup file. `hvcm` looks for the default startup file in <*RELIANT_PATH*>`/etc/CONFIG.rms`. If the default for the environment variable `RELIANT_PATH` has not been changed, this resolves to `/opt/SMAW/SMAWRrms/etc/CONFIG.rms`. Note that the search is always confined to the local node, even if you specify the '`-a`' or '`-s`' option to start RMS remotely.

The `CONFIG.rms` file contains either of the following:

- A simple configuration name, optionally with a '`.us`' suffix.
- An `hvcm` command compliant with *Format 2* that starts the most recently activated configuration.

You cannot specify the '`-h`' or '`-l`' options in *Format 1*. You can, however, edit the `CONFIG.rms` file and insert the options to comply with *Format 2*.

Notes for Format 2

When the '`-c`' option is present, and the configuration file is not an absolute path, `hvcm` looks for the first match in <*RELIANT_STARTUP_PATH*>. If the default for the environment variable `RELIANT_STARTUP_PATH` has not been changed, this resolves to `/opt/SMAW/SMAWRrms/build/`<*config_name*>`.us` (`hvcm` adds the '`.us`' extension if it is not specified as part of the configuration file name). If an absolute path is specified, `hvcm` attempts to read only that file. Note that the search is always confined to the local node, even if you specify the '`-a`' or '`-s`' option to start RMS remotely.

When `hvcm` locates the specified configuration file, it checks to see if the default `CONFIG.rms` file is also present. If it is, `hvcm` compares the configuration names defined by both files to make sure they agree. If they do not agree, `hvcm` aborts the startup processing.

The '`-h`' option sets the UDP heartbeat recovery timeout for the cluster. See "Nodes and heartbeats". The default timeout depends on which method RMS uses to monitor the cluster:

- By default, RMS monitors the state of each node with the Enhanced Lock Manager (ELM), which is implemented in the Cluster Foundation. ELM is not a polling method. Instead, it relies on locks that are held by each node and released when the node or its base monitor go down. When ELM is enabled, the UDP heartbeat timeout defaults to 600 seconds.
- ELM can be disabled for rolling upgrade or debugging operations by setting the HV_USE_ELM environment variable to zero (0). See "`HV_USE_ELM`". When ELM is disabled, the UDP heartbeat defaults to 45 seconds.

i Specifying a heartbeat timeout shorter than the default may cause premature node kills. No data loss will occur, because a node kill begins with a graceful shutdown. However, cluster performance may suffer due to latency as applications are switched to different nodes. Excessively short heartbeat timeouts may also interfere with CF event timeouts.

The ‘`-l`’ option sets the diagnostic output level at startup time. The *loglevels* specification consists of one or more individual numeric levels or hyphen-delimited ranges, each separated by a comma.

8.1.2 Starting RMS automatically at boot time

i This setting takes effect at the next system startup

You can use the following procedure to activate or deactivate automatic RMS startup when the system boots up.

► From the Cluster Admin *rms* tabbed view, select *Tools > Auto Start RMS on Node Boot* (Figure 122).

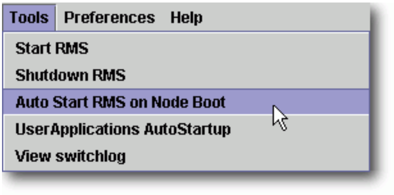
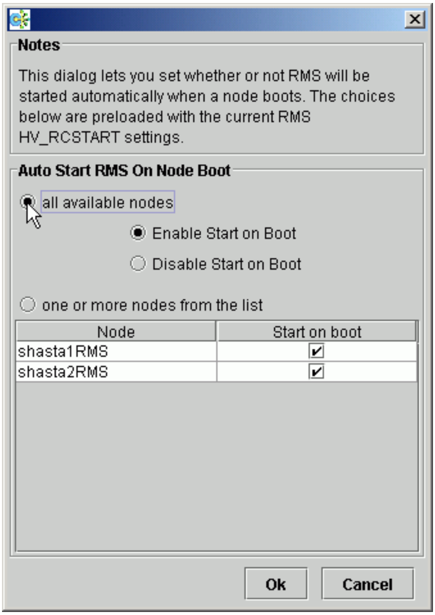


Figure 122: Controlling automatic RMS startup—step 1

You can then choose to activate (or deactivate) the automatic RMS startup on all the nodes, or on just one node (Figure 123).



Notes

This dialog lets you set whether or not RMS will be started automatically when a node boots. The choices below are preloaded with the current RMS HV_RCSTART settings.

Auto Start RMS On Node Boot

● all available nodes

● Enable Start on Boot

○ Disable Start on Boot

○ one or more nodes from the list

Node	Start on boot
shasta1RMS	☑
shasta2RMS	☑

Figure 123: Controlling automatic RMS startup—step 2

To enable this setting, Web-Based Admin View and CF on all the nodes that configure the cluster need to be working.

For how to check the server process status of Web-Based Admin View, and how to start Web-Based Admin View, see "4.3.3 Initial Setup of Web-Based Admin View" in "PRIMECLUSTER Installation and Administration Guide."

For how to check the status of CF and how to start CF, see "4.2 Main CF table" and "4.6 Starting and stopping CF" in "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide."

CLI: hvsetenv

At system startup, the RMS `rc` script checks the environment variable settings: if the `HV_RCSTART` environment variable is set to 1, the `rc` script will attempt to start RMS using the `CONFIG.rms` file. You can set the `HV_RCSTART` variable with the `hvsetenv` command as follows:

```
hvsetenv HV_RCSTART [0|1]
```

The allowable values are:

`0` Do not start RMS at boot time
`1` Start RMS at boot time (default)

If no value is specified, the command reports the current value of the `HV_RCSTART` environment variable.

8.1.3 Stopping RMS

You can stop RMS on all the nodes or on a subset that you select.

Use the *Tools* pull-down menu (Figure 124) and select *Shutdown RMS*.

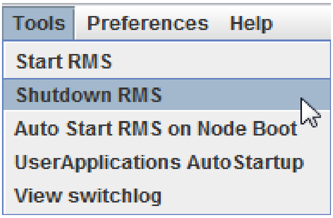
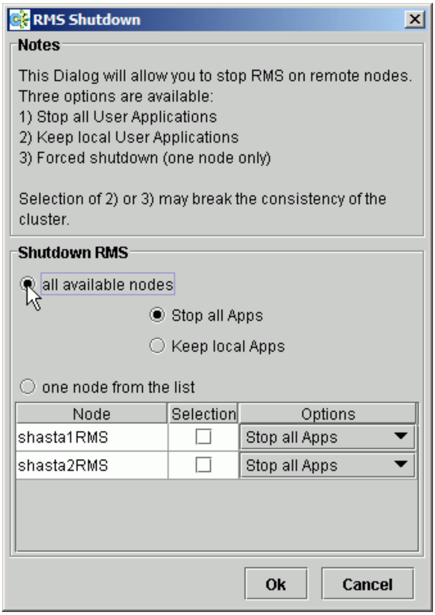


Figure 124: Using the Tools menu to stop RMS

- ► To stop RMS on all the nodes, click the radio button for *all available nodes* and then click *Ok* (Figure 125).



RMS Shutdown

Notes

This Dialog will allow you to stop RMS on remote nodes.
Three options are available:
1) Stop all User Applications
2) Keep local User Applications
3) Forced shutdown (one node only)

Selection of 2) or 3) may break the consistency of the cluster.

Shutdown RMS

● all available nodes

● Stop all Apps

○ Keep local Apps

○ one node from the list

Node	Selection	Options
shasta1RMS	□	Stop all Apps
shasta2RMS	□	Stop all Apps

Figure 125: Stopping RMS on all available nodes

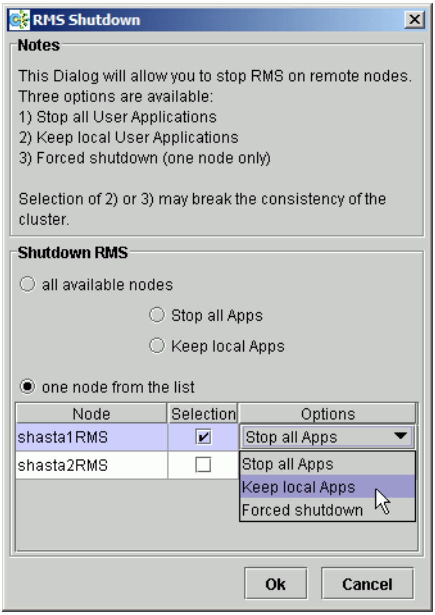
When you shut down *all available nodes*, two radio buttons allow you to choose how you want to handle the applications:

- *Stop all Apps*—Stops all user applications
- *Keep local Apps*—Leaves the applications running

Caution

Leaving the applications running after stopping RMS can lead to data inconsistencies or corruption.

To stop RMS on one specific node, select the radio button for *one node from the list*, and then click the checkbox of the node you want to shut down (Figure 126).



RMS Shutdown

Notes

This Dialog will allow you to stop RMS on remote nodes.
Three options are available:
1) Stop all User Applications
2) Keep local User Applications
3) Forced shutdown (one node only)

Selection of 2) or 3) may break the consistency of the cluster.

Shutdown RMS

○ all available nodes

○ Stop all Apps

○ Keep local Apps

● one node from the list

Node	Selection	Options
shasta1RMS	☑	Stop all Apps
shasta2RMS	□	

Figure 126: Stopping RMS on one node from the list

Each node has a dropdown list in the *Options* column to provide additional control:

- *Stop all Apps*—Stops all user applications on the selected node
- *Keep local Apps*—Leaves the applications running on the selected node
- *Forced shutdown*—Performs a forced shutdown of RMS

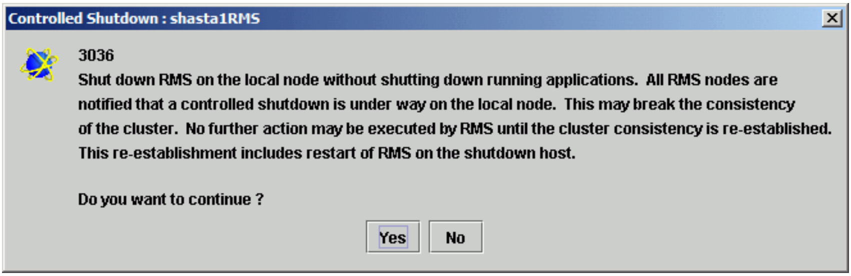
Caution

– *Keep local Apps* or *Forced shutdown* can cause data inconsistencies or corruption.

– Do not stop RMS while RMS is running. Heartbeats between nodes are interrupted and the node where RMS is stopped may be forcibly shut down.

► Click the *Ok* button to initiate the shutdown with your selections.

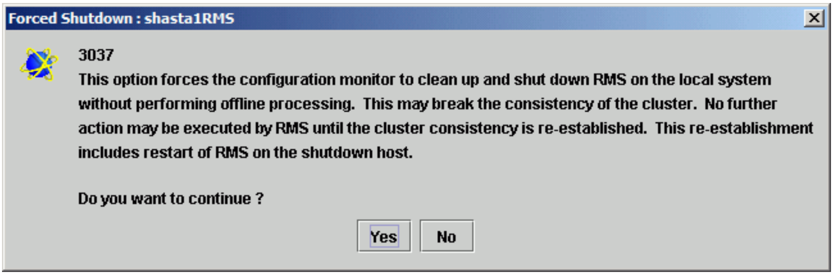
Stop all Apps is the default option for shutting down RMS on all the nodes or on one node. If you select an option other than the default, you will be prompted to confirm the operation (Figure 127 and Figure 128).


Controlled Shutdown : shasta1RMS

3036
Shut down RMS on the local node without shutting down running applications. All RMS nodes are notified that a controlled shutdown is under way on the local node. This may break the consistency of the cluster. No further action may be executed by RMS until the cluster consistency is re-established. This re-establishment includes restart of RMS on the shutdown host.

Do you want to continue ?

Figure 127: Stopping RMS while keeping applications—confirmation


Forced Shutdown : shasta1RMS

3037
This option forces the configuration monitor to clean up and shut down RMS on the local system without performing offline processing. This may break the consistency of the cluster. No further action may be executed by RMS until the cluster consistency is re-established. This re-establishment includes restart of RMS on the shutdown host.

Do you want to continue ?

Figure 128: Forced shutdown of RMS—confirmation

You can also stop RMS on a single node by right-clicking on the node in the RMS tree and then selecting *Shutdown RMS* from the context menu (Figure 129).

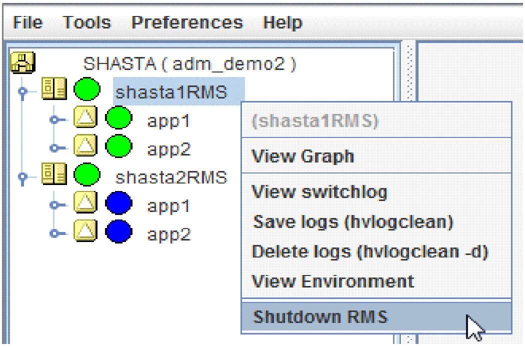
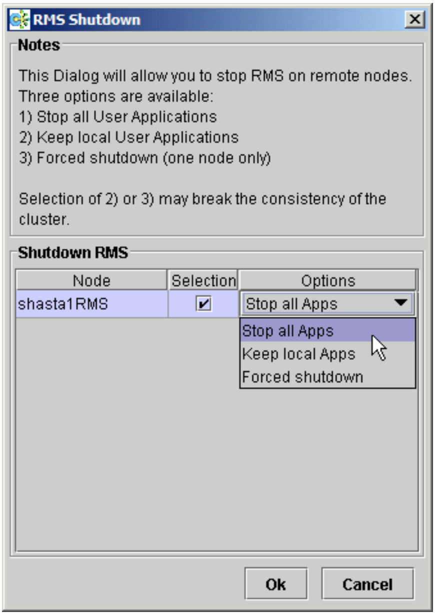


Figure 129: Using the context menu to stop RMS on one node

Only one node will appear in the confirmation window (Figure 130).



Notes

This Dialog will allow you to stop RMS on remote nodes.
Three options are available:
1) Stop all User Applications
2) Keep local User Applications
3) Forced shutdown (one node only)

Selection of 2) or 3) may break the consistency of the cluster.

Shutdown RMS

Node	Selection	Options
shasta1RMS	☑	Stop all Apps

Figure 130: Stopping RMS on one node

Note

When switching online a controlling application with a scalable controller, do not stop RMS during the startup processing. When stopping RMS, the stop processing may timeout.

CLI: hvshut

The syntax for the CLI is as follows:

```
hvshut {-a | -A | -f | -l | -L | -s SysNode}
```

Options:

`-a`	Shut down RMS and applications on all the nodes
`-A`	Shut down RMS on all the nodes without shutting down applications
`-f`	Forced (emergency) shutdown of RMS on the local node
`-l`	Shut down RMS and applications on the local node
`-L`	Shut down RMS on the local node without shutting down applications
`-s`	Shut down RMS only on the specified node

The hvshut command shuts down the RMS software on one or more nodes in the configuration. The base monitor on the local node sends a message to other online nodes indicating which node or nodes are to be shut down. The hvshut command disables all error detection and recovery routines on the nodes being shut down, but does not shut down the operating system.

If any userApplication objects are online when the -A, -f, or -L options are used, the applications remain running but are no longer monitored by RMS. Both The -f and -L options affect only the local node, but the -f option is for emergencies (when other hvshut options do not work).

When you choose to shut down RMS without shutting down the monitored applications, you will be prompted to confirm the operation.

Caution

Use the hvshut -A, -f, and -L options carefully as they could result in inconsistencies or data corruption.

Note

When you stop RMS in a configuration where the operating userApplication exists on 3 or more nodes, perform one of the following operations.

– To stop RMS of all nodes
Perform hvshut -a command with one of the nodes.

– To stop RMS of 2 or more nodes (not of all nodes)
Perform hvshut command on each node to stop RMS. After hvshut command returns on a certain node, perform hvshut command on the next node.

8.1.4 Clearing a SysNode Wait state

You can clear a Wait state of SysNode by the following procedure:

1. Manually stop the node in the Wait state. Make sure the node has stopped completely.

2. Check the CF state in the CF main window.
   If the CF state is `LEFTCLUSTER`, clear `LEFTCLUSTER` in the CF main window and make sure the node state is changed from `LEFTCLUSTER` to `DOWN`.
   For more information on `LEFTCLUSTER` state, refer to "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide."

3. If the `Wait` state of `SysNode` is not cleared after you perform step 2, right-click on the `SysNode` displayed on the RMS main window and select [Clear Wait & shutdown(hvutil -u)] from the pop-up context menu, and then select the `Wait` state node from the sub menu.

Caution

When you manually clear a `Wait` state in step 3, RMS and CF consider that the target node has been stopped. Therefore, if you clear the `Wait` state while the target node is not actually stopped, data corruption may occur.

CLI: hvutil -u

The syntax for performing the operation in step 3 with CLI is as follows:

```
hvutil -u SysNode
```

8.2 Managing RMS applications

This section describes basic procedures related to starting, stopping, and clearing special states of individual applications. Procedures in this section are active: they change the state of the RMS cluster and may have a direct effect on the disposition of data.

As stated in "Overview", the primary means of administration is through the Cluster Admin GUI. This method should be used whenever possible. However, each procedure in this section includes a CLI alternative.

8.2.1 Overriding automatic application startup

The automatic startup of each application is controlled by its `AutoStartUp` attribute:

- If `AutoStartUp` is set to "yes," the application starts automatically when RMS starts.
- If `AutoStartUp` is set to "no," the application does not start automatically when RMS starts (must be started manually).

For maintenance or troubleshooting, you may want to suppress the automatic application startup for all applications during RMS startup. In such cases, you can disable the `AutoStartUp` attribute of all applications at once by changing the value of the RMS environment variable `HV_AUTOSTARTUP`.

The `HV_AUTOSTARTUP` environment variable can be changed with the following procedure.

i The following procedure changes the `HV_AUTOSTARTUP` global environment variable. Changes to `HV_AUTOSTARTUP` do not take effect until the next RMS startup.

► From the Cluster Admin *rms* tab, select *Tools –> UserApplications AutoStartup* (Figure 131).

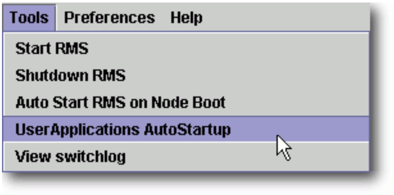
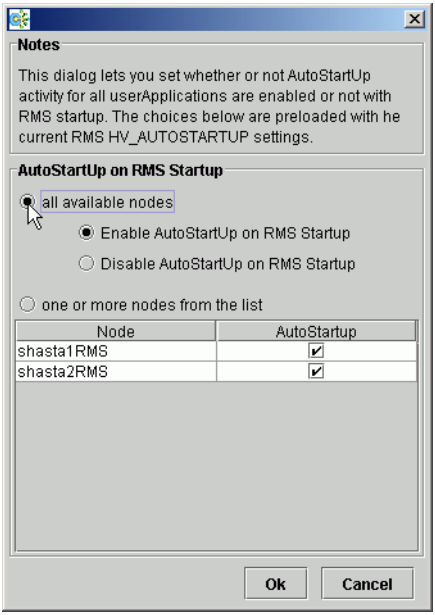


Figure 131: Controlling automatic application startup—step 1

You can then choose to override all `AutoStartUp` settings, or to cancel the override (Figure 132).



Notes

This dialog lets you set whether or not AutoStartUp activity for all userApplications are enabled or not with RMS startup. The choices below are preloaded with he current RMS HV_AUTOSTARTUP settings.

AutoStartUp on RMS Startup

● all available nodes

● Enable AutoStartUp on RMS Startup

○ Disable AutoStartUp on RMS Startup

○ one or more nodes from the list

Node	AutoStartup
shasta1RMS	☑
shasta2RMS	☑

Figure 132: Controlling automatic application startup—step 2

Note

- Even if the `userApplication`'s autostart is enabled, the `userApplication` where `AutoStartUp` is set to "no" needs to be started manually.
- The setting for autostart of `userApplication` is not intended to set the start condition of Standby processing when the RMS starts. For the start condition of Standby processing when RMS starts, follow

AutoStartUP and StandbyTransition attributes. For details, see "How to switch userApplication to Standby automatically when RMS is started, userApplication is switched, or when clearing a fault state of userApplication" in "6.10.1 Setting Contents of a Cluster Application" in "PRIMECLUSTER Installation and Administration Guide."

To enable this setting, Web-Based Admin View and CF on all the nodes that configure the cluster need to be working.

For how to check the server process status of Web-Based Admin View, and how to start Web-Based Admin View, see "4.3.3 Initial Setup of Web-Based Admin View" in "PRIMECLUSTER Installation and Administration Guide."

For how to check the status of CF and how to start CF, see "4.2 Main CF table" and "4.6 Starting and stopping CF" in "PRIMECLUSTER Cluster Foundation (CF) Configuration and Administration Guide."

CLI: hvsetenv

The action of each application's AutoStartUp attribute is controlled by the HV_AUTOSTARTUP environment variable (see the description in "Local environment variables"). You can set this variable with the hvsetenv command as follows:

```
hvsetenv HV_AUTOSTARTUP [0|1]
```

The allowable values are:

0 Prevents automatic application startup at next RMS startup

1 Conducts autostart of application in accordance with AutoStartUp attribute on the next time RMS starts

If no value is specified, the command reports the current value of the HV_AUTOSTARTUP environment variable.

8.2.2 Switching an application

When you switch an application, RMS performs the following tasks:

- If the application is already running in the cluster, RMS shuts it down.
- After the application is completely shut down, RMS starts it on the node you specified.

Switch an application to any node as follows:

- Right-click on the application object on any node and select *Switch* from the context menu. A secondary menu appears, listing the available target nodes for switchover.
- Select the target from the secondary menu to switch the application to that node (Figure 133).

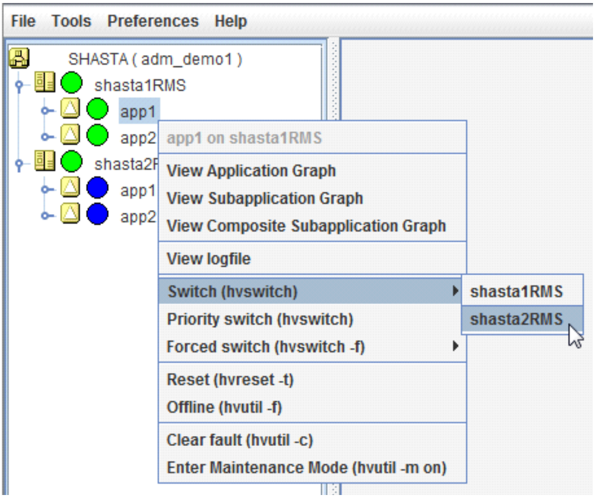


Figure 133: Switching an application

You will be prompted to confirm the action before RMS begins the operation.

A *Priority switch* switches the application to the target node according to the order of nodes in the application's `PriorityList` attribute.

If stopping the application fails, RMS does not start the application. This is because two competing instances of the same application could cause data corruption. In this event, you can start the application by using the *Forced switch* operation.

Caution

Use the *Forced switch* mode only if an application cannot be switched normally. A forced application switch overrides all safety checks and could therefore result in data corruption or other inconsistencies.

Therefore, RMS may kill the node on which RMS is not running before starting the application to reduce the risk of data corruption when the *Forced switch* request of an application is issued.

If the application is busy, the pop-up context menu will not offer the choices to switch the application. Instead, the menu will offer view-only operations, and the last menu item will indicate that the application is in a `Wait` state (Figure 134).

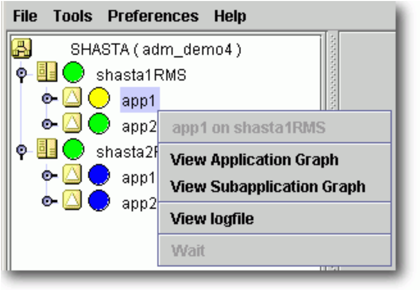


Figure 134: Switching a busy application

CLI: hvswitch userApplication

The syntax for the CLI is as follows:

```
hvswitch [-f] userApplication [SysNode]
```

The `hvswitch` command manually switches control of a `userApplication` or a `gResource` between `SysNodes` in the RMS configuration. When a type of the resource to be switched is `userApplication`, if no `SysNode` is specified, the application is switched to the highest priority node. The `-f` option is a forced-switch option.

Caution

Use the ‘`hvswitch -f`’ operation carefully. A forced switch of an application or a resource overrides all safety checks and could therefore result in data corruption or other inconsistencies.
Therefore, RMS may kill the node on which RMS is not running before starting the application to reduce the risk of data corruption when the *Forced switch* request of an application or a resource is issued.

8.2.3 Starting an application

If the application is already offline everywhere in the cluster, you can start it (bring it online) on a single node as follows:

- Right-click on the application object and select *Online* from the pop-up context menu (Figure 135).

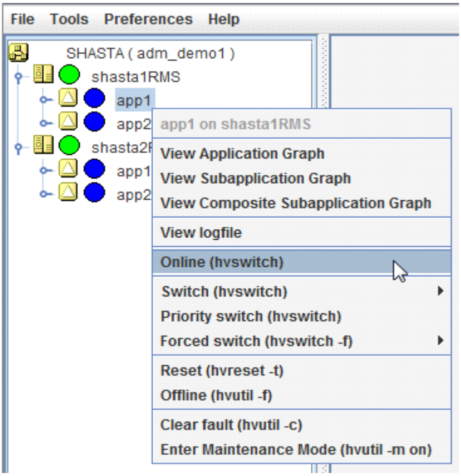


Figure 135: Starting an application

You will be prompted to confirm the action before RMS begins the operation.

CLI

Starting an application on the local node, like switching an application to another node, use the `hvswitch` command. Refer to "CLI: hvswitch userApplication" for the syntax.

8.2.4 Stopping an application

Stop an online application (take it offline) as follows:

► Right-click on the online application object and select *Offline* from the pop-up context menu (Figure 136).

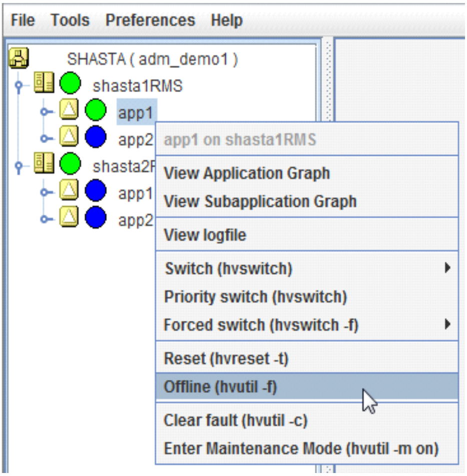


Figure 136: Shutting down an application

You will be prompted to confirm the action before RMS begins the operation.

CLI: hvutil -f

The syntax for the CLI is as follows:

```
hvutil -f userApplication
```

Note that this is a **normal offline request**. There is no “forced” offline request for a `userApplication`.

i Use the command ‘`hvutil -s` *userApplication*’ to bring an offline `userApplication` to a `Standby` state.

8.2.5 Resetting an application

This operation completely re-initializes the target application and all objects in its resource tree (*i.e.*, the entire application graph) based on the actual detector reports. It will interrupt any ongoing RMS processing for the application, and any running scripts will be terminated.

Caution

Resetting an application will cause information about previous failures or any other history to be lost. It will most likely result in an *Inconsistent* state for the application.

This operation is intended for use by an experienced administrator during a test phase. It should never been invoked in a production environment.

Reset (reinitialize) an online application as follows:

► Right-click on the online application object and select *Reset* from the pop-up context menu (Figure 137).

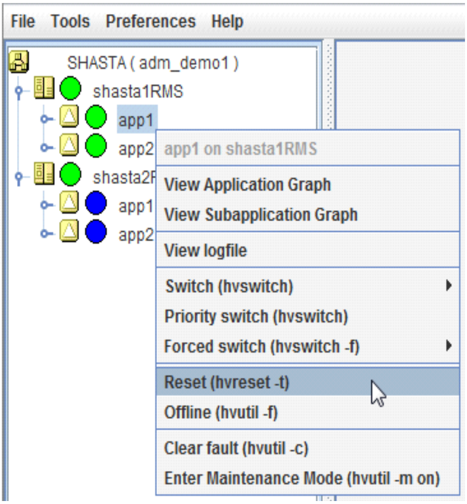
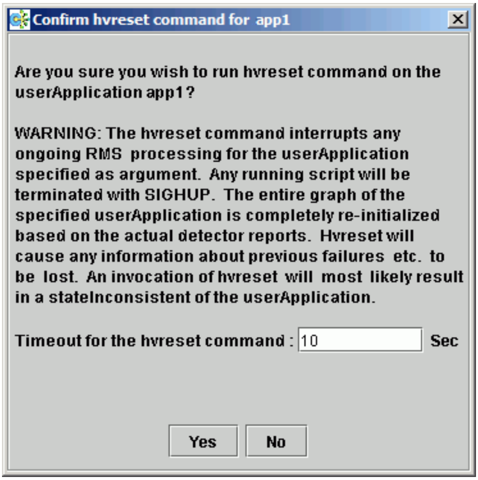


Figure 137: Resetting an application

You will be prompted to enter the reset timeout before RMS begins the operation (Figure 138).



Confirm hvreset command for app1

Are you sure you wish to run hvreset command on the userApplication app1?

WARNING: The hvreset command interrupts any ongoing RMS processing for the userApplication specified as argument. Any running script will be terminated with SIGHUP. The entire graph of the specified userApplication is completely re-initialized based on the actual detector reports. Hvreset will cause any information about previous failures etc. to be lost. An invocation of hvreset will most likely result in a stateInconsistent of the userApplication.

Timeout for the hvreset command : 10 Sec

Figure 138: Choosing the reset timeout for the application

If RMS fails to re-initialize the entire application graph during this amount of time, it terminates with an error message. Default: 10 seconds

- Adjust the timeout value if desired, and then click *Yes* to reset the application.

CLI: hvreset -t

The syntax for the CLI is as follows:

```
hvreset -t timeout userApplication
```

`hvreset` displays a message that warns of the consequences and then prompts you to confirm the action before proceeding.

When the `userApplication` is not performing online, offline, or fault processing, `hvreset` returns immediately and displays a message stating there is nothing to do. This case is considered to be successful command execution and returns exit code 0.

8.2.6 Clearing a fault

For an application that is in the `Faulted` state, clear the fault as follows:

- Right-click on the application object and select *Clear Fault* from the pop-up context menu (Figure 139).

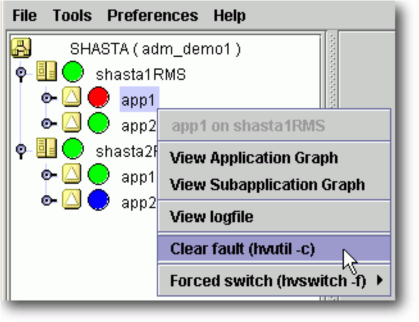
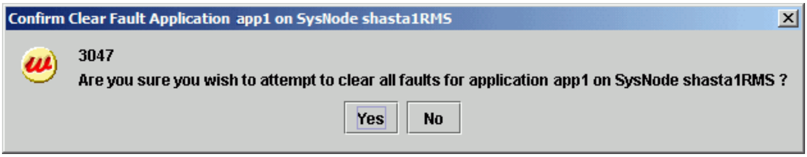


Figure 139: Clearing an application fault

Before the command proceeds, you will be informed of the action to be taken and prompted to confirm the operation (Figure 140).


Confirm Clear Fault Application app1 on SysNode shasta1RMS

3047
Are you sure you wish to attempt to clear all faults for application app1 on SysNode shasta1RMS ?

Figure 140: Clearing an application fault—confirmation dialog

CLI: hvutil -c

The syntax for the CLI is as follows:

```
hvutil -c userApplication
```

If the `userApplication` is in the online state, then clearing the fault will cause RMS to attempt to bring the faulted resource to the online state. If the `userApplication` is in the offline or faulted state, then clearing the fault will attempt to bring the resource to the offline state. You will be informed of the action that is to be taken and prompted to confirm the operation before the command proceeds.

8.2.7 Activating an application

Activating an application takes it from the `Deact` state to the `Offline` state. It does not bring it `Online`. Also, activating a `userApplication` with the Cluster Admin GUI or the CLI has nothing to do with activating an RMS configuration in the Wizard Tools—the two operations are completely independent. Activate a deactivated application as follows:

- Right-click on the application object and select the *Activate* option from the pop-up menu.

CLI: hvutil -a

The syntax for the CLI is as follows:

```
hvutil -a userApplication
```

i You will not need to activate an application unless someone explicitly deactivated it with the command ‘`hvutil -d` *userApplication*’.

8.3 Managing resources

This section describes basic procedures for starting and stopping of each resource. Procedures in this section are active: they change the state of the RMS cluster and may have a direct effect on the disposition of data.

As stated in "Overview" , the primary means of administration is through the Cluster Admin GUI. This method should be used whenever possible. However, each procedure in this section includes a CLI alternative.

Note

When resources under the `userApplication` are partially `Online`, the `userApplication` becomes the `Online` state.

8.3.1 Switching a resource

When you switch a resource, RMS performs the following tasks:

- If the `userApplication` that controls the resource is already started, RMS will stop it.
- After the `userApplication` is completely stopped, RMS will start the resource on the specified node.

Switch the resource in the `Online` state according to the following procedure:

Right-click on the `gResource` object and select *Online resource* from the context menu (Figure 141).

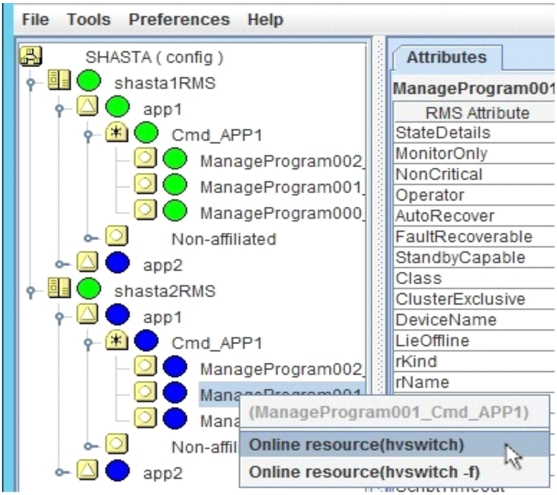
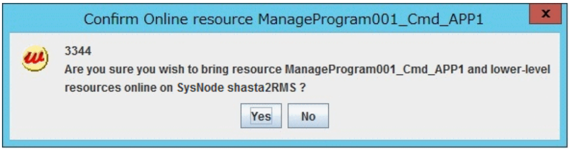


Figure 141: Switching a resource

You will be prompted to confirm the action before RMS begins the operation (Figure 142). Starts all the resources which the specified resource depends on, and then starts the specified resource.



Confirm Online resource ManageProgram001_Cmd_APP1

3344
Are you sure you wish to bring resource ManageProgram001_Cmd_APP1 and lower-level resources online on SysNode shasta2RMS ?

Figure 142: Confirming a resource switchover

If stopping the `userApplication` fails, RMS does not start the resource. This is because two competing instances of the same application could cause data corruption. In this event, you can start the resource by selecting *Forced Resource Online*.

Note

Use the *Forced switch* mode only if a resource cannot be switched normally. A forced resource switch overrides all safety checks and could therefore result in data corruption or other inconsistencies.

Therefore, to reduce the risk of data corruption when the Forced switch request of a resource is issued, the resource may be forcibly started after the node on which RMS is not running is forcibly stopped.

CLI: hvswitch resource

The syntax for the CLI is as follows:

```
hvswitch [-f] resource SysNode
```

The `hvswitch` command manually switches control of a `userApplication` or a `gResource` between `SysNodes` in the RMS configuration. When a type of the resource to be switched is `gResource`, the `SysNode` name of the node on which this command is executed should be specified. The -f option is a forced switch option.

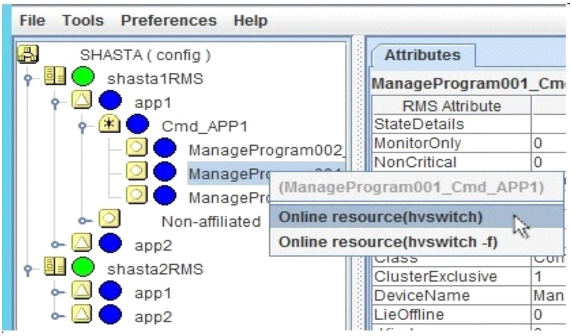
Note

The resource can be switched only when the application to control the resource is `Online`, `Offline`, or `Standby`.

8.3.2 Starting a resource

If a resource is in the `Offline` state or the `Standby` state, you can start it (bring it to the `Online` state) on a single node as follows.

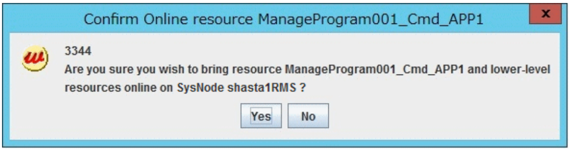
Right-click on the `gResource` object and select *Online resource* from the pop-up context menu (Figure 143).



RMS Attribute	
StateDetails	
MonitorOnly	0
NonCritical	0
Class	Com
ClusterExclusive	1
DeviceName	Man
LieOffline	0

Figure 143: Starting a resource

You will be prompted to confirm the action before RMS begins the operation (Figure 144). Starts all the resources which the specified resource depends on, and then starts the specified resource.



Confirm Online resource ManageProgram001_Cmd_APP1

3344
Are you sure you wish to bring resource ManageProgram001_Cmd_APP1 and lower-level resources online on SysNode shasta1RMS ?

Figure 144: Confirming a resource start

CLI

You can use the `hvswitch` command to start a resource on the local node, like switching a resource to another node. See "CLI: hvswitch resource".

Note

- The resource can be started only when the application to control the resource is `Online`, `Offline`, or `Standby`.
- If some resource becomes `Online` unexpectedly while the `userApplication` is partially `Online`, you cannot specify other inactive resource to start the resource.

8.3.3 Stopping a resource

Stop the online resource (change the resource to offline) as follows:

▶ Right-click on the online `gResource` object and select *Offline Resource* from the pop-up context menu (Figure 145).

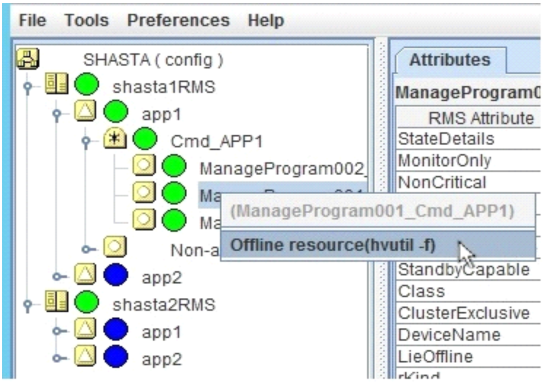
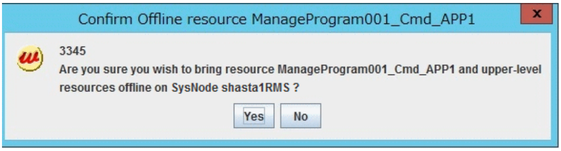


Figure 145: Stopping a resource

You will be prompted to confirm the action before RMS begins the operation (Figure 146). Stop all the resources which the specified resource depends on, and then stop the specified resource.


Confirm Offline resource ManageProgram001_Cmd_APP1

3345
Are you sure you wish to bring resource ManageProgram001_Cmd_APP1 and upper-level resources offline on SysNode shasta1RMS ?

Figure 146: Confirming a resource stop

CLI: hvutil -f

The syntax for the CLI is as follows:

`hvutil -f` *gResource*

This is a normal offline request. There is no "forced" offline request for `gResource`.

Note

– Stopping a resource is possible only when the application which controls the resource is `Online`.

- If some resource becomes `Online` unexpectedly while the `userApplication` is partially `Online`, resource stop request is rejected on the node.
- When a resource fails to be stopped, if the resource, which is not a target resource to be stopped, remains in the `Online` state, the application becomes the `Inconsistent` state. To restore this state, remove the cause of the unexpected stop of the resource, and then, use `hvutil -f` to stop `userApplication`. After that, start the resource if necessary.

8.3.4 Notes on starting and stopping a resource

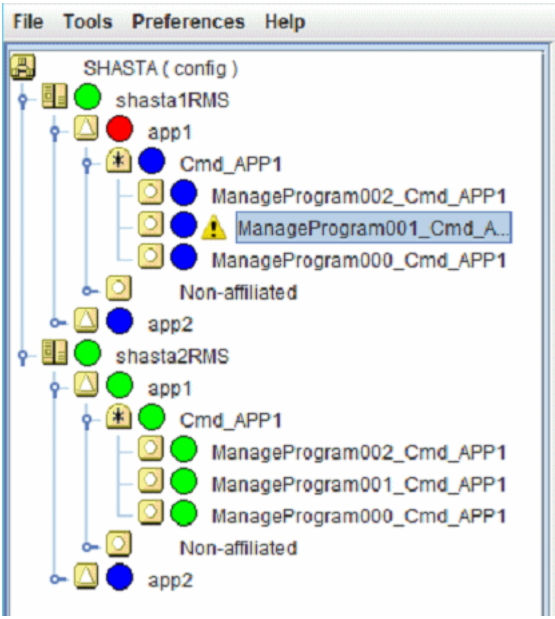
- The information, on which only some resources under `userApplication` are being started, is synchronized on all the nodes where this `userApplication` operates. Therefore, if an application is switched automatically while only some resources are being started, the only resource that was started on the source node can be started on the remote node.
- If some resource becomes `Online` unexpectedly while the `userApplication` is partially `Online`, the `userApplication` remains in `Online` state (does not become `Inconsistent` state). If an application is switched automatically in this state, the unexpected started resource cannot become `Online` on the remote node.
- To start and stop the resources under a `userApplication` that is controlled by the scalable controller, the controlled `userApplication` must be `Offline`.

i To stop the unexpected started resource, make sure to change the corresponding `userApplication` to the Maintenance mode, and then stop the target resource manually (if the resource is stopped without changing the mode to Maintenance mode, the resource is considered to be a resource error).

8.3.5 Fault Traces of Resources

When a resource fault occurs, you can check which resource has a fault from the RMS main window of Cluster Admin.

- The following fault trace icon (⚠) is displayed in the right side of the state icon of the failed resource in the cluster tree (Figure 147).



- SHASTA (config)
  - ● shasta1RMS
    - ● app1
      - ● Cmd_APP1
        - ● ManageProgram002_Cmd_APP1
        - ● ⚠ ManageProgram001_Cmd_A...
        - ● ManageProgram000_Cmd_APP1
      - Non-affiliated
    - ● app2
  - ● shasta2RMS
    - ● app1
      - ● Cmd_APP1
        - ● ManageProgram002_Cmd_APP1
        - ● ManageProgram001_Cmd_APP1
        - ● ManageProgram000_Cmd_APP1
      - Non-affiliated
    - ● app2

Figure 147: Checking the failed resource

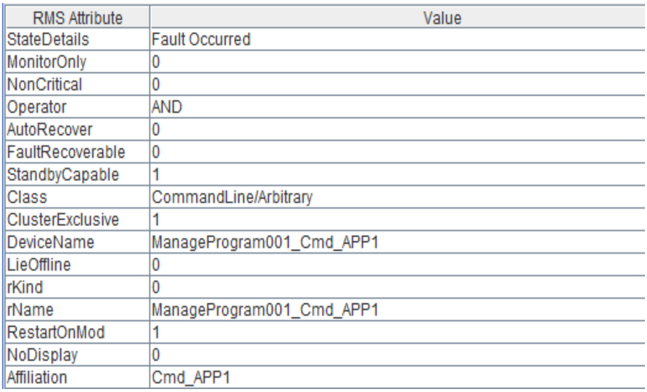
Note

- The fault trace icon shows the resource error has occurred in the past. It does not indicate the current state of the resource. If you want to check the current state of the resource, check the state of the resource object.
- The fault trace icon is displayed in the resource that an error is notified to RMS. Normally, the fault trace icon is displayed on the failed resource. However, the superior resource in the graph tree may detect the failure faster than the actual failed resource depending on the monitoring timing. For example, when the failure occurs in the file system resource, normally the failure is notified to Fsystem resource. Depending on the monitoring timing, however, the superior resource in the graph tree may detect the failure faster than Fsystem resource detects the failure. This can

be found when an operation application that accesses the file system is registered as a resource and the operation application first detects the failure. In this case, the fault trace icon may be displayed for only the superior resource.

– If a resource error is notified from another resource during the state transitions, the resource may not be displayed with the fault trace icon.

- `Fault Occurred` is displayed in the `StateDetails` attribute of the failed resource (Figure 148).



RMS Attribute	Value
StateDetails	Fault Occurred
MonitorOnly	0
NonCritical	0
Operator	AND
AutoRecover	0
FaultRecoverable	0
StandbyCapable	1
Class	CommandLine/Arbitrary
ClusterExclusive	1
DeviceName	ManageProgram001_Cmd_APP1
LieOffline	0
rKind	0
rName	ManageProgram001_Cmd_APP1
RestartOnMod	1
NoDisplay	0
Affiliation	Cmd_APP1

Figure 148: Displaying Fault Occurred in the StateDetails attribute

CLI: hvdisp -a

The syntax for the CLI is as follows.

```
hvdisp -a
```

`Fault Occurred` is displayed in the `StateDetails` attribute of the failed resource.

Clear the fault trace of the resource with the following procedure.

▶ Right-click on the failed resource, and then select [Clear fault trace (`hvutil -c`)] from the pop-up context menu (Figure 149).

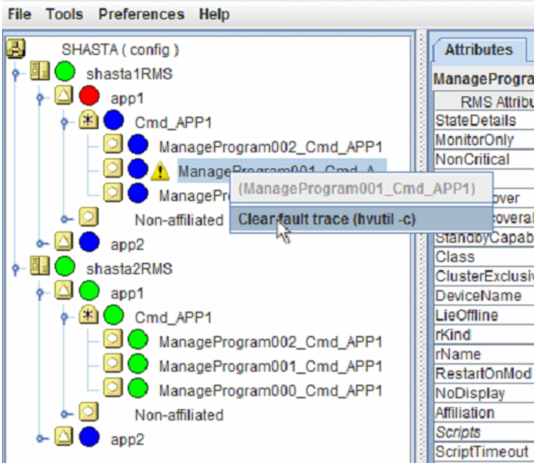
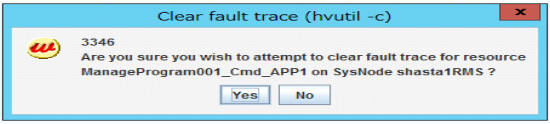


Figure 149: Clearing the Fault trace

▶ Before the command is executed, you are prompted to confirm whether the operation can be performed. Click *Yes* to start to clear the fault trace (Figure 150).


Clear fault trace (hvutil -c)

3346
Are you sure you wish to attempt to clear fault trace for resource ManageProgram001_Cmd_APP1 on SysNode shasta1RMS ?

Figure 150: Checking whether the Faulted trace is cleared

CLI: hvutil -c

The syntax for the CLI is as follows:

```
hvutil -c gResource
```

In addition to the `hvutil -c` command can clear the fault trace, it can be also cleared automatically when the resource becomes `Online` next time. Once the fault trace is cleared, its icon will be disappeared and "`Fault Occurred`" will not be also displayed in the `StateDetails` attribute.

8.4 Using maintenance mode

Maintenance mode is a special mode of operation that allows an application to be temporarily decoupled from its dependent resources. This allows, for example, a file system to be taken offline for backup purposes without disrupting the online state of its parent application.

8.4.1 Entering maintenance mode

You can enter maintenance mode for all applications on all the nodes as follows:

► Right-click on the cluster at the top of the RMS tree and select *Enter Maintenance Mode* from the popup menu (Figure 151).

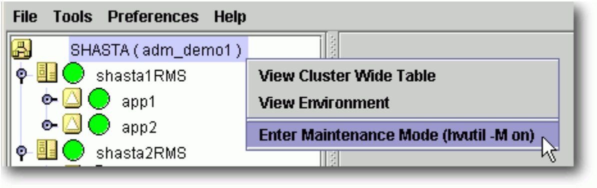


Figure 151: Starting maintenance mode for all applications

Enter maintenance mode for only one application as follows:

► Right-click on an application instance in the RMS tree and select *Enter Maintenance Mode* from the popup menu (Figure 152).

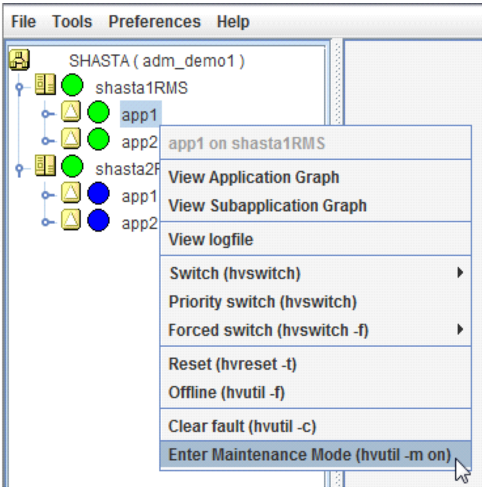
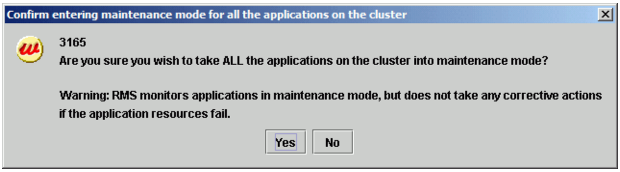


Figure 152: Starting maintenance mode for a single application

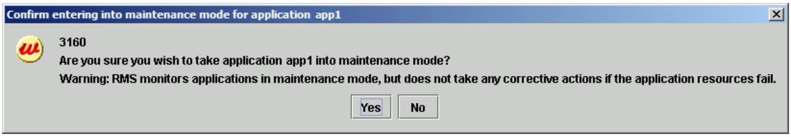
In either case, you will be prompted to confirm the operation (Figure 153 and Figure 154).


Confirm entering maintenance mode for all the applications on the cluster

3165
Are you sure you wish to take ALL the applications on the cluster into maintenance mode?

Warning: RMS monitors applications in maintenance mode, but does not take any corrective actions if the application resources fail.

Figure 153: Maintenance mode confirmation for all applications

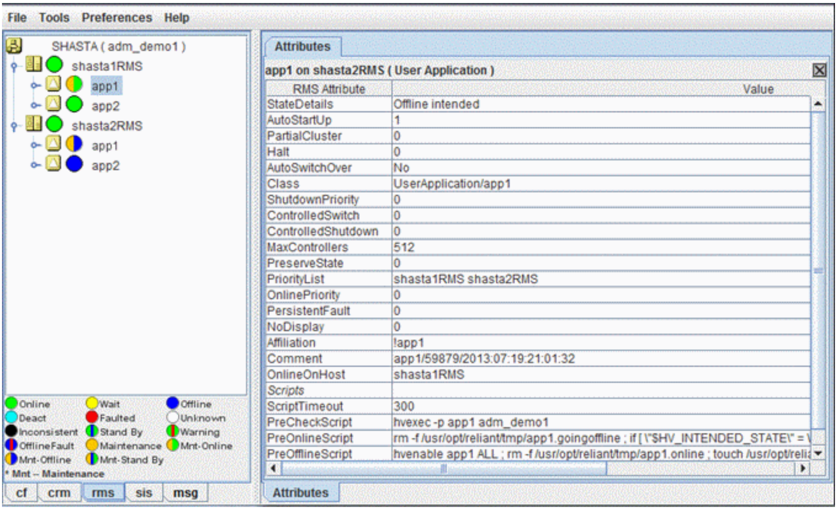

Confirm entering into maintenance mode for application app1

3160
Are you sure you wish to take application app1 into maintenance mode?
Warning: RMS monitors applications in maintenance mode, but does not take any corrective actions if the application resources fail.

Figure 154: Maintenance mode confirmation for one application

> The maintenance mode is applied to the entire cluster. If an application enters the maintenance mode on one node, the maintenance mode is started on all nodes where the application can run.
> The maintenance mode can be started if the cluster application is in the following states on all nodes.
>
> - Online state
> - Standby state
> - Offline state
> - Warning state
> - Inconsistent state (If an application state just before it becomes inconsistent is Faulted state, it is excluded.)
>
> The maintenance mode is rejected if there is any request of dynamic reconfiguration of RMS graph.

Figure 155 shows the Cluster Admin window after one application is put into maintenance mode.



app1 on shasta2RMS (User Application)

RMS Attribute	Value
StateDetails	Offline intended
AutoStartUp	1
PartialCluster	0
Halt	0
AutoSwitchOver	No
Class	UserApplication/app1
ShutdownPriority	0
ControlledSwitch	0
ControlledShutdown	0
MaxControllers	512
PreserveState	0
PriorityList	shasta1RMS shasta2RMS
OnlinePriority	0
PersistentFault	0
NoDisplay	0
Affiliation	!app1
Comment	app1/59879/2013:07:19:21:01:32
OnlineOnHost	shasta1RMS
Scripts	
ScriptTimeout	300
PreCheckScript	hvexec -p app1 adm_demo1
PreOnlineScript	rm -f /usr/opt/reliant/tmp/app1.goingoffline ; if [\"$HV_INTENDED_STATE\" = \
PreOfflineScript	hvenable app1 ALL ; rm -f /usr/opt/reliant/tmp/app1.online ; touch /usr/opt/relia

Figure 155: Typical cluster in maintenance mode

Note how the right half of the application status icons indicate the intended status (the status just before the start of maintenance mode). The intended status is also indicated by the application's *StateDetails* attribute, which is the first item in the *Attributes* table in the right pane.

8.4.2 Maintenance mode operating notes

When an application enters maintenance mode (MM), it affects all other applications that **share the same graph**. For example, if two applications are linked by a controller, then putting one in maintenance mode will cause the other to go into maintenance mode as well; which one is the parent and which one is the child does not matter in this case.

Conversely, if two applications do not share the same graph, *i.e.*, they are not linked by one or more controllers, then one can be put into MM while the other operates under normal RMS control.

For instance, in the example presented earlier, `app1` and `app2` are independent. While `app1` is in MM, `app2` continues to operate normally and can be switched from one node to the other, as illustrated in Figure 156 below.

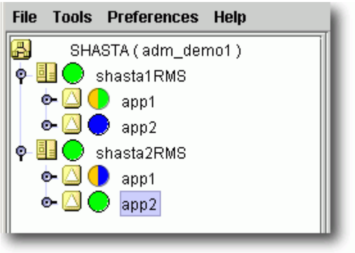


Figure 156: Normal operation of independent application

8.4.2.1 Overall cluster restrictions in maintenance mode

Even though some applications may continue to operate under normal RMS control, MM still places restrictions on the overall cluster operation. In particular, note the following:

- You must exit MM before starting or stopping an application or a resource.
- You must exit MM everywhere in the cluster before you can shut down RMS.

8.4.3 Exiting maintenance mode

To exit maintenance mode, use the following procedure:

► Confirm that there is no ! indicated to the right side of the application icon. If there is, return all the resources under `userApplication` to the status just before the start of maintenance mode.

The status just before the start of maintenance mode can be determined with the color of the application's icon. For details on the icon's color, see "7.1.3 RMS Main Window" of "PRIMECLUSTER Installation and Administration Guide."

► Right-click on the cluster or an application and select *Exit Maintenance Mode* from the popup menu (Figure 157 and Figure 158).

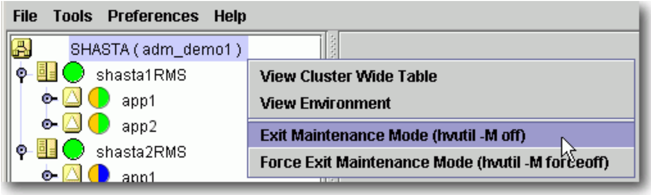

File Tools Preferences Help
SHASTA (adm_demo1)
shasta1RMS
app1
app2
shasta2RMS
app1
View Cluster Wide Table
View Environment
Exit Maintenance Mode (hvutil -M off)
Force Exit Maintenance Mode (hvutil -M forceoff)

Figure 157: Normal maintenance mode exit for all applications

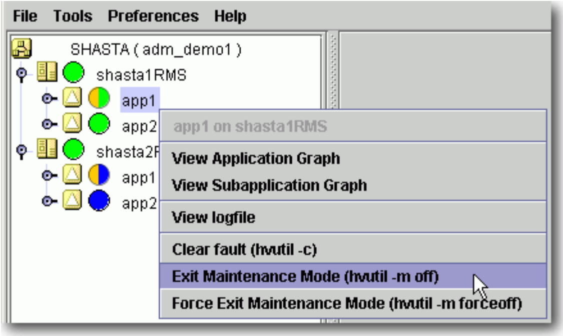

File Tools Preferences Help
SHASTA (adm_demo1)
shasta1RMS
app1
app2
shasta2RMS
app1
app2
app1 on shasta1RMS
View Application Graph
View Subapplication Graph
View logfile
Clear fault (hvutil -c)
Exit Maintenance Mode (hvutil -m off)
Force Exit Maintenance Mode (hvutil -m forceoff)

Figure 158: Normal maintenance mode exit for a single application

In either case, you will be prompted to confirm your action before the operation proceeds.

i You can exit maintenance mode for a single application even if you entered maintenance mode for the entire cluster.

To exit maintenance mode, the following conditions must be met:

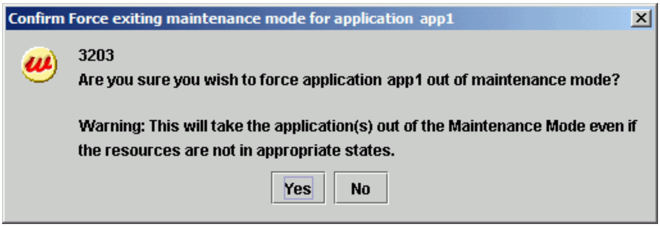
– If you start maintenance mode when the application status is either Online, Offline, Standby, or Warning, statuses of the application and each resource must be the same as those before maintenance mode is started in order to exit maintenance mode. If the status is different, you cannot exit maintenance mode.

– If you start maintenance mode when the application status is Inconsistent, remove causes which put the application into the Inconsistent state. You cannot exit maintenance mode until causes are removed.

For example, in the above example, there is a file system resource Res1 in the application `app1`, and Res1 is in the online state on `shasta2RMS` when starting the maintenance mode in `app1`. In this case, Res1 must be in the online state on `shasta2RMS` to exit the maintenance mode of `app1`.

If you forcibly exit the maintenance mode by using [Force Exit Maintenance Mode] in a different state from when starting the maintenance mode, the application enters the `Inconsistent` state. Therefore, we do not recommend using [Force Exit Maintenance Mode].

Note that both the cluster and application popup menus shown above contain a *Force Exit Maintenance Mode* item. If you choose this command, it will force RMS to exit maintenance mode even if some resources are not in the appropriate state. The prompt to confirm the operation for one application is shown in Figure 159; the prompt for all applications is similar.



3203
Are you sure you wish to force application app1 out of maintenance mode?

Warning: This will take the application(s) out of the Maintenance Mode even if the resources are not in appropriate states.

Figure 159: Forced maintenance mode confirmation for all applications

If the status of `userApplication` before the start of maintenance mode is Online or Standby, Online or Standby processing is executed during the exit of maintenance mode.

In these operations, if resource statuses under `userApplication` are the same as those before maintenance mode is started, the Online script is not executed and the resource statuses are not changed.

However, if the Online processing is executed for Cmdline resource to which the NULLDETECTOR attribute is set, the Online script is definitely executed despite the actual resource statuses.

8.4.4 Maintenance mode CLI: hvutil -m and -M

Control maintenance mode (MM) with the `hvutil` command:

```
hvutil -M { on | off | forceoff }

hvutil -m { on | off | forceoff } userApplication
```

Options:

`-M`	Applies the MM operation to all applications on all the nodes
`-m`	Applies the MM operation to the specified application on all the nodes

Operations:

`on`	Starts maintenance mode
`off`	Stops MM if all resources are in the appropriate state
`forceoff`	Forces MM to stop even if all resources are not in the appropriate state

The `hvutil` maintenance mode commands operate synchronously, so they do not return until the final state has been reached or until an error occurs. In the particular case where ‘`-m off`’ returns a failure because one or more resources were in an inappropriate state, an error message is displayed that lists the problem resources.

Note

To stop the maintenance mode, confirm that all the resources under `userApplication` are in the status just before the start of maintenance mode.

If one of the following information is displayed in StateDetails column of the targeted `userApplication` in the output of hvdisp command, there is a need to return the `userApplication` status to the status just before start of maintenance mode.

- "`Online!!`" is being displayed (`Online` is the status just before starting maintenance mode).
- "`Standby!!`" is being displayed (`Standby` is the status just before starting maintenance mode).
- "`Offline intended`" is being displayed and one or more resources under the `userApplication` is neither `Offline` status nor `Standby` status (`Offline` is the status before starting maintenance mode).

9 Appendix—Site preparation

Preliminary settings are necessary before installing RMS in the cluster system. Some of the procedures require you to modify system files so that RMS can identify the hosts, file systems, and network interfaces used in a configuration. You should have completed these procedures when RMS was installed.

In some cases, you will be creating or modifying your RMS configuration because changes have been made to your site. Certain site changes may require you to review and update your system files first. These changes include, but are not limited to, the following:

- IP addresses were changed.
- Redundant interconnects were added to the cluster.
- Hosts were added, removed, or renamed.
- Two or more clusters were merged into one.
- File systems or SANs were added or removed.

For convenience, the site preparation descriptions for hosts, file systems, and networks are duplicated here. If any of these specifications have changed since your initial RMS installation, you should review this material and make the necessary adjustments before proceeding with your RMS configuration.

The modifications generally involve adding RMS-specific entries to standard system files; pre-existing entries required for proper operation of your hosts and network are not affected. Resources for market-specific applications may require similar customization.

9.1 Network database files

9.1.1 /etc/hosts

The `/etc/hosts` file must contain the IP addresses and RMS names of all the host systems that are part of the cluster.

RMS uses its own internal set of host names to manage the machines in the cluster. When you configure the cluster, you will use the RMS host names and not the standard host names. These names must be entered in `/etc/hosts` on each system in the cluster to avoid problems should access to the DNS fail. If you used Cluster Admin to configure CIP for RMS, then `/etc/hosts` will already contain the correct RMS node names described below.

By default, the names follow the conventions in Table 6.

Entry type	**RMS naming pattern**	**Examples**
RMS host name	<*hostname*>`RMS`	`shasta1RMS` `shasta2RMS`

Table 6: RMS host name conventions in /etc/hosts

i The RMS host name for a machine must match the contents of the `RELIANT_HOSTNAME` variable in that machine's `hvenv.local` configuration file, if that file exists.

RMS does not support IPV6 addresses.

Example

The following entries in `/etc/hosts` are for a cluster with nodes `shasta1` and `shasta2`. The interface names are assigned as follows:

– Standard host names on the public network 172.25.220

– RMS node names on the private network 192.168.10

```
172.25.220.83   shasta1
172.25.220.84   shasta2
# node names for RMS
192.168.10.83   shasta1RMS
192.168.10.84   shasta2RMS
```

9.1.1.1 Network interface names in /etc/hosts

If you plan to configure one or more network interfaces for switchover with the *Ip Address* subapplication, you must first enter the interface name(s) in the `/etc/hosts` file on every node where that interface can exist. Each entry consists of the interface IP address and its name in the normal format; no special comments are required.

Example

An example is shown below.

- If you switch the interface `shastavip` with IPv4 address `172.25.222.223`:
  `172.25.222.223 shastavip`
- If you switch the interface `shastavip6` with IPv6 address `fd00:1::219:99ff:fe18:1b4e`:
  `fd00:1::219:99ff:fe18:1b4e shastavip6`

i

- When you configure the *Ip Address* subapplication, you specify the interface name as it appears in `/etc/hosts`, and not the IP address.
- IPv6 link local addresses are not available.
- When defining the interface name in the `/etc/hosts` file, do not assign the same interface name to the IPv4 and IPv6 addresses.

9.1.2 /root/.rhosts (Linux) and /.rhosts (Solaris)

Contains entries to control trusted login from remote hosts.

The Wizard Tools require automatic login or authentication as `root` on every machine in the cluster. One method is to include the names of trusted hosts in the `.rhosts` file, which must be modified appropriately on each node. See the `rhosts` manual page for a complete description of the format.

Example

If the cluster consists of hosts `shasta1` and `shasta2`, then every machine's `.rhosts` file should contain the following lines:

```
shasta1 root
shasta2 root
```

ℹ The Cluster Foundation (CF) provides the equivalent of `.rhosts` functionality for all RMS configuration, administration, and operation tasks.

9.2 Configuration resource definitions

9.2.1 /opt/SMAW/SMAWRrms/etc/hvipalias

This file contains entries for all of the network interfaces that are to be used as resources in the configuration. Typically, each entry associates a logical interface name, or **IP alias**, with a physical interface on a specified node. The IP alias always presents the same IP address, even though it is switched from node to node, and even if the underlying physical interface has different characteristics on each node.

i Each IP alias with its IP address must be entered in the `/etc/hosts` file. The IP address does not appear in the `hvipalias` file.

Each entry in `hvipalias` must contain the following fields:

<Uname> *<IfName>* *<IfDevice>* *<Netmask/Prefix>*

The fields are defined as follows:

- *Uname*—Name of the machine to host the logical interface. This is usually the value returned by the '`uname -n`' command.

  Alternatively, you can use the Cluster Foundation (CF) node name, which is returned by the '`cftool -ql`' command. This can be used to differentiate two machines which are configured with the same '`uname -n`' setting, provided they were assigned different names when CF was configured.

- *IfName*—Logical interface name, or IP alias. This name must appear with its associated IP address in the node's `/etc/hosts` file, and the associated IP address must be the same on every node.

- *IfDevice*—Physical device name to be associated with the logical interface when it is switched to the specified machine.

- *Netmask/Prefix*—The netmask (IPv4) or the prefix length (IPv6) to use with the IP address associated with the interface name.
  The netmask (IPv4) must be set as the 8-digit hexadecimal number string.
  The prefix length (IPv6) must be set as the decimal number string between 0 to 128.

i To avoid network conflicts, a network hostname or address monitored by the *IpAddress* subapplication can be active on only one node in the cluster at any time.

When a configuration is activated, the local `hvipalias` file is copied to every other node in the configuration; the file with same name and path on the remote node will be overwritten with the new content. Therefore, the file must contain one line for every combination of interface and host where that interface can be switched.

For instance, if the interface named `dbhost` can be switched between two nodes, then `hvipalias` on each node should contain lines for both the local and remote interfaces:

Example (Linux)

```
#Uname    IfName  IfDevice   Netmask
shasta1   dbhost  eth1       0xffffff00
shasta2   dbhost  eth1       0xffffff00
```

Example (Solaris)

```
#Uname  IfName  IfDevice   Netmask
fuji2   dbhost  hme0       0xffffff00
fuji3   dbhost  hme0       0xffffff00
```

9.2.2 /opt/SMAW/SMAWRrms/etc/hvconsoles

Controls customized handling of fault messages, usually to remote consoles or special devices such as pagers. This does not affect the standard messages written to the RMS or system log files.

Each entry specifies a program to be executed when an RMS resource object encounters a fault.

If the file does not exist, you will receive no customized fault information. A complete description of the format is available in the comments in the `hvconsoles.template` file.

9.3 Linux file systems

To manage Linux file systems with RMS, you must create entries in the /etc/fstab.pcl configuration file as described in the following sections. This configuration file has the following features:

- Leading whitespace and empty lines are ignored.
- A line beginning with the string '#RMS#' or '#RMS:<*appname*>#' is a file system specification for RMS. The entire specification must be on the same line—continuation to additional lines is not allowed.
- Any other line beginning with a pound sign (#), or any line beginning with an asterisk (*), is treated as a comment.
- All other lines are presently ignored. However, they may be processed by future versions of RMS.

9.3.1 /etc/fstab.pcl

This file contains entries for all of the local and remote file systems that are to be used as resources in the configuration. RMS is responsible for mounting and unmounting each of these file systems in order to bring them online or offline, respectively, according to the requirements of the running configuration.

For each file system to be managed by RMS, create a line in /etc/fstab.pcl with the standard fstab fields, and then insert the string #RMS# at the beginning of the line. For more information, see the fstab manual page.

Note the following restrictions when you create /etc/fstab.pcl:

- Do not specify the same file system in both a standard /etc/fstab entry and an RMS /etc/fstab.pcl entry. The standard entry will mount the file system at system startup, and this will create a conflict when RMS starts up and attempts to mount the same file system.
- If a remote file system is specified in the form <*server_name*>:<*server_path*>, then <*server_name*> must be a host name that appears in the /etc/hosts file. It cannot be an IP address, and you should not rely on DNS to resolve the name.

Examples

```
#RMS#/dev/sdb2 /fs2    ext2    defaults 1 2
#RMS#/dev/sda1 /mnt/data1  auto    noauto,user  0 0
#RMS#/dev/sda2 /mnt/data2  auto    noauto,user  0 0
```

9.3.1.1 Configuring file systems for particular applications

If the RMS comment is of the form `#RMS:`*<appname>*`#`, the file system entry applies only to the specified application. From an RMS perspective, file systems assigned to a given application are independent of those assigned to other applications. A file system can be assigned to two or more applications, provided only one of the applications is online at any time.

Examples

```
#RMS:app1#/dev/sdb2  /data3  auto   noauto,user  0 0
#RMS:app2#/dev/sdb6  /data4  auto   noauto,user  0 0
```

9.3.1.2 Clusterwide configuration issues

In general, if you create an `/etc/fstab.pcl` control entry for a remote file system or a shared filer on one node, then you should duplicate that entry on every other node in the cluster, even if some nodes will not mount that file system. This helps to ensure that the configuration behaves consistently throughout the cluster.

Use a similar procedure for entries that specify local file systems and mount points. If all the nodes have the same architecture, you may be able to simply copy the entire `/etc/fstab.pcl` control file. However, if the local physical disk device differs from node to node, you must individually adjust the entries for the same mount point. For example, the respective entries for `/mnt1` on `node1` and `node2` might be as follows:

node1:

```
#RMS#/dev/sda3   /mnt1  ...
```

node2:

```
#RMS#/dev/sdb5   /mnt1  ...
```

In all cases, for each mount point that appears in `/etc/fstab.pcl`, be sure to create the directory on every node in the cluster.

9.4 Solaris file systems

- /etc/vfstab.pcl

  Contains entries for all of the local file systems that are to be used as resources in the configuration. In other words, this file describes the file systems that should be mounted locally.

  For each file system to be managed by RMS, create a line with the standard vfstab fields, and then insert the string #RMS# at the beginning of the line. RMS entries appear as comments and will be ignored by all processes other than PRIMECLUSTER components. For more information, see the vfstab manual page.

  Example

  ```
  #RMS#/dev/dsk/c0t0d0s0 /dev/rdk/c0t0d0s0 /testfs1 ufs 1 yes -
  ```

- /etc/dfs/dfstab.pcl

  Contains entries for all of the shared remote resources in the high-availability configuration. In other words, this file describes the file systems that can be mounted on a remote node.

  For each file system to be managed by RMS, create a line with the standard dfstab fields, and then insert the string #RMS# at the beginning of the line. RMS entries appear as comments and will be ignored by all processes other than PRIMECLUSTER components. Therefore, to ensure that the NFS daemons start at boot time, there must be at least one non-comment, non-RMS entry in this file.

  The non-RMS entry might be a dummy entry configured for a local file system and shared only to the local node. This would mean that no real sharing to a remote node is done, but it would still cause the NFS daemons to be started. For more information, see the dfstab manual page.

  Example

  The following contains both a non-RMS entry and an RMS entry:

  ```
  share -F nfs -o ro=localhost /var/opt/example
  #RMS# share -F nfs -o rw,
  root=shasta1RMS:shasta1:045nfs045dia1:045msg:shasta1RMS: /sapmnt/045
  ```

9.4.1 NFS Lock Failover

The NFS Lock Failover feature is available for local file systems. If you configure NFS Lock Failover for a file system and the file system subsequently fails, then both the file system and its NFS locks will failover to the same node.

This feature requires the following site preparation steps:

- You must have a shared disk accessible to all the nodes in the cluster.
- You must dedicate a directory to NFS Lock Failover on that shared disk. If you specify a directory that already exists, no other applications will be allowed to use it after it is configured.
- You must reserve one IP address for each application that uses NFS Lock Failover. You will specify this IP address when you configure the local file system for NFS Lock Failover. You will also configure this address in an Ip Address subapplication so it switches with the application that contains the file system.

  ℹ Only one file system per userApplication object can be selected for NFS Lock Failover.

9.5 NFS servers

In a high availability environment such as RMS, an exported file system must be able to failover transparently when its server node is taken out of service: clients that mounted the file system before the failover should experience no access problems after the failover. NFS file systems require special preparation to achieve this result.

When a client mounts a remote NFS file system, it creates an internal **file handle** that it uses for future operations with the file system. To comply with NFS architecture, the client file handle includes the server's major and minor device numbers for the file system. This design can create access problems in the RMS environment. If the file system goes offline on the original server, and then comes back online on a second server that assigns different major and minor device numbers, the file handle will no longer be valid. This condition is called a **stale file handle**. The solution is to assign the same major and minor device numbers to the file system on every NFS server that may advertise that file system.

The above discussion refers to file systems in general, but in a high availability environment, the file system will actually be a shared disk volume that is accessible from any node that will export it. Preparing a shared disk volume with the same major and minor device number may require changes in the hardware or software configuration. If the shared disk volume is built on top of volume management software, additional steps may be necessary when the volume manager is installed.

This section provides some tips for preparing volume managers for use as NFS servers in the RMS environment.

9.6 Log files

9.6.1 /var/log/messages (Linux) or /var/adm/messages (Solaris)

By default, all RMS messages go to both the system log, `messages`, and the RMS `switchlog` file (located by default in `/var/opt/SMAWRrms/log`). If you do not want to send messages to the system log, then set `HV_SYSLOG_USE = 0` in the `hvenv.local` file. By default, `HV_SYSLOG_USE = 1`.

9.7 Other system services and databases

To configure RMS, the following system service or database must be configured. For details, contact field engineers.

- PRIMECLUSTER Cluster Foundation (CF), including CIP
- `/etc/nsswitch.conf` system service lookup order database

10 Appendix—States

10.1 Basic states

Table 7 lists the states that detectors may report to the base monitor:

State	Description
`Faulted`	Error condition encountered. The error may have occurred in the resource, in one of its children, or during script processing.
`Offline`	Disabled, not ready for use. The scripts have successfully disabled the resource.
`Online`	Enabled, ready for use. All required children are online, and no errors were encountered while scripts were processed.
`Standby`	Ready to be quickly brought `Online` when needed.

Table 7: States reported by detectors for RMS objects

Table 8 lists additional resource states that may be displayed in the Cluster Admin GUI or by `hvdisp`:

State	Description
`Deact`	Applies to `userApplication` objects only. Operator intervention has deactivated the application throughout the cluster (such as for maintenance purposes).
`Inconsistent`	Applies to `userApplication` objects only. The object is `Offline` or `Faulted`, but one or more resource objects in its graph have their `ClusterExclusive` attribute set to 1 and are `Online` or `Faulted`.
`OfflineFault`	Fault that occurred in the past has not yet been cleared.
`Unknown`	No information is available. Reported before object initialization is completed.

Table 8: Additional states that may be displayed for RMS objects

State	**Description**
`Wait`	Temporarily in transition to a known state. An action has been initiated for the affected resource, and the system is waiting for the action to be completed before allocating one of the above states.
`Warning`	Some warning threshold has been exceeded. Note that this state is reported only for selected resources. –
`Maintenance`	Manual, temporary mode of operation in which the state of an application is decoupled from the states of its dependent resources. This allows, for example, a file system to be taken offline for backup without disturbing the state of its parent application. An application in maintenance mode is usually marked with its intended status. The intended status is the status just before the start of maintenance mode.The maintenance mode intended statuses are `Maintenance-Online`, `Maintenance-Offline`, and `Maintenance-Standby`.

Table 8: Additional states that may be displayed for RMS objects

The interpretation of `Offline` and `Faulted` may depend on the resource type. For instance, a mount point resource can be either `Online` (mounted) or `Offline` (not mounted); in this case, the detector would never report the `Faulted` state. On the other hand, a detector for a physical disk can report either `Online` (normal operation) or `Faulted` (input or output error); it would never report `Offline`.

10.2 State details

Besides the basic states listed above, RMS may report additional state details in the following locations:

- In the Cluster Admin GUI, the properties view of an object includes the *State Details* item at the top of the list. Unlike most other attributes, which are determined at configuration time by the Wizard Tools, this information-only field is dynamically set by RMS at runtime.
- In the output of the `hvdisp` utility, the `StateDetails` column appears at the end of each line.

In most cases, the *StateDetails* field is empty. RMS typically provides this extra information when an application is in maintenance mode, or when an object is in a transitional, inconsistent, or standby state. Table 9 lists all possible *StateDetails* values for RMS objects.

Value	**Description**
Failed Over	`Offline` processing successful and failover initiated
Faulted	Received `Faulted` report
Fault Occurred	The resource error has occurred in the past. This value is displayed until the Fault trace is cleared.
Inconsistent on remote	`userApplication` is `Online` on multiple hosts, but is not `Online` on the local host
Initial Fault	`userApplication` already faulted when RMS started
Joined	`SysNode` is in `Offline` state because it has joined the cluster
Killed	`SysNode` is in `Faulted` state because of a successful kill
Not Joined	`SysNode` is in `Offline` state because it has not yet joined the cluster
Offline	Received `Offline` report
Offline Failed	`Offline` processing failed
Offline Success	`Offline` processing successful
Offline intended	Intended state is `Offline`
Online	Received `Online` report

Table 9: StateDetails values for RMS objects

Value	**Description**
Online	`userApplication` is `Online` on multiple hosts
Online !!	Intended state is `Online`, but some resources under `userApplication` are not `Online`
Online intended	Intended state is `Online`
Partial	Resources under the `userApplication` are partially started
PreCheckScriptFailed	`PreCheckScript` failed
Preserved	`PreserveState` set, no `Offline` processing initiated
Shutdown	`SysNode` is in `Faulted` state because it has been shutdown
Standby	Received `Standby` report
Standby !!	Intended state is `Standby`, but some resources under `userApplication` are not `Standby`
Standby intended	Intended state is `Standby`

Table 9: StateDetails values for RMS objects

For example, if an application was online on a particular node before it was put into maintenance mode, it will generally return to the online state on the same node when it leaves maintenance mode. RMS indicates this by reporting *Online intended* in the state details field on that node. On other nodes where the application was previously offline, RMS will report *Offline intended* in the state details field.

11 Appendix—Object types

The following alphabetical list describes all object types that are supplied with RMS and configured by the Wizard Tools.

`andOp`

Required attributes:
`HostName` (for direct children of a `userApplication` object)

Object associated with its children by a logical *AND* operator. This object type is online if all children are online, and offline if all children are offline.

`controller`

Required attributes:
`Resource`

Object that allows a parent `userApplication` to control one or more child `userApplication` objects.

`ENV`

Required attributes:
(none required)

Object containing clusterwide (global) environment variables.

`ENVL`

Required attributes:
(none required)

Object containing node-specific (local) environment variables.

`gResource`

Required attributes:
`rKind`
`rName`

Custom (generic) object. Usually represents system resources such as file systems, network interfaces, or system processes.

`orOp`

Required attributes:
(none required)

Object associated with its children by a logical *OR* operator. This object type is online if at least one child is online.

`SysNode`

Required attributes:

(none required)

Represents nodes in the cluster; at least one required. Only `userApplication` objects are allowed as its children.

`userApplication`

Required attributes:

(none required)

Represents an application to be monitored; at least one required. Must have one or more `SysNode` objects as its parents. For each `SysNode` parent, it must have one child `andOp` with its `HostName` attribute set to the name of the corresponding `SysNode`.

12 Appendix—Attributes

Some object types require specific attributes for RMS to monitor that object type. Some attributes can be modified through the user interface, while others are managed internally by the Wizard Tools. The following sections describe the possible values of all attributes. The default value varies depending on each resource.

12.1 Attributes available to the user

Attributes in this section can be changed using the Wizard Tools user interface.

`AutoRecover`

Possible Values: 0, 1

Valid for resource objects. If set to 1, executes the online script for an object if the object becomes faulted while in an `Online` state. If the object is able to return to the `Online` state, the fault is recovered.

This attribute must be 0 for `controller` objects: RMS handles switchover of child applications automatically.

`AutoStartUp`

Possible Values: yes, no

Valid for `userApplication` objects. If set to "yes," automatically brings the application `Online` when RMS is started.

You can override the `AutoStartUp` attribute for all `userApplication` objects by setting the `HV_AUTOSTARTUP` variable. See the description of `HV_AUTOSTARTUP` in the "Local environment variables".

`AutoSwitchOver`

Possible Values: Valid string containing one or more of the following: `No`, `HostFailure`, `ResourceFailure`, `ShutDown`

Valid for `userApplication` objects. Configures an application for automatic switchover if it becomes faulted. The values can be combined using the vertical bar (“|”) character. The `No` value inhibits automatic switchover and cannot be combined with any other value.

For backward compatibility, the numeric values 0 and 1 are accepted: 0 is equivalent to `No`, and 1 is equivalent to `HostFailure | ResourceFailure | ShutDown`.

`ClusterExclusive`

Possible Values: 0, 1

Valid for resource objects. If set to 1, guarantees that the resource is online on only one node in the cluster at any time. If set to 0, allows a resource to be online on more than one node at a time. Note that “online” in this context refers to any phase of online processing. For instance, if a resource is in the `Online` state on one node while its `PreOnlineScript` is executing on another node, then both resource objects would be considered as online for the purposes of this test.

The user can modify this attribute for `cmdline` subapplications only. The configuration tools control this attribute for all other subapplications.

`FaultScript`

Possible Values: Valid script (character)

Valid for all object types. Specifies a script to be run if the associated object enters the `Faulted` state.

- The argument specified during registration of script will be specified as it is during execution of script.
- Wait until this script finishes in the `Fault` processing.
- If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file but the `Fault` processing continues.

For details about `Fault` processing, refer to "Fault processing".

`HaltFlag (Halt)`

Possible Values: no(0), yes(1)

Valid for `userApplication` objects. Controls local node elimination in the event of a double fault. A double fault occurs when a second fault is generated during the initial fault processing of an application.

If `HaltFlag` is set to yes, and another node is available to run the application, a double fault will trigger the following sequence of events:

1. First, RMS on the local node will exit immediately.
2. Next, RMS on another node will invoke the Shutdown Facility to eliminate the local node.
3. Finally, all applications that were online on the local node, and that have their `AutoSwitchOver` parameter set to include `HostFailure`, will be switched over to the available node.

Note: Even if all the conditions for the `HaltFlag` attribute are met for an application (`AutoSwitchOver` setting, additional hosts available), other applications running on the same host may block the `HaltFlag` operation. For instance, another application may have no other available hosts, or it may not have the appropriate `AutoSwitchOver` setting. In either case, RMS will continue to run on the local node. To prevent this, allocate additional hosts for the other applications and adjust their priority lists to minimize node conflicts with the application that has its `HaltFlag` attribute set.

`LieOffline`

Possible Values: 0, 1

Valid for all resource objects. If set to 1, allows the resource to remain `Online` during `Offline` processing.

`MonitorOnly`

Possible Values: 0, 1

Valid for resource objects. If set to 1, `userApplication` does not become Faulted and switching does not occur even if that resource becomes Faulted.

If the resource becomes Faulted during `Offline` processing due to a manual switchover, for example, `Offline` processing continues, but the switchover is canceled.

`OfflineDoneScript`

Possible Values: Valid script (character)

Valid for `userApplication` objects. Specifies the script to be run after the `Offline` processing of `userApplication` has completed.

– The argument specified during registration of script will be specified as it is during execution of script.

– Do not wait for this script to finish in the `Offline` processing.

– If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file but the `Offline` processing continues.

For details about `Offline` processing, refer to "Offline processing".

`OfflineScript`

Possible Values: Valid script (character)

Valid for all object types except SysNode objects. Specifies the script to be run to bring the associated resource to the Offline state.

OnlinePriority

Possible Values: 0, 1

Valid for userApplication objects. Allows RMS to start the application on the node where it was last online when the entire cluster was brought down and then restarted. If set to 0 or not set (the default), the application comes online on the node with the highest priority in the attribute PriorityList. If set to 1, the application comes online on the node where it was last online. In case of AutoStartUp or a priority switch, this last-online node has the highest priority, regardless of its position in the priority list.

RMS keeps track of where the application was last online by means of timestamps. The node which has the latest timestamp for an application is the node on which the application will go online. Different cluster nodes should be in time-synchronization with each other, but this is not always the case. Since RMS does not provide a mechanism for ensuring time-synchronization between the nodes in the cluster, this responsibility is left to the system administrator. If RMS detects a severe time-discrepancy between the nodes in the cluster, an ERROR message is printed to the switchlog.

NTPD or CHRONY can be used to establish consistent time across the nodes in the cluster. Refer to the manual page for xntpd or chronyd for more information.

The OnlinePriority persistent state information will be cleared if RMS is restarted with the last online node removed from the configuration.

OnlineScript

Possible Values: Valid script (character)

Valid for all objects except SysNode objects. Specifies the script to bring the associated resource to the Online or Standby state.

`PartialCluster`

Possible Values: 0, 1

Valid for `userApplication` objects. Specifies whether an application can negotiate online requests.

If set to 0, then the application can negotiate its online request only when all the nodes where it can possibly run are online.

If set to 1, then the application can negotiate its online request within the current set of online nodes, even if some other nodes (including the application's primary node) are offline or faulted.

`PersistentFault`

Possible Values: 0, 1

Valid for `userApplication` objects. If set to 1, when RMS is starting, the state of `userApplication` that stopped last time will be checked. Under any one of the following conditions, the `userApplication` becomes the `Faulted` state (`InitialFault`) right after RMS is started.

– The shutdown processing of RMS is not performed.

– `userApplication` is in the `Faulted` state when RMS is stopped.

If `userApplication` becomes the `Faulted` state, remove the cause of this error first, and then, use `hvutil -c` to clear the `Faulted` state.

Note

If the PersistentFault attribute is not set to 1, the userApplication does not become the Faulted state at RMS startup after a node error or panic reboot of the operating system. In this case, as it is not the Faulted state, this node is accepted as it can be switched or failed back. if the error definitely occurs on all the nodes that constitute cluster during the Online processing and also panic reboot of the operating system occurs, the failover may repeat infinitely.

`PostOfflineScript`

Possible Values: Valid script (character)

Valid for all objects except `SysNode` objects. Specifies the script to be run after the state of the associated resource changes to `Offline`.

`PostOnlineScript`

Possible Values: Valid script (character)

Valid for all objects except `SysNode` objects. Specifies the script to be run after the state of the associated object changes to `Online` or `Standby`.

- The argument specified during registration of script will be specified as it is during execution of script.
- Wait until this script finishes in the `Online` processing.
- If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file and the `Fault` processing will start.

For details about `Online` processing, refer to "Online processing".

`PreCheckScript`

Possible Values: Valid script (character)

Valid for `userApplication` objects. Specifies the script to be run before the start of `Online` or `Standby` processing.

- The argument specified during registration of script will be specified as it is during execution of script.
- If the script returns with an exit code zero, the `Online` or `Standby` processing will be started. If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file and the `Online` or `Standby` processing will not be started.

For details, refer to "PreCheckScript".

`PreOfflineScript`

Possible Values: Valid script (character)

Valid for all objects except `SysNode` objects. Specifies the script to run before the object is taken to the `Offline` state.

- The argument specified during registration of script will be specified as it is during execution of script.
- Wait until this script finishes in the `Offline` processing.
- If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file but the `Offline` processing continues. `Fault` processing will start after the `Offline` processing is completed.

For details about `Offline` processing, refer to "Offline processing".

`PreOnlineScript`

Possible Values: Valid script (character)

Valid for all objects except `SysNode` objects. Specifies the script to be run before the associated object is taken to the `Online` or `Standby` state.

- The argument specified during registration of script will be specified as it is during execution of script.
- Wait until this script finishes in the `Online` processing.
- If the script returns with an exit code value other than zero, the message indicating script failure will be recorded in switchlog file and the `Fault` processing will start.

For details about `Online` processing, refer to "Online processing".

`PreserveState`

Possible Values: 0, 1

Valid for `userApplication` objects. If set to 1, the resources are not to be taken `Offline` after a fault. Ignored if `ResourceFailure` is set to `AutoSwitchOver`.

`ScriptTimeout`

Possible Values: 0–*MAXINT* (in seconds) or valid string of the form "*timeout_value*[:[*offline_value*][:*online_value*]]"

Valid for all object types. Specifies the timeout value for all scripts associated with that object in the configuration file. RMS sends a kill signal to the script if the timeout expires.

Use the string format to specify individual timeout values of *offline_value* for `OfflineScript` and *online_value* for `OnlineScript`.

`ShutdownPriority`

Possible Values: 0–20

Valid for `userApplication` objects. `ShutdownPriority` assigns a weight factor to the application for use by the Shutdown Facility.

When interconnect failures and the resulting concurrent node elimination requests occur, SF calculates the shutdown priority of each subcluster as the sum of the subcluster's SF node weights plus the RMS `ShutdownPriority` of all online application objects in the subcluster. The optimal subcluster is defined as the fully connected subcluster with the highest weight.

StandbyCapable

Possible Values: 0, 1

Valid for resource objects. If set to 1, the object performs standby processing on all the nodes where the parent application is supposed to be `Offline`.

The user can modify this attribute for a `cmdline` subapplication only. The configuration tools control this attribute for all other subapplications.

StandbyTransitions

Possible Values: `StartUp, SwitchRequest, ClearFaultRequest` or any combination joined by vertical bars (|)

Valid for `userApplication` objects. The value specifies when standby processing is initiated for the application object:

- `StartUp`—at startup. This setting is ignored if the real-world application is already online, or if the application object is forced to go online because the `AutoStartUp` attribute is set.
- `SwitchRequest`—after application switchover, if the application was online before the switchover.
- `ClearFaultRequest`—after a faulted state is cleared with ‘`hvutil -c`’.

WarningScript

Possible Values: Valid script (character)

Valid for resource objects with detector. Specifies the script to be run after the posted state of the associated resource changes to `Warning`.

12.2 Attributes managed by configuration wizards

Attributes in this section are managed internally by the configuration wizards or by RMS at runtime.

AlternateIp

Possible Values: Any interconnect name

Valid for `SysNode` objects. Space-separated list that RMS uses as additional cluster interconnects if the interconnect assigned to the `SysNode` name becomes unavailable. All these interconnects must be found in the /etc/hosts database. By default, the configuration wizards assume the alternate interconnects to node *<nodename>* have names of the form *<nodename>*rmsAI*<nn>*, where *<nn>* is a two-digit, zero-filled number. This setting is restricted to very specific configurations and must never be used in a cluster with CF as interconnect.

Affiliation

Possible Values: Any string

Valid for resource objects. Used for display purposes in the user interface—no functional meaning within RMS.

AutoRecoverCleanup

Possible Values: 0, 1

Valid for controller objects. If set to 1, and AutoRecover is 1, then a faulted child application is requested to go Offline before recovering. If set to 0 and AutoRecover is 1, then a faulted child application recovers without going Offline.

Class

Possible Values: any string

Valid for all objects except SysNode. Describes the class of the resource object. Used by other programs for various purposes (for example, SNMP agents). This value is supplied by the configuration wizards.

Comment

Possible Values: any string

Valid for all objects. Used for documentation in the configuration file—no functional meaning within RMS.

ControlledSwitch

Possible Values: 0, 1

Valid for controlled userApplication objects. If set to 0, RMS allows a manual switch request from the CLI or the GUI. If set to 1, only the parent controller can issue switch requests to this userApplication.

DetectorStartScript

Possible Values: Any valid detector start script

Valid for resource objects with detector. Specify the detector start command directly in the *<configname>*.us file.

Note that a controller object has no detector because RMS determines its state internally.

`HostName`

Possible Values: Any `SysNode` name

Must be set only in the first-level `andOp` children of a `userApplication` object. Each of these `andOp` objects associates its parent application with the `SysNode` specified in its `HostName` attribute; the child `andOp` objects also determine the priority of the application's nodes.

`I_List`

Possible Values: Space-separated list of `SysNode` names

Valid for all `SysNode` objects. List of additional cluster interconnects that should be monitored by RMS. These interconnects are used only by customer applications and not by any PRIMECLUSTER products. All monitored interconnects must be found in the `/etc/hosts` database. In addition, all `SysNode` objects must have the same number of additional interconnects.

`LastDetectorReport`

Possible Values: `Online`, `Offline`, `Faulted`, `Standby`

Valid for resource objects with detector. This attribute contains the most recent detector report for the object. The value may be displayed in the Cluster Admin GUI; the possible values depend on the type of resource the object represents.

`MaxControllers`

Possible Values: 0–512

Valid for `userApplication` objects. Upper limit of parent `userApplication` objects for the specified child application.

`NoDisplay`

Possible Values: 0, 1

Valid for all object types. The resource object set to 1 is displayed only when specifying it with the -i option of the hvdisp command.

`NullDetector`

Possible Values: `on`, `off`

Valid for resource objects with detector. Used to disable a detector at runtime by setting `NullDetector` to `on`. This attribute is for use with dynamic reconfiguration only. `NullDetector` must never be set hard-coded to `on` in the RMS configuration file.

PriorityList

Possible Values: Valid list of SysNode names (character)

Valid for userApplication objects. Contains a list of SysNode objects where the application can come Online. The order in the list determines the next node to which the application is switched during a priority switchover, ordering a switchover after a Fault. The list is processed circularly.

The user specifies this attribute indirectly when selecting the nodes for an application. RMS uses the order in which the nodes were selected and creates PriorityList automatically. The user can change the PriorityList by adding individual nodes from the list in the desired order, rather than automatically selecting the entire list.

For applications controlled by or a controller object, the order of nodes in PriorityList is ignored. However, each child application must be able to run on the nodes specified for the parent application.

Resource

Possible Values: Valid name (character)

Valid for controller objects. Contains the name of the child (controlled) userApplication.

rKind

Possible Values: 0–2047

Valid for gResource objects. Specifies the kind of detector for the object.

rName

Possible Values: Valid string (character)

Valid for gResource objects. Specifies a string to be forwarded to the generic detector.

SplitRequest

Possible Values: 0, 1

Valid for controller objects. If set to 1, then PreOffline and PreOnline requests will be propagated to child applications separately from the Offline and Online requests. If 0, then separate PreOffline or PreOnline requests will not be issued for the child applications.

`StateDetails`

Possible Values: Any string

Valid for all objects. Displays additional state details in the Cluster Admin GUI or the `hvdisp` CLI user interface. In most cases, the state details field is empty. RMS typically provides this extra information when an application is in maintenance mode, or when an object is in a transitional, inconsistent, or standby state.

13 Appendix—Environment variables

This appendix provides a complete list of the environment variables used by RMS, grouped into the following types:

- "Global environment variables"
- "Local environment variables"
- "Script execution environment variables"

The discussion in the "Environment variables" describes how RMS manages environment variables.

13.1 Setting environment variables

Caution

Do not explicitly set RMS environment variables in the user environment. Doing so can cause RMS to lose environment variables settings.

Do not change the hvenv configuration file. Changes to your configuration's environment variables should be confined to the *<RELIANT_PATH>*hvenv.local file.

The values of environment variables are specified as export directives in the hvenv.local file. To adjust a variable's setting, you would open hvenv.local with a text editor of your choice and modify (or add) the appropriate line.

A typical export directive would appear as follows:

```
export SCRIPTS_TIME_OUT=200
```

When RMS starts, it reads the values of environment variables from hvenv and hvenv.local and initializes the ENV and ENVL objects respectively. No further reference is made to these two configuration files while RMS is running. Therefore, any changes you make to hvenv.local will not take effect until the next time RMS starts up.

Values in the ENVL (local) object override values in the ENV (global) object. If a global variable setting appears in the hvenv.local file, it will override the corresponding setting in the hvenv file. However, if you adjust a global variable in the hvenv.local file on one node, you must make the same adjustment to hvenv.local on every other node in the cluster. Global variable settings must agree clusterwide.

While RMS is running, you can display the environment variables with the hvdisp command, which does not require root privilege:

- hvdisp ENV
- hvdisp ENVL

13.2 Global environment variables

i Global variable settings (ENV) are included in the configurations checksum that is common to the cluster. The checksum is verified on each node during startup of the base monitor. RMS will fail to start if it detects a checksum difference between the values on any two nodes.

i The default values of the environment variables are found in *<RELIANT_PATH>*/bin/hvenv. They can be redefined in the hvenv.local configuration file.

The following list describes the global environment variables for RMS:

HV_AUTOSTARTUP_IGNORE

Possible values: List of RMS cluster nodes. The list of RMS cluster nodes must be the names of the SysNodes as found in the RMS configuration file. The list of nodes cannot include the CF name.
Default: “” (empty)

List of cluster nodes that RMS ignores when it starts. This environment variable is not set by default. A user application will begin its automatic startup processing if the AutoStartUp attribute is set and when all cluster nodes defined in the user application have reported Online. If a cluster node appears in this list, automatic startup processing will begin even if this node has not yet reported the Online state.

Use this environment variable if one or more cluster nodes need to be taken out of the cluster for an extended period and RMS will continue to use the configuration file that specifies the removed cluster nodes. In this case, specifying the unavailable cluster nodes in this environment variable ensures that all user applications are automatically brought online even if the unavailable cluster nodes do not report `Online`.

Caution

If the `HV_AUTOSTARTUP_IGNORE` environment variable is used, ensure that it is correctly defined on all cluster nodes and that it is always kept up-to-date. When a node is brought back into the cluster, remove it from this environment variable. If this does not occur, data loss could occur because RMS will ignore this node during the startup procedure and will not check whether the application is already running on the nodes specified in this list. It is the system administrator's responsibility to keep this list up-to-date if it is used.

`HV_AUTOSTART_WAIT`

Possible values: 0–*MAXINT*
Default: 60 (seconds)

Defines the period (in seconds) that RMS waits for cluster nodes to report `Online` when RMS is started. If this period expires and not all cluster nodes are online, a switchlog message indicates the cluster nodes that have not reported `Online` and why the user application(s) cannot be started automatically.

This attribute generates a warning message only. `AutoStartUp` will proceed even if the specified period has expired.

`HV_CHECKSUM_INTERVAL`

Possible values: 0–*MAXINT*
Default: 120 (seconds)

Interval in seconds for which the RMS base monitor waits for each `Online` node to verify that its checksum is the same as the local checksum.

If checksums are confirmed within this interval, then RMS on the local node continues its operations as usual. However, if a checksum from a remote node is not confirmed, or if it is confirmed to be different, then the local monitor shuts down if it has been started less than `HV_CHECKSUM_INTERVAL` seconds before.

Also, if a checksum from a remote node is not confirmed, or if the checksum is confirmed to be different, then the local monitor considers the remote node as `Offline` if that local monitor has been started more than `HV_CHECKSUM_INTERVAL` seconds before.

HV_COM_PORT

Possible values: 0–65535
Default: 8000

The communication port used by the RMS base monitor on all the nodes in the cluster.

HV_LOG_ACTION_THRESHOLD

Possible values: 0–100
Default: 98

Determines conditions under which `hvlogcontrol` cleans up RMS log files. If the percentage of used space on the file system containing *RELIANT_LOG_PATH* is greater than or equal to this threshold, all subdirectories below *RELIANT_LOG_PATH* will be removed. Furthermore, if `HV_LOG_ACTION` is set to `on` and all subdirectories have already been removed, the current log files will be removed too. See `HV_LOG_ACTION` for more information.

HV_LOG_WARN_THRESHOLD

Possible values: 0–100
Default: 95

Defines when `hvlogcontrol` warns the user about the volume of RMS log files. If the percentage of used space on the file system containing *RELIANT_LOG_PATH* is greater than or equal to this threshold value, `hvlogcontrol` issues a warning to the user. See also `HV_LOG_ACTION_THRESHOLD` above.

HV_LOH_INTERVAL

Possible values: 0–*MAXINT*
Default: 30

Specifies the minimum difference in seconds when comparing timestamps to determine the last online host (LOH) for `userApplication`. It is determined if the `OnlinePriority` attribute is set to 1.

If the difference between the LOH timestamp entries logged in the `userApplication` on two cluster nodes is less than the time specified by this attribute, RMS does not perform `AutoStartUp` and does not allow priority switches. Instead, it sends a message to the console and waits for operator intervention.

When adjusting this variable, the quality of the time synchronization in the cluster must be taken into account. The value must be larger than any possible random time difference between the cluster hosts.

`HV_USE_ELM`

Possible values: 0, 1
Default: 1

Specifies the heartbeat monitoring mode used by the RMS base monitor:

`0`—remote node and base monitor states are detected by periodically sending UDP heartbeat packets across the network. If no heartbeats are received from a remote node during an interval defined by `HV_CONNECT_TIMEOUT`, RMS marks the node as down and waits for a recovery period before taking further action.

`1`—combines the Enhanced Lock Manager (ELM) method and the UDP heartbeat method. This setting is valid only when CF is installed and configured. The ELM lock is taken and held by the local node until ELM reports a remote node down or remote base monitor down. In either of these cases, the remote node is immediately killed. Until ELM reports a change in a remote node's state, RMS also monitors the UDP heartbeat of each remote node as described above, but with a much longer recovery timeout.

Whether or not ELM is enabled, a remote node is killed if its UDP heartbeat is not received before its heartbeat recovery timeout expires. When CF is not present, ELM is disabled automatically, and the heartbeat recovery timeout defaults to 45 seconds. When CF is present, ELM is enabled by default, and the heartbeat recovery timeout defaults to 600 seconds; this avoids premature node kills when the remote node is slow to respond.

Only experts should disable ELM manually. When CF is present but ELM is disabled, the default 600 second heartbeat recovery timeout is too long for efficient detection of remote RMS or node outages. In this case, the recovery timeout on the local node must also be adjusted manually by starting RMS with the '`hvcm -h` *<timeout>* `-c` *<config_file>*' command.

Note that the recovery timeout should be set to the same value on every node in the cluster. When ELM is disabled, the recommended global value is 45 seconds.

`RELIANT_LOG_LIFE`

Possible values: Any number of days
Default: 7 (days)

Specifies the number of days that RMS logging information is retained. Every time RMS starts, the system creates a directory that is named on the basis of when RMS was last started, and which contains all constituent log files. All RMS log files are preserved in this manner. All sub directories under `RELIANT_LOG_PATH` whose update time (ctime) is older than the the number of days specified in this variable are deleted by a `cron` job.

`RELIANT_LOG_PATH`

Possible values: Any valid path
Default: `/var/opt/SMAWRrms/log`

Specifies the directory where all RMS and Wizard Tools log files are stored. The location to store the internal log will not be changed even if the value of this variable is changed.

`RELIANT_PATH`

Possible values: Any valid path
Default: `/opt/SMAW/SMAWRrms`

Specifies the root directory of the RMS directory hierarchy. Users do not normally need to change the default setting.

`RELIANT_SHUT_MIN_WAIT`

Possible values: 0–*MAXINT*
Default: MAXINT (seconds)

Defines the period (in seconds) until the `hvshut` command times out.

If the `hvshut` command is executed with any of the `-l` , `-s` , and `-a` options, RMS performs shutdown processing after it performs offline processing of the active applications.

Set the total time of the following items for `RELIANT_SHUT_MIN_WAIT`:

1. Maximum time required to complete offline processing of applications
2. Maximum time required to shut down BM (base monitor) (30 seconds)

Use the total value of the script timeout of all resources included in an application for the value of 1.

To check the script timeout value of each resource, execute the `hvdisp` command by using the resource name as the argument and see the setting value (in seconds) of the `ScriptTimeout` attribute of the resource with which the `OfflineScript` attribute is not blank.

When the `ScriptTimeout` attribute is in "*timeout_value*[:[*offline_value*][:*online_value*]]" format, use the *offline_value* timeout value if *offline_value* exists. If *offline_value* does not exist, use the *timeout_value* timeout value.

If there are two or more applications, use the largest value of the total values of the script timeout for each application.

By increasing the value of `RELIANT_SHUT_MIN_WAIT`, the following effects occur if delay or hang-up in offline processing of applications occurs.

- It may take longer time than the setting value of `RELIANT_SHUT_MIN_WAIT` to shut down RMS or the operating system.
- It may take longer time than the setting value of `RELIANT_SHUT_MIN_WAIT` to automatically switch applications by shutting down RMS or the operating system.

If the value of `RELIANT_SHUT_MIN_WAIT` is too large, use the processing time in the case that it is expected to take the longest time until timeout of the assumed cases where offline processing of an application times out for the value of the item 1 above.

Note that if the value of `RELIANT_SHUT_MIN_WAIT` is too small, timeout of the `hvshut` command may frequently occur before offline processing of applications completes. Tune `RELIANT_SHUT_MIN_WAIT` carefully.

Caution

Resources may remain active without stopping because RMS terminates abnormally when the `hvshut` command times out. Under this situation, if you start RMS on a different node and forcibly activate the application, the resources may become active on several nodes at the same time, and data may be corrupted when a shared disk is controlled by the resources. For this reason, if the `hvshut` command times out, shut down the operating system of the node where RMS has terminated abnormally, or forcibly shut down the node to ensure that resources stop. Then, start RMS and applications.

13.3 Local environment variables

Local environment variable settings can vary from node to node. The following list describes the local environment variables for RMS:

HV_AUTOSTARTUP

Possible values: 0, 1
Default: 1 (normal processing of `AutoStartUp` attribute)

Controls the action of the `AutoStartUp` attribute for all `userApplication` objects on the local node. If set to 1 (the default value) the automatic startup of each `userApplication` is determined by its `AutoStartUp` attribute (see the "Attributes available to the user"). If set to 0, the `AutoStartUp` attribute is ignored and no automatic startup occurs. `HV_AUTOSTARTUP` can be set in the Cluster Admin *Tools* menu or by using the `hvsetenv` command; in either case, the change does not take effect until the next RMS startup.

HV_CONNECT_TIMEOUT

Possible values: 5–*MAXINT*
Default: 30 (seconds). Users do not normally need to change the default setting.

The maximum time (in seconds) that the heartbeat from a node is not received before the base monitor assumes the connection to that node has been lost and starts the UDP heartbeat recovery timer.

Input values less than 5 are converted internally to 5.

HV_LOG_ACTION

Possible values: `on`, `off`
Default: `off`

Determines whether the current log files in the *RELIANT_LOG_PATH* directory will be deleted when the percentage of used space on the file system containing *RELIANT_LOG_PATH* is greater than or equal to `HV_LOG_ACTION_THRESHOLD`. See `HV_LOG_ACTION_THRESHOLD` for more information.

`HV_MAX_HVDISP_FILE_SIZE`

Possible values: 0–*MAXINT*
Default: 20,000,000 (bytes)

Prevents the unlimited growth of the temporary file that RMS uses to supply `hvdisp` with configuration data and subsequent configuration and state changes. The value of this variable is the maximum size in bytes of the temporary file *<RELIANT_PATH>*`/locks/.rms.`*<process id of the hvdisp process>*.

`HV_MAXPROC`

Possible values: 0–99
Default: 30

Defines the maximum number of scripts that RMS can execute at one time. The default (30) is sufficient in most cases.

`HV_MLOCKALL`

Possible values: 0, 1
Default: 0

If set to 1, the base monitor process and any memory it allocates will be locked in memory. If set to 0 (the default), the base monitor may be swapped out.

`HV_RCSTART`

Possible values: 0, 1
Default: 1 (start RMS in the `rc` script)

Determines if RMS is started in the `rc` script. If set to 1 (the default value), RMS is started automatically at system boot time. If set to 0, RMS must be started manually. `HV_RCSTART` can be set in the Cluster Admin *Tools* menu or by using the `hvsetenv` command. (Prerequisite for `rc` start: `CONFIG.rms` exists and contains a valid entry.)

`HV_REALTIME_PRIORITY`

Possible values: 1–99
Default: 50

Defines the real time priority for the RMS base monitor and its detectors. Caution should be used when adjusting this variable. High settings can prevent other OS real-time processes from getting their processor time slice. Low settings can prevent the RMS base monitor from reacting to detector reports and from performing requests from command line utilities.

This variable is processed only on Solaris platforms. It has no effect on Linux platforms.

HV_SCRIPTS_DEBUG

Possible values: 0, 1
Default: 0

Controls debugging output from RMS scripts. If this variable is set to 1, it overrides the setting for scripts that are generated and managed by the Wizard Tools, causing them to write detailed runtime information about the commands that are executed to the RMS `switchlog` file. The type of information logged may vary according to the script. This setting applies only to those scripts provided with PRIMECLUSTER products. To disable script debug message logging, delete the `HV_SCRIPTS_DEBUG` entry or set `HV_SCRIPTS_DEBUG=0` in `hvenv.local`.

Note: when this variable appears in `hvenv.local`, RMS adds it to the script environment but otherwise makes no attempt to process it. Therefore, it is not reported in the Cluster Admin GUI or in '`hvdisp ENVL`' output.

HV_SYSLOG_USE

Possible values: 0, 1
Default: 1 (in `hvenv`)

Controls output to the system log from the RMS base monitor. RMS always records RMS ERROR, FATAL ERROR, WARNING, and NOTICE messages in the RMS `switchlog` file. By default, these messages are duplicated in the system log file `/var/adm/messages` (Solaris) or `/var/log/messages` (Linux). To disable RMS messages in the system log, set `HV_SYSLOG_USE=0` in `hvenv.local`.

Note

It is recommended for Linux to change this variable to 0. If this variable is set to 1 on Linux, under a high load on the system, the system log output will hang due to the performance limit of the system log processing by OS. In this case, RMS may not respond to any heartbeat from other node.

`RELIANT_HOSTNAME`

Possible values: valid name
Default: *<nodename>*`RMS`

The name of the local node in the RMS cluster. The default value of this variable is the node name with an `RMS` suffix (for example: `shasta1RMS`), as generated by the following command:

```
export RELIANT_HOSTNAME=`cftool -l 2>/dev/null | \
tail -1 | cut -f1 -d" "`RMS
```

If this preset value is not suitable, it must be modified accordingly on all the nodes in the cluster.

The specified cluster node name must correspond to the `SysNode` name in the *<configname>*`.us` configuration file. The node name determines the IP address that RMS uses for establishing contact with this node.

`RELIANT_INITSCRIPT`

Possible values: any executable
Default: *<RELIANT_PATH>*`/bin/InitScript`

Specifies an initialization script to be run by RMS when the system is started. This script is run before any other processes are activated. It is a global script that is run once on every cluster node on which it is defined.

`RELIANT_STARTUP_PATH`

Possible values: any valid path
Default: *<RELIANT_PATH>*`/build`

Defines where RMS searches at start time for the configuration files.

`SCRIPTS_TIME_OUT`

Possible values: 0–*MAXINT*
Default: 300 (seconds)

Specifies the global period (in seconds) within which all RMS scripts must be terminated. If a specific script cannot be terminated within the defined period, it is assumed to have failed and RMS begins appropriate processing for a script failure.

If this value is too low, error conditions will be produced unnecessarily, and it may not be possible for the applications to go online or offline. An excessively high value is unsuitable because RMS will wait for this period to expire before assuming that the script has failed.

In case the global setting is not appropriate for all objects monitored by RMS, this global value can be overridden by an object-specific setting of the `ScriptTimeout` attribute.

13.4 Script execution environment variables

The variables in this section are set by the RMS base monitor when it executes an object's script. These exist only in the script's environment and only for the duration of the script execution. Since these variables are explicitly set, they have no default values.

`HV_APPLICATION`

Possible values: any `userApplication` name

Name of the `userApplication` object at the top of the sub-tree that contains the current object.

`HV_AUTORECOVER`

Possible values: 0, 1

If set to 1, the script was initiated due to an `AutoRecover` attempt.

`HV_FORCED_REQUEST`

Possible values: 0, 1

If set to 1, the script is currently processing a forced request.

`HV_LAST_DET_REPORT`

Possible values: one of `Online`, `Offline`, `Standby`, `Faulted`

Last detector report for the current object.

`HV_OFFLINE_REASON`

Possible values: one of `DEACT`, `SWITCH`, `FAULT`, `STOP`, `SHUT`

Reason for a resource to become `Offline` is set:
`SWITCH`: switch request from `userApplication` (‘`hvswitch`’).
`STOP`: stop request from `userApplication` (‘`hvutil -f`’, ‘`hvutil -c`’).
`FAULT`: resource failure
`DEACT`: deact request from `userApplication` (‘`hvutil -d`’)
`SHUT`: stop request from RMS (‘`hvshut`’).

`HV_NODENAME`

Possible values: any object name

Name of current object.

`HV_REQUESTING_CONTROLLER`

Possible values: controller name and node name
If non-empty, contains the name of the controller and node that initiated the request for the current script execution.

`HV_SCALABLE_CONTROLLER`

Possible values: scalable controller name
The name of the scalable controller that controls this application.

`HV_SCALABLE_INFO`

Possible values: scalable applications list
Contains the list of all scalable applications everywhere in the cluster.

`HV_SCRIPT_TYPE`

Possible values: any of the following script types: `PreCheck`, `PreOnline`, `Online`, `PostOnline`, `PreOffline`, `Offline`, `PostOffline`, `OfflineDone`, `Fault`

`NODE_SCRIPTS_TIME_OUT`

Possible values: 0–*MAXINT*

Timeout value for the current object and script type.

i `HV_REQUESTING_CONTROLLER` ,`HV_SCALABLE_CONTROLLER` and `HV_SCALABLE_INFO` can be used only by the Online/Offline processing of the application controlled with the controller object.

14 Appendix—Troubleshooting

This chapter discusses some PRIMECLUSTER facilities for debugging RMS configurations from both the command line interface (CLI) and from the Cluster Admin graphical user interface (GUI). This chapter provides details on log files, their location, how to turn on logging levels, how to view logs from the GUI, and how to view log files from CLI.

Chapter contents:

- "Overview" summarizes the troubleshooting process.
- "Debug and error messages" describes RMS debug and error messages.
- "Log file categories" classifies the RMS log files.
- "Managing base monitor log output" describes how to manage logs produced by the RMS base monitor and its components.
- "Managing application log output" describes how to manage logs produced by the standard RMS Wizard Tools application and resource components.
- "Managing detector log output" describes how to manage logs produced by the standard RMS Wizard Tools resource detectors.
- "Interpreting RMS log messages" describes the formats of messages produced by the components of the RMS base monitor, and the applications and resources configured by the RMS Wizard Tools.
- "Viewing RMS log messages" describes the log viewer facility available in the Cluster Admin GUI.
- "RMS log file cleanup" describes how to control the volume of RMS log files either automatically or manually.
- "RMS troubleshooting" supplies solutions to problems that could occur while using RMS.
- "Collecting information for advanced troubleshooting" describes dump commands for consultants and developers.

14.1 Overview

The RMS troubleshooting process usually begins after you observe an error condition or unexpected state change in Cluster Admin in one of the following areas:

- Clusterwide table
- RMS tree
- Graph

The clusterwide table contains summary information and is a good place to start looking for error conditions. For additional details, you can look at the RMS tree or the graph. Depending on whether you need to look at the switchlogs or application logs, you can then use the log viewer facility to view the log files.

The log viewer has search facilities based on the following:

- Keywords
- Severity
- Non-zero exit codes

Search for causes of errors using the keywords and the date range fields. For emergency, alert, and critical conditions, you can do a search based on severity. For proactive troubleshooting, you can perform a search based on severity for the `error`, `warning`, `notice`, and `info` severity codes.

It is recommended that you periodically use the log viewer and check the log files based on the severity levels to avoid serious problems. If you cannot diagnose the cause of a problem, look at the log viewer from two or more nodes in the cluster.

Refer to the "RMS troubleshooting" for an explanation on corrective action.

Resolve error conditions as follows:

1. Use the Cluster Admin GUI.
2. View the log files if needed.
3. Change log levels to get more details.

4. If you cannot resolve an error condition with the GUI, you can use the command line interface. Use standard UNIX commands.
5. If a problem persists, check if it is a non-RMS issue and refer to the appropriate manual.
6. Check for system-related issues like operating system, hardware, or network errors.
7. Contact field engineers if you cannot resolve the issue.

14.2 Debug and error messages

RMS writes debug and error messages to log files when its components (such as the base monitor or detectors) operate. The default setting is for RMS to store these files in the `/var/opt/SMAWRrms/log` directory. Users can change the directory with the `RELIANT_LOG_PATH` environment variable, which is set in the `hvenv.local` file.

When RMS starts, logging begins. The default setting is for the base monitor to write all error messages to its log file or to `stderr`. Normally, you do not need to change the default setting because the default options allow for very detailed control of debug output.

If required, you can use the base monitor to record every state and message of any node. However, in most cases, the information requires a detailed knowledge of internal RMS operation to interpret the debug output, which can only be evaluated by field engineers.

For the administrator of an RMS cluster, evaluating the `switchlog` file is normally sufficient. This file records all important RMS actions; for example, incoming switch requests or faults that occur in nodes or resources.

i There are also configuration-specific log files in the log directory. It is recommended that administrators evaluate these if necessary. The name of each log file (normally *<userApplication>*`.log`) depends on the configuration that was set up using the RMS Wizard Tools. Refer to the chapter "Managing application log output" for further information.

The `bmlog` log file can also be useful for problem solving.

14.3 Log file categories

Table 10 identifies and explains the RMS log files contained in `/var/opt/SMAWRrms/log`.

Module	**File Name**	**Contents**
Everything (base monitor, generic detector)	`switchlog`	Operational events, such as resource switches or bugs. Normally, `switchlog` is the only log file users need to examine.
generic detector	<*detname*>`g`<*n*>`.log`	All messages and job assignments received by the detector. Also contains resource state change information and all error messages. *detname* is the name of the detector (`hvdet_*`) in the <*RELIANT_PATH*>`/bin` directory.
base monitor	`abortstartlog`	This file contains records about bm exit conditions to assist field engineers in determining why RMS failed to start. This file is generated and the following console message appears when startup failures occur: `FATAL ERROR: RMS has failed to start!` Further details about the problem may appear in the `switchlog`.

Table 10: Log files

Module	**File Name**	**Contents**
base monitor	`bmlog`	General RMS error and message logging information ranges from simple message reporting to more complete information. The error log level determines the contents of this file, which is specified when the base monitor is started. See "Managing base monitor log output" for more information. This file includes all messages received by the base monitor at runtime. It also contains information generated by `hvdump` (see "Using the hvdump command (RMS)"). Should be used by experts only, since turning on log level flags consumes a great deal of disk space. By default, RMS places no messages in `bmlog`.
base monitor	`tracelog`	Records all messages between objects and all modification instructions. By default, RMS places no messages in `tracelog`.
Object's detector and script related to applications	<*application_name*>`.log`	All messages related to applications are recorded. The output of all the scripts which are executed by the application is also written to the log file.

Table 10: Log files

14.4 Managing base monitor log output

At runtime, the RMS base monitor can generate log messages in the *RELIANT_LOG_PATH*/`switchlog` file and in the system log file. This section describes how you can control the **log level** (the amount of detail) in the log files. Each log level reports an internal function that is intended for expert use.

Executing RMS with several active log levels will affect system performance. This feature should be enabled for testing or debugging purposes only.

14.4.1 Managing base monitor log levels

By default, base monitor logging is not running when RMS starts up. You can set the initial log level by specifying `hvcm` with the `-l` option:

```
hvcm -l <level> -c <configuration_file> ...
```

Is RMS is already running, you can use the following commands to manage the base monitor log level:

```
hvutil -l display
```

```
hvutil -l off
```

```
hvutil -l <level>
```

The first `hvutil` command displays the current base monitor log level setting, and the second `hvutil` command turns off base monitor logging.

Specifying '`-l` *<level>*' with `hvcm` or `hvutil` activates base monitor logging, where *<level>* is one or more numbers in one of the following formats:

- A single number.
- A comma-delimited or space-delimited list. If the list is space-delimited, enclose the list in quotes. Examples: 2,4,5,7 "2 4 5 7"
- A single hyphen-separated range in the form *n1–n2*. This includes all log levels from *n1* up to and including *n2*. Specifying *–n2* is the same as 1–*n2*, and specifying *n1–* includes all log levels above *n1*. The *n1* value must be greater than or equal to 1. Examples: 2–7 –7 2–

i

- Specifying a log level of 0 (zero) activates **all log levels**. You must specify the special level `off` to deactivate logging.
- If RMS is being operated continuously for one day or more days when the base monitor logging is activated, to avoid the RMS logs taking up the disk space, configure the `cron` job setting to execute the `hvlogclean` command once a day. According to the setting, the log files are saved for each day. The older log files beyond the days specified by `RELIANT_LOG_LIFE` are deleted automatically. For details on the `hvlogclean` command, see the section "hvlogclean".

The current log level remains in effect until another '`hvutil -l` *<level>*' is issued, a '`hvutil -l off`' is issued, or until RMS is shut down.

Table 11 lists the valid base monitor log levels.

Log Level	**Meaning**
0	Turn on all log levels
1	Unused
2	Turn on detector tracing
3	`hvdisp` level
4	Turn on `mskx` tracing (stack tracing of the base monitor)
5	Error or warning message
6	Heartbeats and communication
7	Base monitor level
8	Generic controller message
9	Administrative command message
10	Basic-type level
11	Dynamic reconfiguration contracting level
12	Shutdown debug level
13	Token level
14	Detector message

Table 11: Base monitor log levels

Log Level	Meaning
15	Local queue level
16	Local queue level
17	Script level
18	userApplication contract level
19	Temporary debug traces
20	SysNode traces
21	Message level
22	bm tracelog
23	Unused

Table 11: Base monitor log levels

14.4.2 Controlling base monitor output to the system log

By default, the RMS base monitor writes the same messages to both the switchlog file and the system log file. This behavior is controlled by the HV_SYSLOG_USE environment variable.

The default setting in hvenv is HV_SYSLOG_USE=1. This sends all RMS NOTICE, WARNING, ERROR, and FATAL ERROR messages to the system log and switchlog.

To suppress RMS messages in the system log, edit the hvenv.local file and set HV_SYSLOG_USE=0. You will have to restart RMS for the change to take effect.

Note: For Log3 RMS messages, the component number is 1080023.

14.5 Managing application log output

Runtime components provided by the RMS Wizard Tools write log messages to files in the same log directory as the RMS base monitor, which is defined in the RELIANT_LOG_PATH environment variable. Messages from these components can be broken down into two categories:

- Messages from resource detectors
- All other messages

Detector logging is described in "Managing detector log output". The following discussion applies to all other log messages.

The runtime components provided by the configuration tools log everything at an application level. In addition to the normal user-oriented messages, they can also generate debug messages with various levels of detail. The user and debug messages may be written to the following files in *RELIANT_LOG_PATH*:

- `switchlog`—The standard subapplications supplied by the RMS Wizard Tools record detector reports related to fault and offline transitions into the `switchlog` file.
- <*application_name*>`.log`—The application-specific log file records all messages associated with that application. The output from any scripts run by the application also go into its log file. The file is created when either offline or online processing for the application begins.
- `hvdet_`<*xxx*>`.g`<*n*>`log`—These are detector log files which record all relevant information regarding the resources they are monitoring, such as all state transitions.

When debugging application problems, the `switchlog` file, the application-specific log file, and any appropriate detector log files may all need to be viewed and interpreted.

14.5.1 Controlling debug messages from standard scripts

You can control debug output from the standard RMS Wizard Tools scripts by setting the environment variable `HV_SCRIPTS_DEBUG` in the `hvenv.local` file:

- To turn on debug output, create the following entry:

  ```
  export HV_SCRIPTS_DEBUG=1
  ```

- To turn off debug output, either remove the `HV_SCRIPTS_DEBUG` entry, comment it out, or set the value to 0.

14.6 Managing detector log output

Each instance of an RMS detector writes information to both the `switchlog` file and to its own dedicated log file, which has a name of the form

RELIANT_LOG_PATH/<*detector_name*>.g<*n*>log

where <*detector_name*> is the name of the detector and <*n*> is the instance number of the detector. There is one such file for every running instance of a detector. Note that the RMS Wizard Tools detectors are named `hvdet_`<*xxx*>, where <*xxx*> denotes the resource type.

For instance, the log file for the first (and only) *hvdet_system* detector is <*RELIANT_LOG_PATH*>`/hvdet_system.g1log`.

Resource state changes are recorded in both the `switchlog` file and the detector's dedicated log file. All other detector messages are recorded only in the dedicated log file.

14.6.1 Debug messages and log levels

Each detector instance maintains an internal 10 KB memory buffer that it uses to maintain debug messages. These are written to the dedicated log file when a debug event (an unexpected resource status report) occurs. The buffer is circular, so when a new message would cause the buffer to overflow, it will instead overwrite one or more of the oldest stored messages. This continues until a debug event causes the entire buffer to be written to the log file, at which time the buffer is reset. Therefore, only the latest messages will be logged. Some older data may be lost, depending on when a debug event occurs.

When the buffer contents are flushed to the log file, the messages are written in chronological order. It is important to note that the latest message in the buffer was generated by the debug event, but earlier messages in the buffer may or may not be related. Therefore, when you examine the detector log, you may find a series of benign messages, followed by a debug event message, followed by more benign messages, followed by another debug event message, etc. This means you must check the timestamp and text of every detector debug message to see if it pertains to the problem you're trying to resolve.

Every message that the detector can generate has an assigned detail level, where higher detail levels produce more debugging information. At runtime, only those messages with a detail level less than or equal to the detector’s current log level will be added to the internal buffer. The default value of each detector log level is set to 1.

The amount of information produced by a specific log level depends on the detector resource type. A high log level for one detector may produce less output than a low log level for another detector.

14.6.2 Setting the detector log level

You can set individual log levels for each resource detector from the command line and the RMS Wizard Tools.

To enable detector logging, the RMS base monitor log level **must include level 2** (detector tracing), regardless of the individual detector log level settings. By default, the base monitor log level is `off`, so detector logging is suppressed. See "Managing base monitor log output".

14.6.2.1 Setting the detector log level with hvutil -L

If RMS is already running, you can use the following commands to manage the detector log level:

```
hvutil -L display <resource>
```

```
hvutil -L <level> <resource>
```

The first `hvutil` command displays the current detector log level for the indicated resource, and the second form of the command sets the log level:

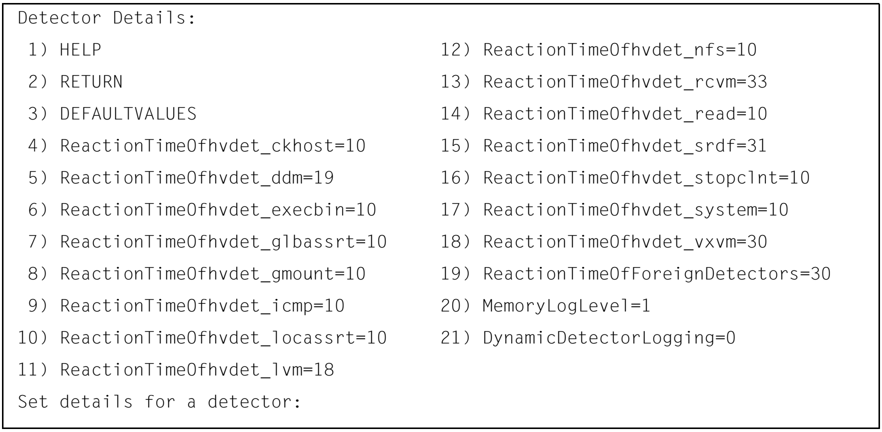
- *<level>* can be either 0 (zero) to turn off logging for the resource, or a positive number to turn on logging at that level.
- *<resource>* is the name of the resource monitored by the detector. This must be a generic resource, *i.e.*, it must be an object of type `gResource`. You can find these in the `hvdisp -a` output.

The current log level remains in effect until another ‘`hvutil -L`’ command changes the log level, ‘`hvutil -l off`’ is issued, or until RMS is shut down.

14.6.2.2 Setting the log level in the Wizard Tools

The valid range of log levels is 1 to 9, and the default value is 1. The log level can be modified from the `hvw` command as follows:

1. Select the *Configuration-Edit-Global-Settings* menu.
2. Choose the *DetectorDetails* sub-menu. The screen in Figure 160 appears.



```
Detector Details:
 1) HELP                                12) ReactionTimeOfhvdet_nfs=10
 2) RETURN                              13) ReactionTimeOfhvdet_rcvm=33
 3) DEFAULTVALUES                       14) ReactionTimeOfhvdet_read=10
 4) ReactionTimeOfhvdet_ckhost=10       15) ReactionTimeOfhvdet_srdf=31
 5) ReactionTimeOfhvdet_ddm=19          16) ReactionTimeOfhvdet_stopclnt=10
 6) ReactionTimeOfhvdet_execbin=10      17) ReactionTimeOfhvdet_system=10
 7) ReactionTimeOfhvdet_glbassrt=10     18) ReactionTimeOfhvdet_vxvm=30
 8) ReactionTimeOfhvdet_gmount=10       19) ReactionTimeOfForeignDetectors=30
 9) ReactionTimeOfhvdet_icmp=10         20) MemoryLogLevel=1
10) ReactionTimeOfhvdet_locassrt=10     21) DynamicDetectorLogging=0
11) ReactionTimeOfhvdet_lvm=18
Set details for a detector:
```

Figure 160: Wizard Tools Detector Details menu

3. Select *MemoryLogLevel* and change the value to the desired level. The log level applies to all detectors.

Runtime adjustment with the Wizard Tools

It is possible to turn debug reporting on or off dynamically from the RMS Wizard detectors by using the `hvw` command as follows:

1. Select *Configuration-Edit-Global-Settings*.
2. Choose the *DetectorDetails* sub-menu.
3. Select the *DynamicDetectorLogging* menu item.

The default value is 0, which turns off debugging. Values in the range 1 to 9 turn on debugging, and higher numbers produce more information. The volume of generated log messages varies according to the detector, so a high value for one detector may produce fewer messages than a low value for another. Changes to this value do not take effect until the next time the configuration is activated.

Using `hvw` to turn on dynamic logging actually creates the file *<RELIANT_PATH>*`/etc/wizardloglevel`, which simply contains the desired debug level as a single-digit ASCII number. You can bypass the `hvw` command and create (or delete) the `wizardloglevel` file manually, as long as you observe the following rules:

- If the file does not exist, or If the file contains the number 0 (zero), then debugging is turned off.
- If the file exists but is empty, a value of 3 is assumed.
- If the file contains a value in the range 1 to 9, debugging is turned on.

i Turning on debugging should only be done when problems occur. Once the problems are resolved, debugging should be turned off to avoid filling the file system with extraneous information.

14.7 Interpreting RMS log messages

This section describes the format of messages from various RMS components.

14.7.1 switchlog message format

The *RELIANT_LOG_PATH*`/switchlog` file records RMS events relevant to the user, such as switch requests and fault indications. It contains the following five message types:

1. Informational messages (notices)
2. Warning messages
3. Error messages
4. Fatal error messages
5. Output from scripts run by RMS

Notices, warnings, errors, and fatal errors

The first four categories of messages all appear in this format:

timestamp: (*err_code*, *err_number*): *msg_type*: *msg_text*: *msg_end*

There is a colon followed by a space (`: `) between each field of the message. The fields are as follows:

1. *timestamp* has the format

   yyyy-mm-dd hh:mm:ss.xxx

2. (*err_code*, *err_number*) is a two or three letter code denoting the internal component that generated the message, followed by the unique number of the message for that component.

3. *msg_type* is one of the following:

   - `NOTICE`
   - `WARNING`
   - `ERROR`
   - `FATAL ERROR`

4. *msg_text* is any text generated by the RMS product. This consists of one or more lines of text, each followed by a newline character.

5. *msg_end* is a series four equal signs (====) followed by a newline character. With the terminal newline of the preceding *msg_text* field and the intervening colon-space field delimiter, this appears as a colon, a space, and four equal signs on a separate line in the log file. This uniquely identifies the end of each message, regardless of the number of lines.

For listings of all RMS `ERROR` and `FATAL ERROR` messages (without the leading *timestamp* and trailing *msg_end* fields), see "PRIMECLUSTER Messages."

Script output

The fifth category of messages, script output, follows no specific format. These messages are simply the redirected standard output and standard error streams generated by scripts defined in the RMS configuration. They generally have neither a leading *timestamp* field nor a trailing *msg_end* field.

Here is an example of a short sequence of script messages:

```
Starting Reliant Monitor Services now
loadcount: 0
loadcount lt 3
```

14.7.2 Application log message format

Applications and resources configured by the RMS Wizard Tools produce log messages in the following format:

resource_ name: *state*: *timestamp*: *msg_type*: *msg_text*: *msg_end*

There is a colon followed by a space (`: `) between each field of the message. The fields are as follows:

1. *resource_name* is the name of the particular resource node in the RMS graph whose script is running. This field may be empty if no resource is associated with the message.
2. *state* is an indication of the type of action that is being performed, and is the value as set by RMS in the environment variable `HV_SCRIPT_TYPE`. The field typically contains the values `online` or `offline`. The RMS configuration tools also set the field with the value `PreCheck`, when a `PreCheck` script is being run. This field will be empty for messages of type `DEBUG` being printed.
3. *timestamp* contains the date and time when the message was generated. It appears in the format *yyyy-mm-dd hh:mm:ss.xxx*.
4. *msg_type* is one of the following:
   - `DEBUG`
   - `NOTICE`
   - `WARNING`
   - `ERROR`
   - `FATAL ERROR`
5. *msg_text* contains the text generated by the RMS Wizard product. This text may consist of more than one line, *i.e.*, it may have **embedded** newline characters. In general, it is not **terminated** with a newline character.
6. *msg_end* is a series of four equal signs (====). Since *msg_text* is not usually terminated with a newline, *msg_end* appears on the same line.

14.7.3 Program log message format

RMS consists of a number of individual programs that contribute to the overall high availability management. Each of these programs can generate its own trace and error messages in a dedicated log file, which can be found at

RELIANT_LOG_PATH/*<program_name>*`log`

For example, the RMS base monitor program is named `bm`, and its dedicated log file is *RELIANT_LOG_PATH*`/bmlog`.

Program trace and error messages are intended for internal troubleshooting purposes only. The format is described here in case you are asked to provide the information to a PRIMECLUSTER consultant.

Trace messages have the following prefix:

timestamp: *file*: *line*:

Error messages have the following prefix:

timestamp: *file*: *line*: `ERROR`

Here is an example of a short sequence of trace messages:

```
2005-12-17 14:42:46.256: det_generic.C: 756: Return from
GdCheck
2005-12-17 14:42:46.256: det_generic.C: 773: Call to
GdGetAttribute
2005-12-17 14:42:46.257: det_generic.C: 775: Return from
GdGetAttribute
2005-12-17 14:42:46.257: det_generic.C: 790: reporting state
to bm
```

14.8 RMS log file cleanup

RMS provides two methods for housekeeping of its log files:

1. `hvlogclean` deletes or backs up log files based on elapsed time
2. `hvlogcontrol` issues warnings or deletes files based on the available space in the file system

Both of these are automatically installed and configured with default settings as part of the RMS installation. This section outlines their functions and lists their control settings.

14.8.1 hvlogclean

The hvlogclean utility saves the current log files into a backup subdirectory of *RELIANT_LOG_PATH* whose name is the time RMS was last started. If invoked with the -d option, it will delete the current log files rather than copy them. In either case, hvlogclean creates a clean set of log files even while RMS is running.

hvlogclean also purges old files in the backup subdirectory. It determines whether or not a backup file is “old” by checking the value of the RELIANT_LOG_LIFE environment variable. If the backup file is older (in days) than the number in the variable, the file will be deleted. See RELIANT_LOG_LIFE for more information.

14.8.2 hvlogcontrol

The hvlogcontrol utility prevents log files from consuming all the free space on the file system containing *RELIANT_LOG_PATH*. According to the limits set in the configuration, hvlogcontrol can warn the user, delete only the subdirectories in *RELIANT_LOG_PATH*, or delete all RMS log files. See the descriptions of the following RMS environment variables for more information:

- HV_LOG_ACTION_THRESHOLD (global)
- HV_LOG_WARN_THRESHOLD (global)
- HV_LOG_ACTION (local)

Changing these controls requires editing the hvenv.local file and then restarting RMS. See "Setting environment variables".

i hvlogcontrol is invoked periodically from the crontab file. It has no manual page.

14.8.3 Logging of background scripts

A Command Line subapplication can invoke a script that executes another command or script in the background. If the background process writes to stdout or stderr, that output will be directed to a log file that remains open until the process ends normally or is terminated. This will cause the log file to be handled differently when RMS log files are cleaned via the `cron` job or `hvlogclean`.

When `hvlogclean` cleans up old log files, it moves them into a backup directory named according to the time RMS was last started. The open log file of the background process will be moved there, too. Because the background process continues to write into the open file, future output for the process will therefore be found in the backup directory, and not in `/var/opt/reliant/log` along with the rest of the RMS processes.

If the log file of the background process is removed while the process is still running (for example, either manually or by the '`hvlogclean -d`' command), the log file will no longer be visible. However, the file will still exist, and the background process will continue to write into the now-invisible file until the process ends or is stopped.

14.9 RMS troubleshooting

When problems occur, RMS prints out meaningful error messages that will assist you in troubleshooting the cause. If no message is available, the following information may help you diagnose and correct some unusual problems:

- RMS dies immediately after being started.

  At startup, the RMS base monitor exchanges its configuration checksum with the other base monitors on remote nodes. If the checksum of the starting base monitor matches the checksums from the remote nodes, the startup process continues. If the checksums do not match, then the RMS base monitor shuts down if all of the following conditions are true:

  1. The base monitor has encountered a different checksum from a remote monitor within the initial startup period (see "`HV_CHECKSUM_INTERVAL`").
  2. There are no applications on this node that are online, waiting, busy, or locked.
  3. There are no online remote base monitors encountered by this base monitor.

Otherwise, the base monitor keeps running, but all remote monitors whose checksums do not match the local configuration checksum are considered to be offline. Therefore, no message exchange is possible with these monitors, and no automatic or manual switchover will be possible between the local monitor and these remote monitors.

When different checksums are encountered, certain messages are placed in the switchlog explaining the situation.

i Configuration checksum differences often result when global environment variables are changed manually but inconsistently on different nodes.

Action:

To verify that a configuration checksum difference is not the cause of the problem, ensure that all the nodes have been updated with the proper configuration by using the following procedure:

1. Stop RMS everywhere in the cluster. This may require an explicit `hvshut` command on any nodes that are not communicating with the others.

2. Determine which configuration to run. Use '`hvdisp -a`' or '`hvdisp -T SysNode`' on each node to verify the name of the configuration file. (The `hvdisp` command does not require root privilege.)

   A configuration may have the same name but different contents on two or more nodes if one of the following has occurred:

   – The most recent activation did not distribute the configuration to all the nodes in the cluster. For instance, the user may have specified *Ignore Down Nodes* when activating with Wizard Tools.

   – If the Wizards Tools were used on more than one node in the cluster, there may be more than one version of the configuration with the same name.

3. Activate the correct configuration with the same tool (Wizard Tools) that was used to create it. For the correct procedure, see the section "Activating a configuration".

   Alternatively, redistribute the existing <*configname*>`.us` file with one of the following methods:

   – In the RMS Wizard Tools, use *Configuration Push*.

Make sure the activation is successful so that all the nodes are updated.

4. Start RMS on the entire cluster. All the nodes should now be running the same configuration.

- RMS hangs after startup (processes are running, but `hvdisp` hangs)

  This problem might occur if the local node is in the CF state LEFTCLUSTER from the point of view of one or more of the other nodes in the cluster.

  Action:

  Verify the problem by using '`cftool -n`' on all cluster nodes to check for a possible `LEFTCLUSTER` state.

  Use '`cftool -k`' to clear the `LEFTCLUSTER` state. RMS will continue to run as soon as the node has joined the cluster. No restart should be necessary.

- RMS loops (or even dies) shortly after being started.

  This problem could occur if the CIP configuration file `/etc/cip.cf` contains entries for the netmask. These entries are useless (not evaluated by CIP). From the RMS point of view these entries cannot be distinguished from IP addresses, which have the same format, so RMS will invoke a `gethostbyaddr`(). This normally does no harm, but in some unusual cases the OS may become confused.

  Action:

  Verify the problem by checking if netmask entries are present in `/etc/cip.cf`.

  Remove the netmask entries, and restart RMS.

- RMS detects a failure of another node, but the node is not killed.

  This problem could occur if `SysNode` is in the `Wait` state.

  Action:

  Check the CF state by using `cftool -n`.

If the CF state is `LEFTCLUSTER`, manually stop the `LEFTCLUSTER` node, and then clear the `LEFTCLUSTER` state by using `cftool -k`.

Once CF state changes from `LEFTCLUSTER` to `DOWN`, execute "`hvdisp -T SysNode`" to see the state of all `SysNode` objects.

If there is any `SysNode` in `Wait` state, execute "`hvutil -u` *`SysNode`*" to clear the `Wait` state.

Caution

When using the `cftool -k` command and the `hvutil -u` command, you must manually stop the node in the `Wait` state before executing the commands. The execution of these commands may invoke the failover of the applications. Therefore, if you execute these commands without stopping the node in the `Wait` state, this may cause data corruption.

- The RMS base monitor detects a loss of detector heartbeat, but there is no indication as to the reason for the loss.

  RMS automatically invokes a tool that provides diagnostic information for this event. The diagnostic tool performs the following actions:

  – Invokes `truss(1)` on Solaris or `strace(1)` on Linux to trace the detector process

  – Turns on full RMS and detector logging with the `-l0` (lowercase “L”, zero) option

  – Gathers system and users times for the process

  The `truss(1)/strace(1)` invocation and logging levels will be terminated after the number of seconds specified in the `ScriptTimeout` attribute. All information is stored in the `switchlog` file.

  Note that user-specified operations such as detector tracing will continue on each node, even if it appears to have left the cluster. In extreme cases, turning on high detail trace levels may affect the performance of a node and contribute to delays in its base monitor heartbeat.

Action:

See the switchlog for the diagnostic information.

14.10 Collecting information for advanced troubleshooting

The procedures in this section provide advanced debugging information and are intended for use by consultants and developers.

14.10.1 Using the hvdump command (RMS)

The `hvdump` command collects RMS debugging information on the local node. A normal RMS installation creates the file

RELIANT_PATH`/bin/hvdump`

By default, *RELIANT_PATH* is `/opt/SMAW/SMAWRrms/`. Symbolic links to the same file are also created in `/usr/bin/hvdump` (which is usually in the default search path) and `/opt/SMAW/bin/hvdump`.

Invoking `hvdump` gathers log files and configuration data and places them in the *RELIANT_PATH* directory in the following archive:

<*nodename*>`RMS.`<*timestamp*>`.debug_information.tar.`<*suf*>

where the suffix <*suf*> is ‘`gz`’ on Linux platforms, and ‘`Z`’ on Solaris platforms.

The archive file is intended for use by RMS support specialists. The `hvdump`(1M) manual page presents a detailed list of the files and information included in the archive.

14.11 SNMP Notification of Resource Failure

If an error was detected, SNMP Trap can be sent to the server on which the SNMP manager is running.

By using this function, the SNMP manager can monitor the cluster system.

For details on how to set this function, see "6.10.1 Setting Contents of a Cluster Application" in "PRIMECLUSTER Installation and Administration Guide (Linux)."

For SNMP Trap, the version 2c is used and the following pieces of information are contained in SNMP Trap to be sent.

– OIDs corresponding to the resource types

– Message indicating the resource failure

To send SNMP Trap, the `snmptrap` command is used and the following operation is performed.

```
snmptrap -v 2c -c <Community name> <Destination host> \
       .1.3.6.1.4.1.211.4.68.257 <OID> s <Message>
```

The following table shows OIDs set for SNMP Trap.

No	OID	Description
1	.1.3.6.1.4.1.211.4.68.257.1	This OID is set when a resource failure occurs in an application or middleware. It is set when a failure is detected in the Cmdline resource, procedure resource, or in middleware resource.
2	.1.3.6.1.4.1.211.4.68.257.2	This OID is set when a network failure occurs. It is set when a failure is detected in the Gls resource, or in the takeover network resource.
3	.1.3.6.1.4.1.211.4.68.257.3	This OID is set when a file system failure is detected. It is set when a failure is detected in the Fsystem resource.
4	.1.3.6.1.4.1.211.4.68.257.4	This OID is set when a disk failure is detected. It is set when a failure is detected in the Gds resource.

Table 12: OID set in SNMP Trap

The message which RMS outputs to switchlog when the resource failure occurs is contained in "Message indicating a resource failure." The message indicates what failure is detected in which resource.

Example of a message:

```
2014-07-28 17:07:09.254:(DET, 7): ERROR: FAULT REASON:
Resource <ManageProgram000_Cmd_APP1> transitioned to a
Faulted state due to the resource unexpectedly becoming
Offline.
```

You can also confirm the cause and action of the resource failure by searching the message in "PRIMECLUSTER Messages."

Note

- If an error occurs in the communication path between the cluster node and the host on which the SNMP manager is running, the notification of resource failure by SNMP Trap does not work.
- If the `userApplication` is switched over when the multiple resource failures are detected in one `userApplication` at the same time, only one of the resource failures will be notified. Check if other resource failures occur in the switchlog file after the cause of the notified resource failure has been removed on the cluster node.

15 Appendix—RMS command line interface

The primary interface for configuring RMS is the RMS Wizard Tools, and the primary interface for administering RMS is the Cluster Admin GUI. These user interfaces call the RMS command line interface (CLI), and, under certain conditions, you may find it useful to invoke the CLI directly.

The following section lists the RMS CLI commands available to administrators. Specific procedures using some of these commands are described in the "Controlling RMS operation". For a complete description of any command's usage, see the "Controlling RMS operation". For all PRIMECLUSTER commands related to RMS, see the manual pages of each command.

i With few exceptions, RMS CLI commands require root privilege. The exceptions are noted in the following list.

15.1 Available RMS CLI commands

`hvassert`

Tests an RMS resource for a specified resource state. It can be used in scripts when a resource must achieve a specified state before the script can issue the next command. Does not require root privilege.

`hvcm`

Starts the base monitor and the detectors for all monitored resources. In most cases, it is not necessary to specify options to the `hvcm` command.

The base monitor is the decision-making module of RMS. It controls the configuration and access to all RMS resources. If a resource fails, the base monitor analyzes the failure and initiates the appropriate action according to the specifications for the resource in the configuration file.

`hvconfig`

Either displays the current RMS configuration or sends the current configuration to an output file.

The output of the `hvconfig` command is equivalent to the running RMS configuration file, but does not include any comments that are in the original file. Also, the order in which the resources are listed in the output might vary from the actual configuration file.

`hvdisp`

Displays information about the current configuration for RMS resources. Does not require root privilege.

`hvdispall`

Display the resource information of all the nodes in RMS.

`hvdump`

Gets debugging information about RMS on the local node.

`hvlogclean`

Either saves old log files into a subdirectory whose name is the time RMS was last started, or, if invoked with the `-d` option, deletes old log files. In either case, `hvlogclean` creates a clean set of log files even while RMS is running.

`hvreset`

Reinitializes the graph of an RMS user application on one or more nodes in the configuration. Running scripts will be terminated, ongoing requests and contracts will be cleaned up, and information about previous failures will be purged.

Caution

The entire graph is returned to its initial consistent state by this command, but it may also become an inconsistent state. Therefore, use this command for test purposes only, and never execute it on a production cluster system.

`hvsetenv`

Provides an interface for changing the following RMS environment variables on the local node:

– `HV_RCSTART` controls the automatic startup of RMS.

– `HV_AUTOSTARTUP` controls the automatic startup of all applications.

-

For more information about these environment variables, see "Appendix—Environment variables".

`hvshut`

Shuts down RMS on one or more nodes in the configuration. The base monitor on the local node sends a message to other online nodes indicating which node or nodes will be shut down.

`hvswitch`

Manually switches control of a `userApplication` or a `gResource` between SysNodes in the RMS configuration.

`hvutil`

Provides general administration interface to RMS. It performs various resource administration tasks, such as dynamically setting logging levels, sending a resource `Offline`, clearing faulted resources or hung cluster nodes in the `Wait` state, setting detector time periods, setting Maintenance Mode, and so forth.

Caution

Setting high logging levels in `hvutil` can cause disk overflow if enabled for too long. See the section "Managing base monitor log levels" for more information.

16 Appendix—Release information

This appendix provides information about the changed sections in this manual.

No	VL	Edition	Location	Description
1	4.5A00	December 2017	"Main configuration menu when RMS is not active"	Added the note about main configuration menu.
2	4.5A00	December 2017	"Stopping RMS"	Added the note when stopping RMS.
3	4.5A00	December 2017	"Overriding automatic application startup"	Changed the explanation when automatically starting the application.
4	4.5A00	December 2017	"Attributes available to the user"	Changed the explanations of the following attributes available to the user: - `AutoStartUp` - `OnlinePriority` - `PartialCluster`
5	4.5A00	December 2017	"Global environment variables"	Changed the explanation of `HV_AUTOSTART_WAIT`.
6	4.5A00	December 2017	"Appendix—Troubleshooting"	Deleted the explanation of "Configuration troubleshooting."

Glossary

Items in this glossary that apply to specific PRIMECLUSTER components are indicated with the following notation:

- (CF)—Cluster Foundation
- (RMS)—Reliant Monitor Services
- (SIS)—Scalable Internet Services

Some of these products may not be installed on your cluster. See your PRIMECLUSTER sales representative for more information.

AC

See *Access Client*.

Access Client

GFS kernel module on each node that communicates with the Meta Data Server and provides simultaneous access to a shared file system.

administrative LAN

An optional private local area network (LAN) used for administrative commands to the nodes in the cluster. To provide an extra level of security, normal users do not have access to the administrative LAN. In PRIMECLUSTER configurations, the System Console and Cluster Console reside on the administrative LAN if one is present.

See also public LAN.

API

See Application Program Interface.

application (RMS)

In the RMS context, an application object is a special resource used to group other resources into a logical collection. Typically, it is used to represent a real-world application or application suite in a high-availability configuration.

Application Program Interface

A shared boundary between a service provider and the application that uses that service.

application template (RMS)

A predefined group of object definition value choices used by the Wizard Tools or the Wizard Kit to create object definitions for a specific type of application.

attribute (RMS)

The part of an object definition that specifies how the base monitor acts and reacts for a particular object type during normal operations.

automatic power control

This function is provided by the Enhanced Support Facility (ESF), and it automatically switches the server power on and off.

automatic switchover (RMS)

The procedure by which RMS automatically switches control of a `userApplication` over to another node after specified conditions are detected.

See also directed switchover (RMS), failover (RMS, SIS), switchover (RMS), symmetrical switchover (RMS).

availability

Availability describes the need of most enterprises to operate applications via the Internet 24 hours a day, 7 days a week. The relationship of the actual to the planned usage time determines the availability of a system.

base cluster foundation (CF)

This PRIMECLUSTER module resides on top of the basic OS and provides internal interfaces for the CF (Cluster Foundation) functions that the PRIMECLUSTER services use in the layer above.

See also Cluster Foundation (CF).

base monitor (RMS)

The RMS module that maintains the availability of resources. The base monitor is supported by daemons and detectors. Each node being monitored has its own copy of the base monitor.

Cache Fusion

The improved interprocess communication interface in Oracle 9i that allows logical disk blocks (buffers) to be cached in the local memory of each node. Thus, instead of having to flush a block to disk when an update is required, the block can be copied to another node by passing a message on the interconnect, thereby removing the physical I/O overhead.

CCBR (Solaris)
See Cluster Configuration Backup and Restore (Solaris).

CF
See Cluster Foundation (CF).

CF node name (CF)
The CF cluster node name, which is configured when a CF cluster is created.

child (RMS)
A resource defined in the configuration file that has at least one parent. A child can have multiple parents, and can either have children itself (making it also a parent) or no children (making it a leaf object).

See also resource (RMS), object (RMS), parent (RMS).

cluster
A set of computers that work together as a single computing source. Specifically, a cluster performs a distributed form of parallel computing.

See also RMS configuration (RMS).

Cluster Admin
A Java-based, OS-independent management tool for PRIMECLUSTER products such as CF, SIS, and RMS. Cluster Admin is available from the Web-Based Admin View interface.

See also Cluster Foundation (CF), Scalable Internet Services (SIS), Reliant Monitor Services (RMS), Web-Based Admin View.

Cluster Configuration Backup and Restore (Solaris)
CCBR provides a simple method to save the current PRIMECLUSTER configuration information of a cluster node. It also provides a method to restore the configuration information.

Cluster Foundation (CF)
The set of PRIMECLUSTER modules that provides basic clustering communication services.

See also base cluster foundation (CF).

cluster interconnect (CF)
The set of private network connections used exclusively for PRIMECLUSTER communications.

Cluster Join Services (CF)
This PRIMECLUSTER module handles the forming of a new cluster and the addition of nodes.

configuration file (RMS)
In the RMS context, the single file that defines the monitored resources and establishes the interdependencies between them. The default name of this file is `config.us`.

console
See single console.

custom detector (RMS)
See detector (RMS).

custom type (RMS)
See generic type (RMS).

daemon
A continuous process that performs a specific function repeatedly.

database node (SIS)
Nodes that maintain the configuration, dynamic data, and statistics in a SIS configuration.

See also gateway node (SIS), service node (SIS), Scalable Internet Services (SIS).

detector (RMS)
A process that monitors the state of a specific object type and reports a change in the resource state to the RMS base monitor.

DHCP
Dynamic Host Control Protocol. A standard method of delivering information to a host at boot time. This is most often used to dynamically assign the host’s IP address and netmask, but many other parameters are possible, including domain names, DNS servers, and time servers.

directed switchover (RMS)
The RMS procedure by which an administrator switches control of a `userApplication` over to another node.

See also automatic switchover (RMS), failover (RMS, SIS), switchover (RMS), symmetrical switchover (RMS).

DOWN (CF)

A node state that indicates that the node is unavailable (marked as down). A `LEFTCLUSTER` node must be marked as `DOWN` before it can rejoin a cluster.

See also UP (CF), LEFTCLUSTER (CF), node state (CF).

Enhanced Lock Manager (ELM) (CF)

A light weight, high performance, highly responsive lock manger, specifically designed for providing a high reliability heartbeat messaging mechanism for PRIMECLUSTER modules.

ENS (CF)

See Event Notification Services (CF).

environment variables

Variables or parameters that are defined globally.

error detection (RMS)

The process of detecting an error. For RMS, this includes initiating a log entry, sending a message to a log file, or making an appropriate recovery response.

Event Notification Services (CF)

This PRIMECLUSTER module provides an atomic-broadcast facility for events.

failover (RMS, SIS)

With SIS, this process switches a failed node to a backup node. With RMS, this process is known as switchover.

See also automatic switchover (RMS), directed switchover (RMS), switchover (RMS), symmetrical switchover (RMS).

Fast switching mode

One of the LAN duplexing modes presented by GLS. This mode uses a multiplexed LAN simultaneously to provide enhanced communication scalability between servers, and highspeed switchover if a LAN failure occurs.

gateway node (SIS)

Gateway nodes have an external network interface. All incoming packets are received by this node and forwarded to the selected service node, depending on the scheduling algorithm for the service.

See also service node (SIS), database node (SIS), Scalable Internet Services (SIS).

generic type (RMS)

An object type which has generic properties. A generic type is used to customize RMS for monitoring resources that cannot be assigned to one of the supplied object types.

See also object type (RMS).

Global Disk Services

This optional product provides volume management that improves the availability and manageability of information stored on the disk unit of the Storage Area Network (SAN).

Global File Services

This optional product provides direct, simultaneous accessing of the file system on the shared storage unit from two or more nodes within a cluster.

Global Link Services

This PRIMECLUSTER optional module provides network high availability solutions by multiplying a network route.

generic type (RMS)

An object type which has generic properties. A generic type is used to customize RMS for monitoring resources that cannot be assigned to one of the supplied object types.

See also object type (RMS).

graph (RMS)

See system graph (RMS).

graphical user interface

A computer interface with windows, icons, toolbars, and pull-down menus that is designed to be simpler to use than the command-line interface.

GUI

See graphical user interface.

high availability

A system design philosophy in which redundant resources are used to avoid single points of failure.

See also Reliant Monitor Services (RMS).

Intelligent Platform Management Interface

A firmware and hardware specification that provides common interfaces for monitoring and managing computers. IPMI operates through an onboard Baseboard Management Controller (BMC) on the target machine to provide OS-independent remote management functions, whether or not the target machine is powered on.

interconnect (CF)

See cluster interconnect (CF).

Internet Protocol address

A numeric address that can be assigned to computers or applications.

See also *IP aliasing*.

Internode Communications facility

This module is the network transport layer for all PRIMECLUSTER internode communications. It interfaces by means of OS-dependent code to the network I/O subsystem and guarantees delivery of messages queued for transmission to the destination node in the same sequential order unless the destination node fails.

IP address

See *Internet Protocol address*.

IP aliasing

This enables several IP addresses (aliases) to be allocated to one physical network interface. With IP aliasing, the user can continue communicating with the same IP address, even though the application is now running on another node.

See also *Internet Protocol address*.

IPMI

See *Intelligent Platform Management Interface*.

JOIN (CF)

See *Cluster Join Services (CF)*.

keyword

A word that has special meaning in a programming language. For example, in an RMS configuration file, the keyword `object` identifies the kind of definition that follows.

leaf object (RMS)

A bottom object in a system graph. In the configuration file, this object definition is at the beginning of the file. A leaf object does not have children.

LEFTCLUSTER (CF)

A node state that indicates that the node cannot communicate with other nodes in the cluster. That is, the node has left the cluster. The reason for the intermediate `LEFTCLUSTER` state is to avoid the network partition problem.

See also *UP (CF)*, *DOWN (CF)*, *network partition (CF)*, *node state (CF)*.

link (RMS)

Designates a child or parent relationship between specific resources.

local area network

See *public LAN*.

local node

The node from which a command or process is initiated.

See also *remote node, node*.

log file

The file that contains a record of significant system events or messages. The Wizard Tools, the RMS base monitor, and RMS detectors each maintain their own log files as well.

Management Information Base

A hierarchical database of information about the local network device. The database is maintained by network management software such as an SNMP agent.

See also *Simple Network Management Protocol*.

MDS

See *Meta Data Server*.

message

A set of data transmitted from one software process to another process, device, or file.

message queue

A designated memory area which acts as a holding place for messages so they can be processed in the same order they were received.

Meta Data Server

GFS daemon that centrally manages the control information, or metadata, of a file system.

MIB

See *Management Information Base*.

MMB

Abbreviation for Management Board, which is one of the hardware units installed in PRIMEQUEST.

mount point

The point in the directory tree where a file system is attached.

multihosting

Multiple controllers simultaneously accessing a set of disk drives.

native operating system

The part of an operating system that is always active and translates system calls into activities.

network partition (CF)

This condition exists when two or more nodes in a cluster cannot communicate over the interconnect; however, with applications still running, the nodes can continue to read and write to a shared device, compromising data integrity.

NIC switching mode

One of the LAN duplexing modes presented by GLS. The duplexed NIC is used exclusively, and LAN monitoring between the server and the switching HUB, and switchover if an error is detected are implemented.

node

A host that is a member of a cluster.

node state (CF)

Every node in a cluster maintains a local state for every other node in that cluster. The node state of every node in the cluster must be either `UP`, `DOWN`, or `LEFTCLUSTER`.

See also *UP (CF)*, *DOWN (CF)*, *LEFTCLUSTER (CF)*.

object (RMS)

A representation of a physical or virtual resource in the RMS configuration file or in a system graph.

See also *leaf object (RMS)*, *object definition (RMS)*, *object type (RMS)*.

object definition (RMS)

An entry in the configuration file that identifies a resource to be monitored by RMS. Attributes included in the definition specify properties of the corresponding resource.

See also *attribute (RMS)*, *object type (RMS)*.

object type (RMS)

A category of similar resources monitored as a group, such as disk drives. Each object type has specific properties, or attributes, which limit or define what monitoring or action can occur. When a resource is associated with a particular object type, attributes associated with that object type are applied to the resource.

See also *generic type (RMS)*.

online maintenance

The capability of adding, removing, replacing, or recovering devices without shutting or powering off the node.

operating system dependent (CF)

This module provides an interface between the native operating system and the abstract, OS-independent interface that all PRIMECLUSTER modules depend upon.

Oracle Real Application Clusters (RAC)

Oracle RAC allows access to all data in a database to users and applications in a clustered or MPP (massively parallel processing) platform. Formerly known as Oracle Parallel Server (OPS).

OSD (CF)

See *operating system dependent (CF)*.

parent (RMS)

An object in the RMS configuration file or system graph that has at least one child.

See also *child (RMS), configuration file (RMS)*, leaf object (RMS), *system graph (RMS)*.

physical IP address

The IP address that is directly assigned to the interface of a network interface card (for example, hme0).

primary node (RMS)
The default node on which a user application comes online when RMS is started. This is always the node name of the first child listed in the `userApplication` object definition.

PRIMECLUSTER services (CF)
Service modules that provide services and internal interfaces for clustered applications.

private network addresses
Private network addresses are a reserved range of IP addresses specified by the Internet Corporation for Assigned Names and Numbers (ICANN). Modern switches and routers prevent these addresses from being routed to the Internet, allowing two or more organizations to assign the same private addresses for internal use without causing conflicts or security risks.

private resource (RMS)
A resource accessible only by a single node and not accessible to other RMS nodes.

See also *resource (RMS)*, *shared resource*.

public LAN
The local area network (LAN) by which normal users access a machine.

See also *administrative LAN*.

queue
See *message queue*.

redundancy
The capability of one component to assume the resource load of another physically similar component in case the original component fails or is shut down. Common examples include RAID hardware and/or RAID software to replicate data stored on secondary storage devices, multiple network connections to provide alternate data paths, and multiple nodes that can be dynamically reprovisioned to maintain critical services in a cluster.

Reliant Monitor Services (RMS)
The package that maintains high availability of user-specified resources by providing monitoring and switchover capabilities on Linux and Solaris platforms.

remote node
A node that is accessed through a LAN or telecommunications line.

See also *local node, node*.

reporting message (RMS)
A message that a detector uses to report the state of a particular resource to the base monitor.

resource (RMS)
A hardware or software element (private or shared) that provides a function such as a mirrored disk, mirrored disk pieces, or a database server. A local resource is monitored only by the local node.

See also *private resource (RMS)*, *shared resource*.

resource definition (RMS)
See *object definition (RMS)*.

resource label (RMS)
The name of the resource as displayed in a system graph.

resource state (RMS)
Current state of a resource.

RMS
See *Reliant Monitor Services (RMS)*.

RMS commands (RMS)
Commands that enable RMS resources to be administered from the command line.

RMS configuration (RMS)
A configuration made up of two or more nodes connected to shared resources. Each node has its own copy of operating system and RMS software, as well as its own applications.

RMS Wizard Kit (RMS)
Each component of RMS Wizard Kit adds new menu items to the RMS Wizard Tools of the specific applications (Oracle and Networker).

See also *RMS Wizard Tools (RMS)*, *Reliant Monitor Services (RMS)*, and *wizard (RMS)*.

RMS Wizard Tools (RMS)
A software package composed of various configuration and administration tools used to create and manage applications in an RMS configuration.

See also *RMS Wizard Kit (RMS)*, *Reliant Monitor Services (RMS)*.

route

In the PRIMECLUSTER Concepts Guide, this term refers to the individual network paths of the redundant cluster interfaces that connect the nodes to each other.

SAN

See *Storage Area Network*.

scalability

The ability of a computing system to efficiently handle any dynamic change in work load. Scalability is especially important for Internet-based applications where growth caused by Internet usage presents a scalable challenge.

Scalable Internet Services (SIS)

The package that dynamically balances network traffic loads across cluster nodes while maintaining normal client/server sessions for each connection.

SCON

See *single console*.

script (RMS)

A shell program executed by the base monitor in response to a state transition in a resource. The script may cause the state of a resource to change.

service node (SIS)

Service nodes provide one or more TCP services (such as FTP, Telnet, and HTTP) and receive client requests forwarded by the gateway nodes.

See also *database node (SIS)*, *gateway node (SIS), Scalable Internet Services (SIS)*.

SF

See *Shutdown Facility*.

shared resource

A resource, such as a disk drive, that is accessible to more than one node.

See also *private resource (RMS)*, *resource (RMS)*.

Shutdown Facility

The PRIMECLUSTER interface that manages the shutdown of cluster nodes. The SF is automatically invoked during failover operations. It also notifies other PRIMECLUSTER products of the successful completion of node shutdown so that recovery operations can begin.

Simple Network Management Protocol

A set of protocols that facilitates the exchange of information between managed network devices. The protocols are implemented by software agents residing in the devices. Each agent can read and write data in the local Management Information Base (MIB) in response to SNMP requests from other devices on the network.

See also *Management Information Base*.

single console

The workstation that acts as the single point of administration for nodes being monitored by RMS. The single console software, SCON, is run from the single console.

SIS

See *Scalable Internet Services (SIS)*.

SNMP

See *Simple Network Management Protocol*.

state

See *resource state (RMS)*.

Storage Area Network

The high-speed network that connects multiple, external storage units and storage units with multiple computers. The connections are generally fiber channels.

subapplication (RMS)

A part of the configuration template that is designed to configure one resource type for high availability. The RMS configuration may include multiple instances of each resource type. The Generic template contains subapplications for commands, application controllers, IP addresses, virtual network interfaces, local and remote file systems, volume managers, and storage managers.

switching mode

LAN duplexing mode presented by GLS. There are switching mode types: fast switching mode, NIC switching mode, GS/SURE linkage mode (Solaris), GS linkage mode (Linux), virtual NIC mode, and multipath mode (Solaris).

switchover (RMS)

The process by which RMS switches control of a `userApplication` over from one monitored node to another.

See also *automatic switchover (RMS)*, *directed switchover (RMS)*, *failover (RMS, SIS)*, *symmetrical switchover (RMS)*.

symmetrical switchover (RMS)

This means that every RMS node is able to take on resources from any other RMS node.

See also *automatic switchover (RMS)*, *directed switchover (RMS)*, *failover (RMS, SIS)*, *switchover (RMS)*.

synchronized power control

When the power of one node is turned in the cluster system, this function turns on all other powered-off nodes and disk array unit that are connected to nodes through RCI cables.

system disk (GDS)

Disk on which the active operating system is installed. System disk refers to the entire disk that contains the slices that are currently operating as one of the following file systems (or the swap area):

For Solaris: /, /usr, /var, or swap area
For Linux: /, /usr, /var, /boot, /boot/efi, or swap area

system graph (RMS)

A visual representation (a map) of monitored resources used to develop or interpret the RMS configuration file.

See also *configuration file (RMS)*.

template

See *application template (RMS)*.

type

See *object type (RMS)*.

UP (CF)

A node state that indicates that the node can communicate with other nodes in the cluster.

See also *DOWN (CF)*, *LEFTCLUSTER (CF)*, *node state (CF)*.

virtual disk

A pseudo-device that allows a portion or a combination of physical disks to be treated as a single logical disk. The virtual disk driver is inserted between the highest level of the OS logical input/output (I/O) system and the physical device driver(s), allowing all logical I/O requests to be mapped to the appropriate area on the physical disk(s).

See also *subapplication (RMS)*.

Web-Based Admin View

A Java-based, OS-independent interface to PRIMECLUSTER management components.

See also *Cluster Admin*.

wizard (RMS)

An interactive software tool that creates a specific type of application using pretested object definitions.

Wizard Kit (RMS)

See *RMS Wizard Kit (RMS)*.

Wizard Tools (RMS)

See *RMS Wizard Tools (RMS)*.

Abbreviations

AC
Access Client

API
application program interface

AS
Adaptive Services

bm
base monitor

CCBR
Cluster Configuration Backup/Restore

CDL
Configuration Definition Language

CF
Cluster Foundation or Cluster Framework

CIM
Cluster Integrity Monitor

CIP
Cluster Interconnect Protocol

CLI
command line interface

CLM
Cluster Manager

CRM
Cluster Resource Management

DHCP
Dynamic Host Control Protocol

DLPI
Data Link Provider Interface

ELM
Enhanced Lock Manager

ENS
Event Notification Services

GDS
Global Disk Services

GFS
Global File Services

GLS
Global Link Services

GUI
graphical user interface

HA
high availability

ICF
Internode Communication Facility

I/O
input/output

IPMI
Intelligent Platform Management Interface

JOIN
cluster join services module

LAN
local area network

MDS
Meta Data Server

MIB
Management Information Base

MIPC
Mesh Interprocessor Communication

MMB
Management Board (on PRIMEQUEST systems)

NIC
network interface card

NSM
Node State Monitor

OSD
operating system dependent

PAS
Parallel Application Services

RCCU
Remote Console Control Unit

RCI
Remote Cabinet Interface

RMS
Reliant Monitor Services

SA
Shutdown Agent

SAN
Storage Area Network

SCON
single console software

SD
Shutdown Daemon

SF
Shutdown Facility

SIS
Scalable Internet Services

SNMP
Simple Network Management Protocol

VIP
Virtual Interface Provider

XSCF
eXtended System Control Facility

Figures

Tables

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