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To maintain the quality of our publications, we need your comments on the accuracy, clarity, organization and value of this book.

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Introduction

The LifeKeeper for Linux Software RAID (md) Recovery Kit provides software RAID support for other LifeKeeper recovery kits. Thus, LifeKeeper-protected applications can take advantage of the benefits offered by software RAID, including lower cost data redundancy, data replication over a SAN and simplified storage management.

The Software RAID Recovery Kit is different from most other LifeKeeper recovery kits in that it is never used alone, but always as a dependency of another LifeKeeper resource. As such, many of the operations typically associated with a LifeKeeper recovery kit – for example, creating a hierarchy – are not directly applicable to the Software RAID Recovery Kit.

Document Contents

This guide explains the following topics:

- **Documentation and References.** Provides a list of related LifeKeeper for Linux documents and where to find them, along with references to a number of helpful documents about the Linux Software RAID product.

- **Requirements.** Describes the hardware and software necessary to properly set up, install and operate the Software RAID Recovery Kit. Refer to the *LifeKeeper for Linux Planning and Installation Guide* for specific instructions on how to install or remove LifeKeeper for Linux software.

- **Overview.** Provides a general description of the Software RAID Recovery Kit and corresponding resource types.

- **LifeKeeper Software RAID Hierarchy Creation and Administration.** Includes a detailed description of Software RAID Recovery Kit administration tasks through LifeKeeper.

- **Troubleshooting.** Provides a list of informational and error messages with recommended solutions.
The following LifeKeeper documentation is available from SIOS Technology Corp.:

- *LifeKeeper for Linux Release Notes*
- *LifeKeeper for Linux Online Product Manual* (available from the Help menu within the LifeKeeper GUI)
- *LifeKeeper for Linux Planning and Installation Guide*

This documentation, along with documentation associated with other LifeKeeper recovery kits, is available on the SIOS Technology Corp. website at:

http://us.sios.com/support.

For information on Linux Software RAID, refer to the on-line manual pages for md(4) and mdadm(8) as well as the *HowTo*; Jakob Østergaard and Emilio Bueso, Maintainers, available at

www.unthought.net/Software-RAID.HOWTO.
Requirements

Your LifeKeeper configuration must meet the following requirements prior to the installation of the LifeKeeper for Linux Software RAID (md) Recovery Kit. Please see the LifeKeeper for Linux Planning and Installation Guide for specific instructions regarding the configuration of your LifeKeeper hardware and software.

Hardware Requirements

- **Servers.** This recovery kit requires two or more computers configured in accordance with the requirements described in the LifeKeeper Release Notes and the LifeKeeper Planning and Installation Guide, which are shipped with the product media.

- **Data Storage.** The Software RAID Recovery Kit can be used in conjunction both with shared storage and with replicated storage provided by the LifeKeeper Data Replication product. It cannot be used with network-attached storage (NAS). Otherwise, the kit has no specific requirements on storage configurations beyond the requirements of the recovery kit protecting the application sitting on top of the RAID device(s).

Software Requirements

- **Operating System.** The Linux Software RAID product is included in all major Linux distributions. See the LifeKeeper Release Notes for a list of supported distributions and versions.

- **mdadm(8) utility.** The recovery kit installation requires that the mdadm rpm package be installed. The specific versions of mdadm supported are those delivered by the Linux distributions.

- **LifeKeeper Software.** The same version of LifeKeeper core software and any recovery kits must be installed, including the Software RAID Recovery Kit, and any patches on each server. Please refer to the LifeKeeper Release Notes for specific LifeKeeper requirements.

- **LifeKeeper for Linux Software RAID (md) Recovery Kit.** The Software RAID Recovery Kit is provided on a CD. It is packaged, installed and removed via the Red Hat Package Manager, rpm. The following rpm file is supplied on the LifeKeeper for Linux Software RAID (md) Recovery Kit CD: steelye-lkMD.

During package installation, checks are made to ensure that supported versions of both the LifeKeeper Core package and the mdadm package are present on the system where the Software RAID Recovery Kit is being installed. The LifeKeeper for Linux Release Notes contains information on the required versions of these packages.

Refer to the LifeKeeper for Linux Planning and Installation Guide for instructions on how to install or remove the LifeKeeper Core software and the Software RAID Recovery Kit.

The Software RAID Recovery Kit must be installed on each server in the cluster on which software RAID using md is being used to manage disk resources that are to be protected by LifeKeeper.

The Software RAID Recovery Kit must be installed prior to the hierarchy creation and extension of applications that sit on top of a RAID device.
Overview

Software RAID (md) Operation

The Multiple Device driver (md) is currently the standard Linux software RAID product included with all of the major Linux distributions. Linux software RAID allows multiple physical disks and/or disk partitions to be grouped together to form virtual devices. Virtual devices are accessed as regular block devices, and as such may be used by file systems or any application that can operate directly with a block device.

Software RAID is principally used to provide data redundancy where hardware RAID (or storage replication) is not practical or feasible. The following diagram shows the relationship of the software RAID entities. File systems or applications use virtual devices. Virtual devices consist of the aggregation of one or more physical disk partitions or disks.

Figure 1: Software RAID Entity Relationships
In Figure 2 below, writes are written to both arrays in this single-path mirror. This is MDs prime function, replacing expensive storage replication.

LifeKeeper for Linux Software RAID (md) Recovery Kit

The LifeKeeper Software RAID (md) Recovery Kit provides the support needed to allow other LifeKeeper recovery kits to operate properly with Linux software RAID virtual devices. To accomplish this support, the Software RAID Recovery Kit installs two new resource types: \texttt{md} and \texttt{mdComponent} that correspond to virtual devices and each partition or disk configured in the virtual device. The \texttt{md} and \texttt{mdComponent} resources exist solely for internal use so that other LifeKeeper resources can operate.
The `mdComponent` resource allows the Software RAID Recovery Kit to present the state of each individual component in the virtual device:

- **ISP** – the component is configured properly in the virtual device and operating normally.
- **ISU** – the component is a spare device. Note that when a device is hot added to a virtual device it will respond as a spare while the device is being restored.
- **OSU** – the component is not configured in the virtual device. This may be a result of the component being removed from the virtual device. If a virtual device has a failed component and is unconfigured (stopped) and reconfigured (assembled), the failed component will no longer appear as a configured device, i.e., it will not show up as failed but as unconfigured.
- **OSF** – the component has failed. **Note:** To receive an email notification when in this state, enable this option using `lk_confignotifyalias(8)`.

As shown in Figure 1, the virtual device `md0` is composed of 2 disk partitions, sda1 and c1d0p1. This could reflect a RAID-1 mirror or a RAID-0 striped array. A typical LifeKeeper hierarchy containing a virtual device looks much like the relationships shown in Figure 1. Refer to Figure 4 in the LifeKeeper Software RAID Hierarchy Creation and Administration section for an example of an actual LifeKeeper hierarchy.

The Software RAID Recovery Kit uses the `mdadm(8)` command provided by the `mdadm` package to manage the virtual device resources in a LifeKeeper hierarchy. The virtual device is configured (or assembled) when a hierarchy is being brought in-service during a failover or switchover operation, and is unconfigured (or stopped) when a hierarchy is being taken out-of-service.

### Software RAID Recovery Kit Notes and Restrictions

The following notes and restrictions apply to this version of the Software RAID Recovery Kit.

**Activating Virtual Devices During Boot Up**

Virtual devices on shared storage should not be activated during system boot-up. Virtual devices on non-shared storage using the LifeKeeper Data Replication Recovery Kit must be configured during boot-up.

**Persistent Superblock**

All virtual devices must be configured with a persistent superblock. The superblock is 4K long and is written in a 64K aligned block that starts at least 64K and less than 128K from the end of the device. This space must be accounted for when planning the size of your virtual device as this space is not usable by an application. **Note:** MD can now be configured with a bitmap using the “internal” feature. This creates a bitmap in this already required superblock, therefore, no additional space is required or additional LUN or additional file system. The bitmap will not show up in the hierarchy, but will just be “automatically” used. See the manual page for `mdadm(8)` and `md(4)` referenced in the Documentation and References section for further details.
**HOMEHOST**

The HOMEHOST feature in newer versions of mdadm is not supported by LifeKeeper. If a mirror is configured with HOMEHOST set, LifeKeeper will fail during resource creation.

As shown in Figure 3, the following messages will be displayed:

- “The MD device "/dev/md5" is configured with the unsupported "homehost" setting.”
- “Recreate the MD device without homehost set.”

![Create gen/filesys Resource](image)

Messages produced while creating a resource are displayed in the dialog and the output panel (if open), and are logged on the server on which you are creating the resource.

**Figure 3: Create File System Hierarchy Failure**

**Recreating the MD Device Without the Homehost Set**

In order to recreate the MD device, the “--homehost=’’” setting will need to be used:

```
mdadm --create /dev/md5 --level=1 --raid-devices=2 /dev/sde1 /dev/sdf1 --homehost="
```

**RAID Level Support**

The supported RAID levels are linear, RAID 0 (striping), RAID 1 (mirroring) and RAID 10 (striped mirror).

**Spare Support**

Spare components are supported as an element of a specific virtual device. A “spare-group” is not supported.
Support for Raw I/O and Entire Disks

While Figure 1 shows a virtual device residing below a file system, it is important to note that the Software RAID Recovery Kit can support raw access to a virtual device when used in conjunction with the LifeKeeper Raw I/O Recovery Kit, and can manage virtual devices that are composed of one or more entire disks (e.g. /dev/sdc) rather than disk partitions (e.g. /dev/sdc1).

Partitioning Virtual Devices

Linux software RAID does not support direct partitioning of a virtual device. There have been several attempts by individuals to add support for partitioning, but the maintainers of the md driver have not accepted this. In place of direct partitioning, the software RAID HowTo referenced in the Documentation and References section above recommends using LVM. Figure 6 shows a hierarchy using LVM.

MD_ASSEMBLE_OPTIONS

In this version of the Software RAID Recovery Kit, the parameter “--run” has been removed from the mdadm command used to assemble (start) the mirror. This parameter is needed in some error situations where mdadm is not sure about the state of the components. Due to this uncertainty, the data could become corrupted, so by default, this parameter is no longer used. Where before a forced mirror in-service would be attempted, an error will now be displayed similar to the following:

Tue Apr 27 11:46:02 EDT 2010 restore: BEGIN restore of "md23051" on server "shrek.sc.steeleye.com"
Tue Apr 27 11:46:06 EDT 2010 restore: start: mdadm: failed to add /dev/sdc1 to /dev/md1: Invalid argument
mdadm: /dev/md1 assembled from 0 drives - not enough to start the array

Although not recommended, this parameter can be used by adding it to the LifeKeeper defaults file: MD_ASSEMBLE_OPTIONS="--run" (this will then be used for every assemble). It is instead recommended that the logs in the cluster be reviewed to determine which component/leg has the best data and then manually assemble the mirror using mdadm.

Note: On some systems (for example those running RHEL 6), there is an AUTO entry in the configuration file (/etc/mdadm.conf) that will automatically start mirrors during boot (example: AUTO +imsm +1.x -all). Since LifeKeeper requires that mirrors not be automatically started, this entry will need to be edited to make sure that LifeKeeper mirrors will not be automatically started during boot. The previous example (AUTO +imsm +1.x -all) is telling the system to automatically start mirrors created using imsm metadata and 1.x metadata minus all others. This entry should be changed to "AUTO -all", telling the system to automatically start everything “minus” all; therefore, nothing will be automatically started. Important: If system critical resources (such as root) are using MD, make sure that those mirrors are started by other means while the LifeKeeper protected mirrors are not.
Software RAID Hierarchy Creation and Administration

LifeKeeper software RAID hierarchies are created automatically during the hierarchy creation process for resources that sit on top of virtual devices. The creation and extension of hierarchies containing the software RAID resource types will always be driven by the create and extend processes of a higher-level resource type, likewise the delete and unextend.

Figure 4 is a LifeKeeper GUI screen shot showing a complete hierarchy containing software RAID resources. The resources in the hierarchy are displayed using the default display showing the LifeKeeper tags. Figure 5 displays the same hierarchy with the display showing the LifeKeeper IDs.

Figure 4: LifeKeeper Hierarchy Containing Software RAID Resources
The hierarchy pictured in Figure 4 is a file system hierarchy, created by selecting the **File System** recovery kit under the **Edit > Server > Create Resource Hierarchy** menu selection. It consists of a file system resource, `tests/mirror0`, mounted on a software RAID virtual device, tag `md8657`. That virtual device is a RAID-1 (mirror) with 2 components: `mdComponent8660` and `mdComponent8918`. The components are configured on partitions on different underlying device types, one being from the CCISS recovery kit (`CCISS_device8884`) and the other using the default SCSI recovery kit (`device9142`). The hierarchy also includes the underlying disk devices, `CCISS_disk8699` and `disk9061`, below each of the disk partitions. The hierarchy can also include a “terminal resource” to tie the bottom of each hierarchy to a single resource. For more information on the terminal resource, see **Terminal Resource** in the **Best Practices** section below.
Notice that the **mdComponent** resource has the same ID as the underlying device. This is unusual in a LifeKeeper hierarchy but is a result of the mdComponent being a resource to allow the Software RAID Recovery Kit to show the state of each component in a virtual device.

---

Figure 6: LifeKeeper Hierarchy Containing Software RAID Resources

Figure 6 above shows a hierarchy using LVM with software RAID.
Hierachy Creation Procedure

To create a hierarchy in which a file system or higher-level application uses a software RAID virtual device, the following high-level procedure should be followed.

1. Determine the desired configuration of your virtual devices. In doing this, keep in mind all of the disk resources associated with a given virtual device must move together from one server to another in the LifeKeeper cluster.

2. On the system which is to be the primary server for your application, create the desired virtual devices using mdadm(8) provided by the mdadm package and described in the Linux Software RAID HowTo and the mdadm(8) on-line manual page referenced in the Documentation and References section above. When creating the virtual device, a persistent superblock MUST be used. Refer to the section Persistent Superblock above for further details.

3. If using shared storage, ensure that all components of the virtual device are properly shared between the machines in the LifeKeeper cluster on which the protected application will be run.

4. Create file systems on each virtual device. If raw I/O will be used instead, bind a raw device to each of the virtual devices.

5. Configure the protected application on the file systems, following the configuration instructions in the administration guide for the LifeKeeper recovery kit associated with the application.

6. Create and extend the application hierarchy following the instructions in the appropriate application recovery kit administration guide.
Software RAID Reconfiguration

One of the primary benefits of using software RAID is the ability to dynamically add, remove and resize virtual devices as storage requirements change. Because this may involve adding or deleting physical partitions or disks from a virtual device definition, the Software RAID Recovery Kit includes a mechanism for modifying an existing resource hierarchy to reflect such a change.

All virtual device and file system reconfigurations should be performed outside of LifeKeeper prior to modifying the LifeKeeper hierarchy to reflect the changes. Refer to the Software RAID HowTo document referenced in the Documentation and References section for information about how this is done. If any of the steps require a resource that is being protected by LifeKeeper to be unmounted or unconfigured, be sure to use the LifeKeeper GUI to do so, using the Out-of-Service operation.

To update a LifeKeeper hierarchy following these changes, first access the Resource Properties dialog for the modified md resource, either by right-clicking on the md resource and selecting Properties, or by using the Edit > Resource > Properties menu selection and selecting the appropriate md resource in the Select Resource field. The resulting Resource Properties dialog should look like the one pictured in Figure 7 below, including the Status and Reconfigure buttons near the bottom.

![Figure 7: Software RAID Resource Properties Dialog](image)
Clicking the **Status** button will display an information box displaying the current status of the virtual device. Figure 8 below shows an example of the status of a virtual device where all components are functioning properly.

**Figure 8: Software RAID Status**
Clicking the **Reconfigure** button initiates the mechanism for reconfiguring your hierarchy to reflect any modifications to the virtual device resource. After a brief pause, an information box will display the modifications that LifeKeeper has detected.

The following three figures show examples of the status and configuration information boxes that would be displayed when a device is removed from a virtual device.

![Software RAID Status for a Deleted Device](image)

**Figure 9: Software RAID Status for a Deleted Device**
Figure 10: Software RAID Reconfiguration for Deleted Device

As stated in the information box, to reconfigure the LifeKeeper virtual device to reflect the changes that have been detected, simply click the **Reconfigure** button. To cancel the LifeKeeper hierarchy modification, click **Cancel**.
After clicking the **Reconfigure** button, an information box will appear, showing the progress of the reconfiguration procedure, as shown in Figure 11 below. When the process has been completed successfully, the **Done** button will become enabled. Clicking **Done** will close the information box and display the **Resource Properties** dialog.

![Resource Reconfiguration for md30484](image)

Figure 11: Software RAID Completed Reconfiguration for Deleted Device
The following four figures show examples of the status and configuration information boxes that would be displayed when a device is added to a virtual device.

**Figure 12: Software RAID Reconfiguration for Added Device**

The reconfiguration mechanism will modify a LifeKeeper md resource hierarchy to reflect the addition or deletion of devices from the actual md array.

The devices that have been added or deleted are displayed below. To modify the LifeKeeper md resource hierarchy to reflect the changes below, click the <Reconfigure> button. Otherwise, click <Cancel> to exit.

Devices in the md array, but not in LifeKeeper (will be added to LifeKeeper):
/dev/sdg

Devices in LifeKeeper, but not in the md array (will be deleted from LifeKeeper):
NONE
Figure 13: Software RAID Completed Reconfiguration for Added Device
While the component is being configured into the virtual device, the **Status** button will show the synchronization progress.

![Software RAID Status During Resynchronization](image)

**Figure 14: Software RAID Status During Resynchronization**
Figure 15: LifeKeeper Hierarchy During Resynchronization
Software RAID Repair

If one of the legs of a mirror fails, a repair can be done on that leg.

If a problem occurs, the resource will be marked OSF.  (Note:  An email notification will occur if enabled.)

The mdComponent could be marked OSF while the disk is okay, but the component is marked "faulty" in the mirror.  This can be due to some issue detected by mdadm when the device was brought on-line (check the error log for further information) or could be due to a manual operation where the mdadm utility was used to "break" the mirror.

The mdComponent as well as the underlying disk/device could be marked OSF if they failed during the in-service operation.  For example, the disk was "broken" or physically not connected when the virtual device was started.
The following screen shots depict an array failure from before the array failed and initial handling of that failure to updating the state to “failed” and bringing it back in service. (These screen shots include an example using a "terminal resource" to tie the bottom of each hierarchy to a single resource.)

Figure 17 - Before Failure of Array
When the failure of the array is initially handled, all resources will be marked OSF. During this failure, IOs continue to the good component or leg of the mirror.
Figure 19 - Failed Disk Array
If the failed component was successfully removed from the mirror configuration during the error handling, the resource will transition to OSU. This is done when the MD quickCheck runs after the failure. If, during the handling, the failed component could not be removed from the mirror configuration, then the resource will remain in the OSF state.

**Figure 20 - Updating Failed Component to Standby**
If the server has to reboot while in the failed state, perhaps to repair the failure to the storage, then the storage resources under the failed component will be restored (if it was properly repaired), but the failed component will not automatically be re-added into the mirror. An in-service (from the GUI or using `perform_action(1M)`) of the failed component will re-add the failed component. This will trigger a resumption of IO to the leg. The mirror will then do a partial resync if an internal bitmap is configured or a full resync will be done otherwise.
If the failed leg is repaired manually in the virtual device, LifeKeeper will automatically detect the change when quickCheck runs. The state of the resource will change to reflect its new state. However, if the resources below the component are failed, aka the device and/or disk, those states will not be updated. To update those states, the GUI or perform_action(1M) must be used to bring the resource(s) in-service.
IMPORTANT: When there is a failure that causes resources to be marked OSF and especially failures that result in resources being moved from one system to another (via a sendevent), it is important that the administrator verify that the failed resource is repaired before trying to bring the resource in-service where it failed.

An example is with the MD kit where there is a complete loss of all paths. When all paths to a mirror fail, the MD kit will recover the failure by moving the mirror to the standby system. The kit will try to clean up or remove all parts of the hierarchy on the failed system before trying to bring the parts in-service on the standby system. However, in many cases, these parts or resources cannot be completely cleaned up due to the failure.

When the administrator repairs the failure, the administrator must also make sure all residual OS items are cleaned up. If there is a mounted file system on the failed mirror, this file system often cannot be unmounted, so even though LifeKeeper moves the file system to the standby system, the failed system will show the file system as mounted (via the mount command). This will cause failures if the administrator then moves the LifeKeeper file system hierarchy back to the repaired system.

The administrator needs to not only repair the failed paths but also needs to make sure all parts of the hierarchy are cleaned up (MD device is still not configured, file system is not mounted, application is completely stopped, etc). A clean reboot may be necessary to make sure all aspects of the hierarchy are cleaned up.
Best Practices

Terminal Resource

In order to avoid some failures seen when all components of a mirror fail, it is recommended that a terminal resource (or instance or leaf node) be created. This terminal resource is a "gen app" resource that is used to tie all of the components (legs) of a mirror to a single point. This terminal instance is useful for several reasons.

- It provides a single point to take the full hierarchy out of service rather than having to select each component directly.
- It avoids some confusing transient situations where part of the hierarchy is active on one node and part is active on another node. This is especially seen while a hierarchy is being moved from one server to another. When the move is complete, all resources should end up on the same server, but while LifeKeeper is moving everything, it can look strange.
- It avoids some error situations where LifeKeeper is trying to quickly move resources from one system to another (all path failure), but the process of starting a resource is slow due to cluster failures. This will force LifeKeeper to take all resources out of service at the same time instead of taking one component out of service, bringing that component in service, then taking the next component out of service and then bringing it in service.

The terminal resource is created through the Create Resource Hierarchy option. This brings up the Create Resource Wizard, where you will select Generic Application from the Recovery Kit list.

For further information on creating the terminal resource, refer to the LifeKeeper Online Product Manual at http://us.sios.com/support under GUI Tasks>Administrator Tasks > Resource > Creating Resource Hierarchies > Creating a Generic Application Resource Hierarchy.

MD Device Number

If/when configuring an MD device on a node in a cluster, use a unique MD number within the cluster, even if the MD device will not be used with or controlled by LifeKeeper.

All MD Devices In-Service

When creating a NetRAID resource in a cluster, all MD devices configured in the cluster should be in-service on the node where the NetRAID device is configured. This will enable NetRAID to use an MD number that will not conflict with any existing MD devices. If this is not done, then the MD kit will reorder the numbers used for the MD resources that have a conflict on the next in-service operation.
Troubleshooting

Error Messages

This section provides a list of messages that may be encountered with the use of the LifeKeeper Software RAID Recovery Kit. Where appropriate, it provides an additional explanation of the cause of an error and necessary action to resolve the error condition.

Because the Software RAID Recovery Kit relies on other LifeKeeper components to drive the creation and extension of hierarchies, messages from these other components are also possible. In these cases, please refer to the documentation for the appropriate LifeKeeper component.

Messages in this section fall under these topics:

- Common Error Messages
- Hierarchy Creation
- Hierarchy Extension
- Hierarchy Restore
- Resource Monitoring
- Software RAID Recovery Kit Error Messages

### Common Error Messages

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<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000002</td>
<td>Usage error</td>
</tr>
<tr>
<td>000010</td>
<td>Error getting resource information</td>
</tr>
<tr>
<td>000011</td>
<td>Both Tag and ID name not specified</td>
</tr>
<tr>
<td>000019</td>
<td>Resource not found on local server</td>
</tr>
<tr>
<td>000022</td>
<td>END failed hierarchy &lt;tag name&gt; in-service on server &lt;server name&gt;</td>
</tr>
<tr>
<td>000026</td>
<td>END failed ACTION for &lt;tag name&gt; on server &lt;server name&gt; due to &lt;signal&gt; signal</td>
</tr>
</tbody>
</table>

### Hierarchy Creation

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000012</td>
<td>Switchback type not specified</td>
</tr>
<tr>
<td>000013</td>
<td>Usage error</td>
</tr>
<tr>
<td>000014</td>
<td>Resource with either matching tag &lt;tag name&gt; or ID exists</td>
</tr>
<tr>
<td>000015</td>
<td>ins_create failed on server &lt;server name&gt;</td>
</tr>
<tr>
<td>000018</td>
<td>Error creating resource &lt;tag name&gt; on server &lt;server name&gt;</td>
</tr>
<tr>
<td>000021</td>
<td>Removing resource instance &lt;tag name&gt; from server &lt;server name&gt; due to an error during creation</td>
</tr>
</tbody>
</table>
### Troubleshooting

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000023</td>
<td>Error bringing resource <code>&lt;tag name&gt;</code> in-service on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000024</td>
<td>Failed resource creation of resource <code>&lt;tag name&gt;</code> on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000027</td>
<td>Removing file system dependency from <code>&lt;parent tag&gt;</code> to <code>&lt;child tag&gt;</code> on server <code>&lt;server name&gt;</code> due to an error during creation</td>
</tr>
<tr>
<td>000028</td>
<td>Removing file system hierarchy <code>&lt;filesystem tag&gt;</code> created by <code>&lt;parent tag&gt;</code> on server <code>&lt;server name&gt;</code> due to an error during creation</td>
</tr>
</tbody>
</table>
| 000029       | Switchback type mismatch between parent `<parent tag>` and child `<child tag>` on server `<server name>`  
**Action:** Switchback mismatches can lead to unexpected behavior. Switchback types for resources can be manually altered using the `ins_setas` command to eliminate this mismatch. |
| 000030       | create: `<tag name>` not specified  
or  
extend: `<tag name>` not specified |

### Hierarchy Extension

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000003</td>
<td>Template resource <code>&lt;tag name&gt;</code> on server <code>&lt;server name&gt;</code> does not exist</td>
</tr>
<tr>
<td>000004</td>
<td>Template resource <code>&lt;tag name&gt;</code> cannot be extended to server <code>&lt;server name&gt;</code> because it already exists there</td>
</tr>
<tr>
<td>000005</td>
<td>Cannot access <code>canextend</code> script on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000006</td>
<td>Cannot access <code>extend</code> script <code>&lt;path to extend&gt;</code> on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000007</td>
<td>Cannot access <code>depstextend</code> script <code>&lt;path to depstextend&gt;</code> on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000008</td>
<td>Cannot extend resource <code>&lt;tag name&gt;</code> to server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000009</td>
<td>Either <code>&lt;templatesys&gt;</code> or <code>&lt;templatetag&gt;</code> argument missing</td>
</tr>
<tr>
<td>000014</td>
<td>Resource with either matching tag <code>&lt;tag name&gt;</code> or ID exists</td>
</tr>
<tr>
<td>000015</td>
<td><code>ins_create</code> failed on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000018</td>
<td>Error creating resource <code>&lt;tag name&gt;</code> on server <code>&lt;server name&gt;</code></td>
</tr>
<tr>
<td>000025</td>
<td>END failed resource extension of <code>&lt;tag name&gt;</code> on server <code>&lt;server name&gt;</code> due to a &quot;&lt;signal&gt;&quot; signal - backing out changes made to server</td>
</tr>
</tbody>
</table>
| 000030       | create: `<tag name>` not specified  
or  
extend: `<tag name>` not specified |
### Hierarchy Restore

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000023</td>
<td>Error bringing resource <code>&lt;tag name&gt;</code> in-service on server <code>&lt;server name&gt;</code></td>
</tr>
</tbody>
</table>

### Resource Monitoring

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>000001</td>
<td>Calling sendevent for resource <code>&lt;tag name&gt;</code> on server <code>&lt;server name&gt;</code></td>
</tr>
</tbody>
</table>

### Software RAID Recovery Kit Error Messages

<table>
<thead>
<tr>
<th>Error Number</th>
<th>Error Message</th>
</tr>
</thead>
<tbody>
<tr>
<td>117000</td>
<td><code>&lt;resource type&gt;</code> resource type is not installed on <code>&lt;LifeKeeper server name&gt;</code></td>
</tr>
<tr>
<td></td>
<td><strong>Action:</strong> Install the MD Recovery Kit on the identified system</td>
</tr>
<tr>
<td>117001</td>
<td>This script must be executed on <code>&lt;LifeKeeper server name&gt;</code></td>
</tr>
<tr>
<td>117002</td>
<td>Failed to create <code>&lt;device name&gt;</code> hierarchy</td>
</tr>
<tr>
<td>117003</td>
<td>Failed to create dependency <code>&lt;resource tag&gt;</code>-<code>&lt;resource tag&gt;</code> on machine <code>&lt;LifeKeeper server name&gt;</code></td>
</tr>
<tr>
<td>117004</td>
<td>LifeKeeper internal ID <code>&lt;resource ID&gt;</code> already in use</td>
</tr>
<tr>
<td>117005</td>
<td><code>&lt;resource type&gt;</code> constructor requires a valid argument</td>
</tr>
</tbody>
</table>