SIOS Protection Suite for Linux

IP Recovery Kit

v8.3.2

Administration Guide

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

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Chapter 1: Introduction

IP Recovery Kit Technical Documentation

The SIOS Protection Suite for Linux Internet Protocol (IP) Recovery Kit provides a mechanism to recover an IP address from a failed primary server to a backup server in a LifeKeeper environment. The IP Recovery Kit can define an IP address that can be used to connect to a LifeKeeper-protected application. As with other LifeKeeper resources, IP resource switchovers can be initiated automatically as a result of a failure or manually by an administrative action.

The IP Recovery Kit supports the implementation of the TCP/IP protocol suite using secondary addresses on existing network interfaces, allowing it to provide switchover and failover of IP addresses without requiring extra standby network interface cards or *dummy* IP addresses. Starting with Release 7.4, the IP Recovery Kit supports both IPv4 and IPv6 addresses.

- SPS Documentation

SIOS Protection Suite Documentation

The following SPS product documentation is available from the SIOS Technology Corp. website:

- SPS for Linux Release Notes
- SPS for Linux Technical Documentation
- Optional Recovery Kit Documentation

Principles of Operation

LifeKeeper brings an IP resource into service by creating an IP alias address on one of the physical network interfaces on the primary server. Users connect to the node using this alias address.

The IP Recovery Kit software performs checks to help ensure that the selected address, network mask and interface can function properly. The software verifies the following elements:

- **Unused resource**. The new IP address is not already assigned to any other IP resource in the LifeKeeper cluster.
- **Unique address**. The address cannot be currently active on the network. In addition to checking during creation, the software also performs the uniqueness check immediately before bringing the resource into service. If the software detects a duplicate address on the net, it does not bring the resource into service.

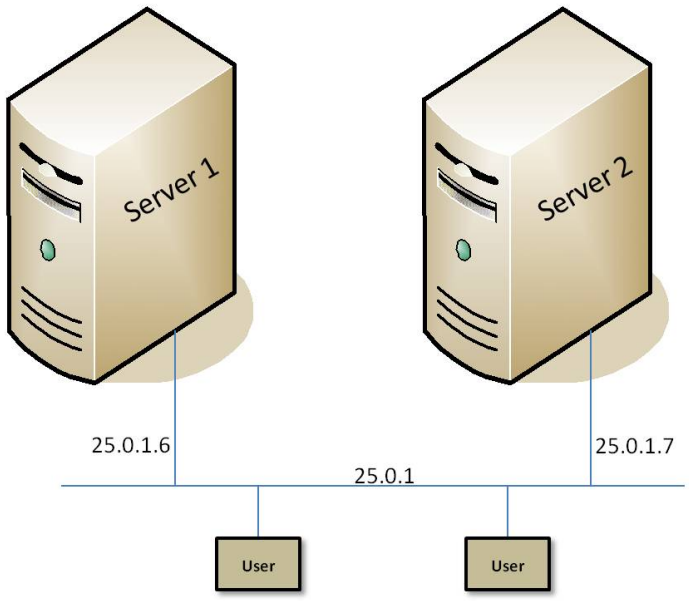
When the primary server fails, the IP Recovery Kit brings the IP resource into service on a backup server by configuring the IP alias on one of that server's physical network interfaces.

Since session context is lost following recovery, after the recovery, IP users must reconnect using exactly the same procedures they used to connect originally.

In a manual switchover, the IP Recovery Kit removes the alias address from service on the active server before adding it to the backup server.

To clarify the administration and operation of the IP Recovery Kit, consider the scenario shown in Figure 1. This example configuration contains two servers, Server 1 and Server 2. Each server has a single LAN interface, eth0, connected to subnet 25.0.1. The user systems are also on this subnet. The LAN interfaces on Server 1 and Server 2 have addresses 25.0.1.6 and 25.0.1.7, respectively.

Figure 1. Administration and Operation Scenario



The system administrator decides to use 25.0.1.10 as the alias address for an IP resource, to be called *ipname*. The administrator creates entries in the */etc/hosts* files (and in the DNS, if used), similar to the following:

25.0.1.6	server1
25.0.1.7	server2
25.0.1.10	ipname

Assuming that Server 1 is the primary server for the resource, the administrator creates the IP resource hierarchy for *ipname* on Server 1 using the wizard described in the section entitled Creating an IP Resource Hierarchy. The software finds the address associated with *ipname* (25.0.1.10) from */etc/hosts*, verifies that it is available and brings it into service by configuring a secondary address on eth0 on Server 1. eth0 on Server 1 now responds to both *server1* and *ipname*.

With LifeKeeper 7.3 or earlier, the new alias address can be verified using the ifconfig or ip addr show command. Starting with LifeKeeper 7.4, the `ip addr show` command should be used (for more information, see the IPv6 Known Issue).

Users can then connect to Server 1 by entering, for example, telnet ipname. If Server 1 crashes, LifeKeeper automatically switches over the *ipname* address to eth0 on Server 2. The user sessions on Server 1 terminate. When users re-run telnet ipname, they are connected to Server 2.

Regardless of where *ipname* is actively in service, addresses *server1* and *server2* are active and usable, though not protected by LifeKeeper recovery. The addresses could be used for any cases that require connection to a specific server by name rather than to a switched application. Examples might include remote system management and the LifeKeeper communications path. (In this case, for example, 25.0.1.6 and 25.0.1.7 would be used for the LifeKeeper communications path.)

IP Resource Monitoring

LifeKeeper monitors the health of the IP resources under its control on a periodic basis, using the following techniques, in this order.

1. Check the link status for the network interface on which the IP resource is configured to determine whether the interface is properly connected to the physical network.
2. Verify that the IP resource is still configured as an alias on the appropriate network interface.
3. Perform a broadcast ping test or ping a pre-configured list of addresses, using the protected IP address as the source address of the pings, to determine whether the IP resource can successfully send and receive data on the network.

   The broadcast ping test is the default test mechanism. It operates by sending a broadcast ping packet to the broadcast address of the subnet associated with the IP resource, using the protected IP address as the source address. If a response is received from any address other than addresses on the local system, the test is considered successful.

   For environments in which there are no systems on the network that can respond to the broadcast ping test (which is the default configuration of many systems), LifeKeeper also offers the ability to configure a list of addresses to be pinged as an alternative to the broadcast ping test. If such a list has been specified, the broadcast ping test is skipped, and all of the addresses in the list are pinged in parallel. The test is considered successful if a ping response is received from any one of the addresses in the Ping List. This technique is also useful to reduce *broadcast storms* on larger networks.

If any of these tests fail during the periodic health check of an IP resource, LifeKeeper is notified of the failure. LifeKeeper will first attempt a local recovery operation to try to restore the IP resource to a working state on the local node. See the section IP Local Recovery and Configuration Considerations for more information about the local recovery procedure. If local recovery is unsuccessful in restoring the IP resource to a working

state, LifeKeeper will then attempt to migrate the application hierarchy containing the IP resource to another LifeKeeper system in the cluster.

LifeKeeper also uses these same health checks to verify the proper operation of an IP resource immediately after it is brought in-service. A failure of any of the checks will cause the in-service operation to fail.

The IP health check mechanisms can be tuned and adjusted in many ways. See the sections Viewing/Editing IP Configuration Properties and Adjusting IP Recovery Kit Tunable Values for details.

Chapter 2: Requirements

Before attempting to install or remove the IP Recovery Kit, you must understand the hardware and software requirements for the package and the installation and removal procedures.

Kit Hardware and Software Requirements

Before installing and configuring the LifeKeeper IP Recovery Kit, be sure that your configuration meets the following requirements:

- **Servers**. The recovery kit requires two or more supported computers configured in accordance with LifeKeeper requirements described in the SIOS Protection Suite for Linux Technical Documentation and the SIOS Protection Suite for Linux Release Notes.
- **LifeKeeper software**. You must install the same version of LifeKeeper software and any patches on each server. Please refer to the SPS for Linux Technical Documentation and the SPS for Linux Release Notes for specific LifeKeeper requirements.
- **LifeKeeper IP Recovery Kit**. You must have the same version of this recovery kit on each server.
- **IP network interface**. Each server requires at least one Ethernet TCP/IP-supported network interface. In order for IP switchover to work properly, user systems connected to the local network should conform to standard TCP/IP specifications. This interface should be configured. If there are no *ifcfg** files, IP switchover may fail when the interface is down.

  Note: Even though each server requires only a single network interface, you should use multiple interfaces for a number of reasons; for example, heterogeneous media requirements, throughput requirements, elimination of single points of failure, network segmentation and local recovery support.
- **TCP/IP software**. Each server also requires the TCP/IP software.

Consult the SPS for Linux Release Notes or your sales representative for the latest release compatibility and ordering information.

You should refer to the SIOS Protection Suite Installation Guide for specific instructions on how to install or remove the LifeKeeper IP Recovery Kit.

Chapter 3: Configuration

To ensure that your LifeKeeper configuration provides the protection and flexibility you require, you need to be aware of the configuration rules. To appropriately plan your configuration, you must understand your network configuration, interface selection, user system setup, hierarchy options and the IP configuration tasks. In addition to planning your configuration, this section also includes configuration examples and the specific tasks required to configure your recovery kit.

Configuring TCP/IP with LifeKeeper

This section contains information you should consider before you start to configure TCP/IP and examples of typical LifeKeeper IP configurations.

Please refer to the SPS for Linux Technical Documentation for instructions on configuring your LifeKeeper Core resource hierarchies.

Specific Configuration Considerations for TCP/IP

In order to properly configure your IP Recovery Kit, you should review the following topics to ensure that you have the information necessary to complete the configuration tasks:

- Interface Selection
- User System Setup
- General IP Planning Considerations

See the following topics for further configuration considerations and examples:

- IP Resource Monitoring and Configuration Considerations
- IP Local Recovery and Configuration Considerations
- Configuration Examples
- Guidelines for Creating an IP Dependency

LifeKeeper Configuration Tasks

The following configuration tasks for virtual IP address resources are described in this section, as they are unique to an IP resource instance and different for each recovery kit.

- Creating an IP Resource Hierarchy. Creates an application resource hierarchy in your LifeKeeper cluster.

- Deleting a Resource Hierarchy. Deletes a resource hierarchy from all servers in your LifeKeeper cluster.
- Extending Your Hierarchy. Extends a resource hierarchy from the primary server to a backup server.
- Unextending Your Hierarchy. Unextends (removes) a resource hierarchy from a single server in your LifeKeeper cluster.
- Testing Your Resource Hierarchy. Tests a virtual IP resource hierarchy for proper configuration and operation.
- Viewing/Editing IP Configuration Properties. Displays configuration details for an IP resource and allows some of them to be modified.
- Adjusting IP Recovery Kit Tunable Values. Tunes characteristics of the overall behavior of the IP Recovery Kit.

The following tasks are described in the Administration section within the SPS for Linux Technical Documentation because they are common tasks with steps that are identical across all Recovery Kits.

- Create a Resource Dependency. Creates a parent/child dependency between an existing resource hierarchy and another resource instance and propagates the dependency changes to all applicable servers in the cluster.
- Delete a Resource Dependency. Deletes a resource dependency and propagates the dependency changes to all applicable servers in the cluster.
- In Service. Brings a resource hierarchy into service on a specific server.
- Out of Service. Takes a resource hierarchy out of service on a specific server.
- View/Edit Properties. View or edit the properties of a resource hierarchy on a specific server.

Note: Throughout the rest of this section, we explain how to configure your recovery kit by selecting certain tasks from the **Edit** menu of the LifeKeeper GUI. You can also select each configuration task from the toolbar. You may also right-click on a global resource in the Resource Hierarchy Tree (left-hand pane) of the status display window to display the same drop down menu choices as the **Edit** menu. This, of course, is only an option when a hierarchy already exists.

You can also right-click on a resource instance in the Resource Hierarchy Table (right-hand pane) of the status display window to perform all the configuration tasks, except Creating a Resource Hierarchy, depending on the state of the server and the particular resource.

Adjusting IP Recovery Kit Tunable Values

The table below lists and explains the tunable values that are available for modifying the behavior of the IP Recovery Kit. These values are tuned by editing the */etc/default/LifeKeeper* configuration file. Because none of the components of the IP Recovery Kit are memory resident, changes to these particular values become effective immediately after they are changed in */etc/default/LifeKeeper*, without requiring a LifeKeeper restart.

Tunable Value	Explanation
NOBCASTPING	Can be used to disable the broadcast ping mechanism for checking the health of IP resources. 0 = Keep the broadcast ping test enabled (Default) 1 = Disable the broadcast ping test
NOIPUNIQUE	Can be used to disable the check that an IP address is not already active somewhere on the network before it is brought in-service. 0 = Keep the IP uniqueness check enabled (Default) 1 = Disable the IP uniqueness check
IP_PINGTIME	Time in seconds that LifeKeeper will wait for a ping reply during IP health checks. Default = 1 (Note: When using a manually configured *Ping List* rather than the broadcast ping mechanism, any value greater than 3 for this tunable is ineffective, because the Linux TCP/IP implementation always returns a "Destination Host Unreachable" error after 3 seconds with no reply, regardless of the timeout value specified in the ping command.)
IP_PINGTRIES	The number of ping retries that will be performed during an IP health check. Default = 3
IP_ PINGPRELOAD	The number of ping packets that will be preloaded onto the network during an IP health check. Default = 1
IP_ NOSAVEREPLY	Can be used to disable the saving of the address that first responds to a broadcast ping for use in subsequent IP health checks. 0 = Keep address saving and use enabled (Default) 1 = Disable saving and use of responding address
IP_ NOLINKCHECK	Can be used to disable the link status check portion of the IP health check. 0 = Keep the link status check enabled (Default) 1 = Disable the link status check

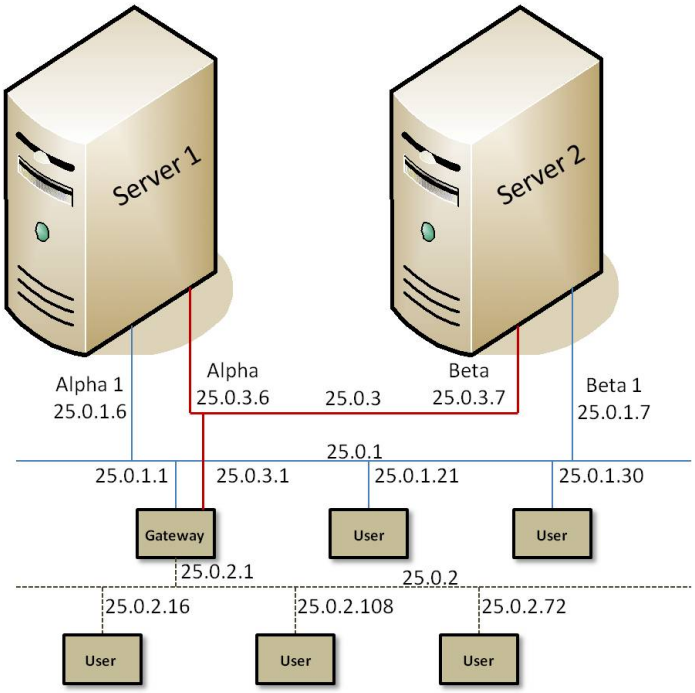
Configuration Examples

This topic identifies example network configurations and then describes two sample IP configuration exercises. The first example illustrates a typical case of a database application dependent upon a single IP resource and configured on a pre-existing subnet. The second example illustrates an active/active scenario where multiple IP resources are configured.

Network Configuration

The first two configuration examples assume the network configuration diagrammed in the following figure.

Network Configuration



The network configuration has these components:

- **Servers**. The configuration has two servers, Server 1 and Server 2, each with the appropriate LifeKeeper and application software installed.
- **Interfaces**. Each server has two Ethernet interfaces, eth0 and eth1, configured as follows:

Interface	Server 1	Server 2
eth0	Server1	Server2
	25.0.3.6	25.0.3.7
eth1	Server11	Server21
	25.0.1.6	25.0.1.7

- **Network**. The network consists of three subnetworks:
  - Low traffic backbone (25.0.3) primarily for servers
  - High traffic backbone (25.0.1) with both servers and clients
  - High traffic client network (25.0.2.)

    A gateway provides interconnection routing between all LANs. A Domain Name Server (not shown) is used for address resolution.
- **Heartbeat**. TCP heartbeat communication paths would be configured using either or both of the server subnetworks.

Typical Configuration Example

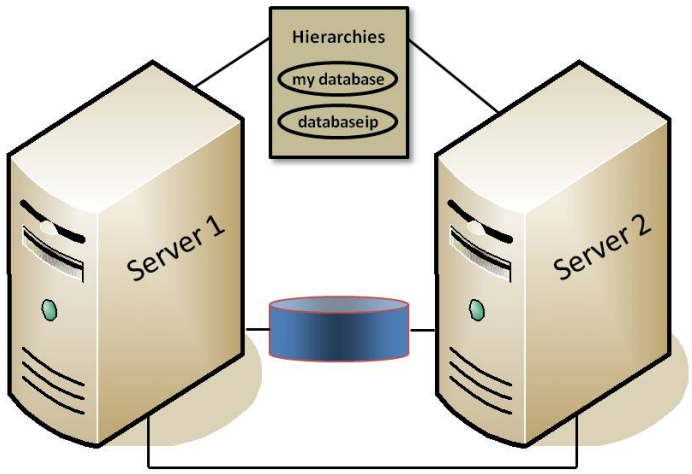
Server 1 and Server 2 have access to an application called mydatabase that resides on a shared disk. To ensure that the application mydatabase and the IP resources used to access it are switched together, the system administrator creates a mydatabase application resource and adds the IP resource to the application hierarchy as a dependency.

These are the configuration issues:

- **Application hierarchy**. The application hierarchy must exist before the administrator names it as a parent of the IP resource. For the purposes of this example, Server 1 is the primary server. The application resource tags are mydatabase-on-server1 and mydatabase-on-server2.
- **IP resource name**. The administrator adds the name and address of the IP resource to the */etc/hosts* file on both Server 1 and Server 2 and to the DNS database. In this example, the IP resource name is databaseip and its network address is 25.0.1.2. If no name-to-IP address association is necessary, then this is not required.
- **Routers, gateways, and users**. Because databaseip is an address on an existing subnet, no additional configuration is necessary. The IP resource is on the 25.0.1 subnet. All users connect to databaseip via the route they currently use to get to the 25.0.1 subnet. For example, users on 25.0.2 go through the gateway and users on 25.0.1 connect directly.
- **IP instance definition**. When the administrator enters databaseip as the IP resource on the Resource Hierarchy Create screen, the software performs several tests. It verifies that Server 1 can determine the address that goes with databaseip (it is in the hosts file and/or can be retrieved from the DNS). It also verifies that the address retrieved, address 25.0.1.2, is not already in use. Since the IP resource is on the 25.0.1 subnet, the IP Recovery software will ensure that it is configured on the eth1 interface. If the IP resource is acceptable, the software fills in the remainder of the wizard dialog boxes with default values, as shown in the table below Figure 3. If you selected all the default values, an independent IP resource hierarchy called ip-databaseip would be created.

Note: The tables associated with each configuration illustration provide examples of the appropriate information that would be entered in the Create Resource Hierarchy wizard for the primary server (Server 1) and Extend Resource Hierarchy wizard for the backup server (Server 2). For additional details on what information should be entered into the wizards, refer to the LifeKeeper Configuration Tasks section later in this section. These tables can be a helpful reference when configuring your recovery kit.

Figure 3. Typical Configuration Example of IP Resource Creation



Configuration Notes:

1. The application resource is mydatabase-on-server1.
2. The IP resource is databaseip with a tag name of ip-databaseip.
3. If mydatabase-on-server1 fails, LifeKeeper switches it to Server 2; (ip-databaseip is only switched if a dependency exists).
4. If Server 1 fails, both resources are brought in-service on Server 2.
5. During a switchover, databaseip users would be disconnected. When they log back in, they can access any applications on Server 2.
6. During a manual switchover, users connected to Server 1 via connections other than databaseip remain connected to Server 1.

Creating an IP resource hierarchy on Server 1:

Server:	Server1
IP Resource:	databaseip
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-databaseip

Note: See the topic Guidelines for Creating an IP Dependency before extending an IP resource to a backup server.

Extending an IP resource hierarchy to Server 2:

Template Server:	Server1
Tag to Extend:	databaseip
Target Server:	Server2
Target Priority:	10
**IP Resouce:	25.0.1.2
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-databaseip

** Note that the actual IP address associated with the DNS name is displayed in the Extend Wizard as the IP resource.

Test Your IP Resource

To verify the successful creation of the IP resource, the administrator should perform the following tasks:

1. From the LifeKeeper GUI, observe whether ip-databaseip is in-service (ISP) on Server 1.
2. From a remote server, connect to address databaseip using ping or telnet.
3. Test manual switchover by selecting the in_service option on Server 2 and selecting ip-databaseip. Verify that the IP address migrates to Server 2.

Active/Active Configuration Example

The second example, using the same network configuration, describes two IP resources, one active on each server.

Resource Addresses

For this example, the IP resources are server1ip (address 25.0.6.20) and server2ip (address 25.0.6.21). Entries for these resources must be in the */etc/hosts* files on each server and in the DNS database.

Router Configuration

Because the selected addresses are on a new (logical) subnet, they can be configured for either eth0 or eth1. However, both must go on the same interface.

For this example, choosing eth0 means that all users would have to go through the gateway. Choosing eth1 would allow the users on the 25.0.1 subnet to access the resources directly (assuming that the new subnet

had been added to their internal routing tables). Users on subnet 25.0.2 would still require the gateway. For the purposes of this example, the selected interface is eth1.

Regardless of which physical network is chosen to support the new subnet, the network administrator would have to add routing information to the gateway system before creating the IP resources.

First IP Resource Definition

The administrator creates the first IP resource on Server 1. eth0 is the first available interface on each server and would appear as the default. To define eth1 as the interface, the administrator selects it from the list of available interfaces.

Creating an IP resource hierarchy on Server 1:

Server:	Server1
IP Resource:	server1ip
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-server1ip

Note: See the topic Guidelines for Creating an IP Dependency before extending an IP resource to a backup server.

Extending an IP resource hierarchy to Server 2:

Template Server:	Server1
Tag to Extend:	server1ip
Target Server:	Server2
Target Priority:	10
**IP Resouce:	25.0.6.20
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-server1ip

** Note that the actual IP address associated with the DNS name is displayed in the ***Extend Wizard*** as the IP resource.

Second IP resource definition

The administrator creates the second IP resource on Server 2. eth0 is the first available interface on each server and would appear as the default. To define eth1 as the interface, the administrator selects it from the list of available interfaces.

Creating an IP resource hierarchy on Server 2:

Server:	Server2
IP Resource:	server2ip
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-server2ip

Note: See the topic Guidelines for Creating an IP Dependency before extending an IP resource to a backup server.

Extending an IP resource hierarchy to Server 1:

Template Server:	Server2
Tag to Extend:	server2ip
Target Server:	Server1
Target Priority:	10
**IP Resouce:	25.0.6.21
Netmask:	255.255.252.0
Network Interface:	eth1
IP Resource Tag:	ip-server2ip

** Note that the actual IP address associated with the DNS name is displayed in the ***Extend Wizard*** as the IP resource.

Note: Since subnet 25.0.6 is not active on Server 2, both eth0 and eth1 are available choices for the Primary network interface. On Server 1 (the backup server), the only choice is eth1 because the first IP resource, 25.0.6.20, is in service there. When the administrator saves the definition, LifeKeeper brings address 25.0.6.21 in-service on eth1 on Server 2.

Testing IP Resources

The administrator should verify that the new resources are functioning on both servers by performing the following tests:

1. With each resource on its primary server, verify that each is accessible by using either ping or telnet. The administrator may also want to test connectivity from all user sites.
2. Test switchover by manually bringing ip-server1ip into service on Server 2. Verify both resources are functional on Server 2.

3. Bring both resources into service on Server 1. Verify both resources are functional on Server 1.
4. Bring ip-server2ip back into service on its primary server, Server 2.

Creating an IP Resource Hierarchy

To create a resource instance from the primary server, complete the following steps:

1. From the LifeKeeper GUI menu, select **Edit**, then **Server**. From the drop down menu, select **Create Resource Hierarchy**.
2. A dialog box will appear with a dropdown list box menu listing all recognized recovery kits installed within the cluster. Select **IP** from the dropdown list and click **Next**.
3. You will be prompted to enter the following information. When the **Back** button is active in any of the dialog boxes, you can go back to the previous dialog box. This is especially helpful should you encounter an error that might require you to correct previously entered information.

   If you click the **Cancel** button at any time during the sequence of creating your hierarchy, LifeKeeper will cancel the entire creation process.

Field	Tips
Switchback Type	This dictates how the IP instance will be switched back to this server when the server comes back up after a failover. You can choose either *intelligent* or *automatic*. Intelligent switchback requires administrative intervention to switch the instance back to the primary/original server. Automatic switchback means the switchback will occur as soon as the primary server comes back on line and reestablishes LifeKeeper communication paths. The switchback type can be changed later from the General tab of the Resource Properties dialog box.
Server	Select the **Server** where you want to place the IP Address (typically this is referred to as the primary or template server). All the servers in your cluster are included in the drop down list.
IP Resource	Select or enter the actual **IP Resource.** This is the IP address or symbolic name that LifeKeeper will use for this resource. This is used by client applications to log in to the parent application over a specific network interface. If you use a symbolic name, it must exist in the local */etc/hosts* file or be accessible via a Domain Name Service (DNS). Alias names and domain names are acceptable as long as they meet the criteria listed above. No defaults are provided for this information field. **Note:** If you choose to use a symbolic name, be advised that when you extend this resource, the actual IP address will appear in one of the dialog boxes as the IP resource designation.

Field	Tips
Netmask	Select or enter the network mask, **Netmask**, which your IP resource will use on the target server. Any standard netmask for the class of the specific IP resource address is valid. **Note:** The netmask you choose, combined with the IP address, determines the subnet that will be used by the IP resource and should be consistent with the network configuration.
Network Interface	Select or enter the **Network Interface** where your IP resource will be placed under LifeKeeper protection. This is the physical Ethernet card that the IP address is interfacing with. Valid choices will depend on the existing network configuration and values chosen for the IP resource address and netmask. The default value is the interface within the set of valid choices which most closely matches the address and netmask values you have selected.
IP Resource Tag	Select or enter a unique **IP Resource Tag** name for the IP resource instance you are creating.This field is populated automatically with a default tag name, ip-<resource>, where <resource> is the resource name or IP address. You can change this tag if you want to.

4. Click **Create**. The ***Create Resource Wizard*** will then create your IP resource.
5. At this point, an information box appears and LifeKeeper will validate that you have provided valid data to create your IP resource hierarchy. If LifeKeeper detects a problem, an ERROR will appear in the information box. If the validation is successful, your resource will be created. Click **Next**.
6. Another information box will appear explaining that you have successfully created an IP resource hierarchy, and you must Extend that hierarchy to another server in your cluster in order to place it under LifeKeeper protection.

   When you click **Continue**, LifeKeeper will launch the **Pre-Extend configuration task**. Refer to the Extending Your Hierarchy topic for details on how to extend your resource hierarchy to another server.

   If you click **Cancel** now, another dialog box will appear alerting you that you'll need to come back and extend your IP resource hierarchy to another server at some other time to put it under LifeKeeper protection.

Deleting a Resource Hierarchy

To delete a resource hierarchy from all the servers in your LifeKeeper environment, complete the following steps:

1. From the LifeKeeper GUI menu, select **Edit**, then **Resource**. From the drop down menu, select **Delete Resource Hierarchy**.
2. Select the name of the Target Server where you will be deleting your IP resource hierarchy and then click **Next**. (This dialog will not appear if you selected the **Delete Resource** task by right-clicking on a resource instance in either pane.)

3. Select the **Hierarchy to Delete**. Identify the resource hierarchy you wish to delete, and highlight it and then click **Next**. (This dialog will not appear if you selected the Delete Resource task by right-clicking on a resource instance in the left or right pane.)
4. An information box appears confirming your selection of the target server and the hierarchy you have selected to delete. Click **Delete** to proceed with resource deletion.
5. Another information box appears confirming that the IP resource was deleted successfully.
6. Click **Done** to exit out of the Delete Resource Hierarchy menu selection.

Extending Your Hierarchy

Note: See the section on Guidelines for Creating an IP Dependency before extending an IP resource to a backup server.

After you have created a hierarchy, you will want to extend that hierarchy to another server in the cluster. There are three possible scenarios to extend your resource instance from the template server to a target server. The first scenario is when you "Continue" from creating the resource into extending that resource to another server. The second scenario is when you enter the Extend Resource Hierarchy task from the edit menu as shown below. The third scenario is when you right click on an unextended hierarchy in either the left or right hand pane. Each scenario takes you through the same dialog boxes (with a few exceptions, which are clearly detailed below).

1. If you are entering the ***Extend wizard*** from the LifeKeeper GUI menu, select **Edit**, then **Resource**. From the drop down menu, select **Extend Resource Hierarchy**. This will launch the ***Extend Resource Hierarchy wizard.*** If you are unfamiliar with the Extend operation, click **Next**. If you are familiar with the LifeKeeper Extend Resource Hierarchy defaults and want to bypass the prompts for input/confirmation, click **Accept Defaults**.
2. The ***Pre-Extend Wizard*** will prompt you to enter the following information. **Note**: The first two fields appear only if you initiated the **Extend** from the **Edit** menu. It should be noted that if you click **Cancel** at any time during the sequence of extending your hierarchy, LifeKeeper will cancel the extension process to that particular server. However, if you have already extended the resource to another server, that instance will continue to be in effect until you specifically unextend it.

Field	Tips
Template Server	Enter the server where your IP resource is currently in service.
Tag to Extend	Select the IP resource you wish to extend. This is the name of the IP instance you wish to extend from the template server to the target server. The wizard will list in the drop down list box all the resources that you have created on the template server that you selected in the previous dialog box.
Target Server	Select the **Target Server** where you are extending your IP resource hierarchy. The drop down box provides the names of the servers in your cluster that are not already in the selected hierarchy.

Field	Tips
Switchback Type	Select the **Switchback Type.** This dictates how the IP instance will be switched back to this server when it comes back into service after a failover to the backup server. You can choose either *intelligent*or *automatic*. Intelligent switchback requires administrative intervention to switchback the instance to the primary/original server. Automatic switchback means the switchback will occur as soon as the primary server comes back on line and reestablishes LifeKeeper communication paths. The switchback type can be changed later, if desired, from the General tab of the Resource Properties dialog box.
Template Priority	Select or enter a **Template Priority**. This is the priority for the IP hierarchy on the server where it is currently in service. Any unused priority value from 1 to 999 is valid, where a lower number means a higher priority (1=highest). The extend process will reject any priority for this hierarchy that is already in use by another system. The default value is recommended. **Note:** This selection will appear only for the initial extend of the hierarchy.
Target Priority	Select or enter the **Target Priority**. This is the priority for the new extended IP hierarchy relative to equivalent hierarchies on other servers. Any unused priority value from 1 to 999 is valid, indicating a server's priority in the cascading failover sequence for the resource. A lower number means a higher priority (1=highest). Note that LifeKeeper assigns the number "1" to the server on which the hierarchy is created by default. The priorities need not be consecutive, but no two servers can have the same priority for a given resource.

3. An information box will appear explaining that LifeKeeper has successfully checked your environment and that all the requirements for extending this IP resource have been met. If there were some requirements that had not been met, LifeKeeper would not allow you to select the Next button, and the Back button would be enabled. If you click Back, you can make changes to your resource extension according to any error messages that may appear in the information box. If you click Cancel now, you will need to come back and extend your IP resource hierarchy to another server at some other time to put it under LifeKeeper protection. When you click Next, LifeKeeper will launch you into the Extend Resource Hierarchy configuration task.
4. The Extend Resource Hierarchy configuration task will prompt you to enter the following information.

Field	Tips
IP Resource	This is the same **IP Resource** or address used in the Create Resource Wizard. This dialog box is for information purposes only. You cannot change the**IP Resource** that appears in the box.
Netmask	This is the same **Netmask** that was selected when the IP resource was created for the template server and will now be used by the IP resource for the target server. This dialog box is for information purposes only. You cannot change the **Netmask**that appears in the box.
Network Interface	Select or enter the **Network Interface.** This is the name of the network interface (i.e. Ethernet card) the IP resource will use on the target server.
IP Resource Tag	Select or enter the **IP Resource Tag.** This is the resource tag name to be used by the IP resource being extended to the target server.

5. An information box will appear verifying that the extension is being performed.

   Click **Next Server** if you want to extend the same IP resource instance to another server in your cluster. This will repeat the Extend Resource Hierarchy operation.

   If you click **Finish**, LifeKeeper will verify that the extension of the IP resource was completed successfully.

6. Click **Done** to exit from the **Extend Resources Hierarchy** menu selection.

   Note: Be sure to test the functionality of the new instance on all the servers.

General IP Planning Considerations

After you have selected the addresses, netmasks and associated host/domain names you intend to use for IP resource hierarchies, add the appropriate entries to each server's */etc/hosts* file, and to the Domain Name Server (DNS), if used.

Note: Even if you are using a DNS, it is strongly recommended that you place entries for the IP resources in the local */etc/hosts* files on all LifeKeeper servers. This will reduce recovery times. However, if the resource name that you enter when creating the IP instance is the IP address itself, then the host file entry is unnecessary.

Do not configure the protected IP addresses into your system as you would if you were creating a permanent logical interface to be activated at system boot time. The LifeKeeper software will manage them instead of the system software.

If any of the resource addresses are on new (logical) subnets, update routers to handle routing to these subnets.

Guidelines for Creating an IP Dependency

How and/or when you are going to create a parent/child dependency between a LifeKeeper-protected application and a LifeKeeper-protected IP address is typically dependent on the LifeKeeper-protected application. For example, in a LifeKeeper-protected Apache environment, the parent/child dependency is created during the creation of the Apache resource hierarchy (assuming you have already created a protected IP address). In other applications that do not create this dependency automatically, it is recommended you use the following steps:

1. Create the application/parent resource hierarchy. Note: Do not extend the resource hierarchy to a backup server at this time. You will receive a warning message when you elect not to extend your hierarchy, but in this particular situation, it is the proper action to take.
2. Create the IP resource hierarchy. Note: Do not extend the IP resource hierarchy to a backup server at this time. You will receive a warning message when you elect not to extend your hierarchy, but in this particular situation, it is the proper action to take.
3. Create the parent/child dependency between the parent application resource hierarchy and the IP resource hierarchy using the Create Resource Dependency configuration task (see the LifeKeeper for Linux topic, Creating a Resource Dependency.

4. Finally, extend the application resource hierarchy to the backup server. Since the dependency has already been created, the dependent IP resource instance will also be extended to the backup server as part of the parent application resource hierarchy.

The steps outlined above save you from performing one extra extension (i.e. the extension of the IP resource to the backup server).

Interface Selection

When creating an IP resource, select the IP resource address, the netmask to use with the address and the network interface. Not all combinations are allowed. The address/netmask pair provided and all the address/netmask pairs currently in-service determine choices. Also, see the section on IP Local Recovery for additional configuration considerations if planning on using this feature of the recovery kit.

The selected address/netmask determines the subnet for the resource. If another address on the same subnet (either a physical or logical interface address) is currently in service on any interface, then the IP resource must be configured on that interface. The software performs tests to determine the allowed choices based upon the current network configuration. Select from any of the choices provided.

Because the IP Recovery Kit software does not distinguish between physical media types, the physical network for the resource must be determined and the address selected appropriately. For example, assume that you have a server connected to an Ethernet backbone on subnet xx.yy.12 and Ethernet LANs on subnets xx.yy.20 and xx.yy.30. If you want to create a resource on the first Ethernet subnet, select an address on that subnet, such as xx.yy.20.120.

In general, even though the IP Recovery Kit software allows you to select almost any value for the netmask, you should avoid selecting multiple netmasks for the same physical interface because multiple masks can cause packet misrouting.

One further consideration is the need to be consistent in your selection of interfaces on all LifeKeeper servers. If you configure several IP resources on a single interface on Server A, they should also be configured on a single interface on Server B.

When creating an IP resource hierarchy, you may utilize any interface which is initially UP and has a corresponding and correct network interface configuration file on both the primary and backup hosts, i.e. if using *eth1*, *eth1* must be UP and *eth1* must have a corresponding and correct *ifcfg-eth1* file (test with `ifup/ifdown ifcfg-eth1`) even if the configuration is minimal without any address assignments or is DOWN on boot.

IP Local Recovery and Configuration

The standard Linux NIC bonding mechanism is the recommended means of providing network interface redundancy in a high availability configuration. The LifeKeeper IP Recovery Kit fully supports the creation of virtual IP addresses on bonded interfaces.

Local Recovery Scenario

When a failure of an IP address is detected by the IP Recovery Kit, the resulting failure triggers the execution of the IP local recovery script. LifeKeeper will first attempt to bring the IP address back in-service on the

current network interface. If the local recovery attempt fails, LifeKeeper will perform a failover of the IP resource and all dependent resources to a backup server.

IP Resource Monitoring and Configuration

By default, the LifeKeeper IP Recovery Kit monitors IP resources by executing a broadcast ping on the IP addresses logical subnet, then listening for replies. For this test to work properly, at least one additional non-LifeKeeper system capable of responding to broadcast pings must exist on the physical network, with an IP address on the same logical subnet as the IP resource. A router on the same logical subnet is usually sufficient to meet this need. Note that the default configuration of many devices is to not respond to braodcast pings, so it may be neccessary to change the configuration of at least one device.

If this requirement cannot be met, you can choose to either disable the broadcast ping test completely, or you can configure a static list of IP addresses that should be pinged as an alternative to the broadcast ping test mechanism. See the Adjusting IP Recovery Kit Tunable Values and Viewing/Editing IP Configuration Properties topics for more information about how to configure these options.

Testing Your Resource Hierarchy

You can test your IP resource hierarchy by initiating a manual switchover. This will simulate a failover of a resource instance from the primary server to the backup server.

Performing a Manual Switchover from the GUI

You can initiate a manual switchover from the LifeKeeper GUI by selecting **Edit**, then **Resource**, then finally **In Service** from the dropdown menu. For example, an in-service request executed on a backup server causes the application hierarchy to be placed in service on the backup server and taken out of service on the primary server. At this point, the original backup server is now the primary server and original primary server has now become the backup server.

If you execute the **Out of Service** request, the application is taken out of service without bringing it in service on the other server.

In a manual switchover, the IP Recovery Kit removes the address from service on the active server before adding it to the backup server.

After switchover, the IP resource has a different hardware (MAC) address because it is associated with a different LAN interface. Before user systems can reconnect, the user systems' TCP/IP software must determine this new address mapping. The IP Recovery Kit automatically informs all connected servers that they must update their ARP (Address Resolution Protocol) tables to reflect the new mapping.

User systems running full TCP/IP implementations are updated immediately. User systems with less sophisticated implementations may have delayed update or may require routers as addressing intermediaries.

Unextending Your Hierarchy

1. From the LifeKeeper GUI menu, select **Edit**, then **Resource**. From the dropdown menu, select **Unextend Resource Hierarchy**.

2. Select the Target Server where you want to unextend the IP resource. It cannot be the server where the IP address is currently in service.

   Note: If you selected the Unextend task by right-clicking from the right pane on an individual resource instance, this dialog box will not appear.

   Click **Next** to proceed to the next dialog box.

3. Select the **IP Hierarchy to Unextend**.

   Note: If you selected the Unextend task by right-clicking from either the left pane on a global resource or the right pane on an individual resource instance, this dialog will not appear.

   Click **Next** to proceed to the next dialog box.

4. An information box appears confirming the target server and the IP resource hierarchy you have chosen to unextend.

   Click **Unextend**.

5. Another information box appears confirming that the IP resource was unextended successfully.

6. Click **Done** to exit out of the **Unextend Resource Hierarchy menu**.

User System Setup

When the IP Recover Kit software switches an IP resource from one server to another, the MAC address associated with the switched IP address changes because the interface changes. Each router and user system on the LAN must reflect this change in its ARP table before it can contact the IP address at its new location. In certain operating systems, when a new IP address is added to a network interface, an ARP packet is automatically sent out by the operating system to update all clients' ARP tables on the subnet. This feature does not exist in Linux. LifeKeeper therefore must send out an ARP packet after adding a switchable IP address to an interface to force this client ARP cache update.

TCP/IP implementations differ in their ability to implement the required ARP updates in response to this ARP packet. The following list describes some important cases:

- **Full Linux TCP/IP implementation**. Fully functional TCP implementations in Linux and most other operating systems support ARP cache updates when the systems receive an ARP request packet. LifeKeeper uses this feature, as described above, to force ARP cache updates on such systems.
- **ARP cache**. User systems that do not support the ARP refinements but do support an ARP cache usually have a timer associated with the cache to maintain some level of currency. For some implementations, decreasing the timer value can minimize the time required for that particular user system to reflect the changed address mapping. If the number of users on the LAN is small, this option may be acceptable. For other systems, decreasing the timer value may not be necessary. For example, the TCP implementation shipped with Windows NT uses a ten second timer value, so no change in timer value would be needed.
- **Static address mapping**. For systems without a dynamic ARP cache or those where cache timing is not tunable, routers can be used to handle mapping changes. Such user systems would access the IP resource subnet by way of a router (gateway). In this configuration, cache update is needed only for the

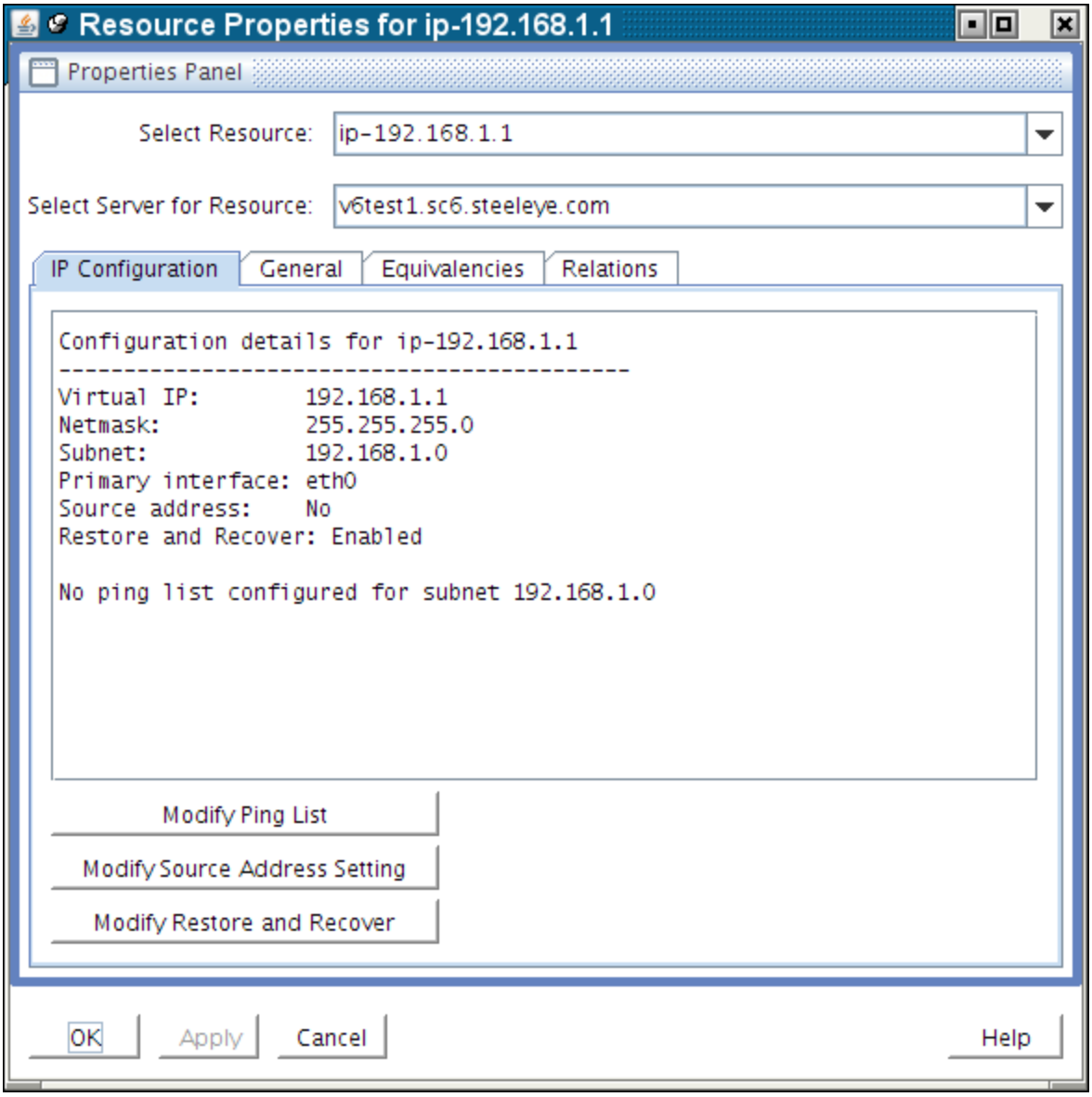
routers directly connected to the resource subnet and no changes are needed on the user systems themselves.

Viewing and Editing IP Configuration Properties

The **IP Configuration Properties** page allows you to view the configuration details for a specific IP resource, as well as to modify a number of selected configuration items.

To access the **IP Configuration Properties** page, from the LifeKeeper GUI menu select **Edit**, then **Resource**. From the dropdown menu, select **Properties**. Then select the resource for which you want to view properties from the **Resource list** and the server for which you want to view that resource from the **Server list**. You can also access the properties page using the context-sensitive menu that appears when you right-click on a specific IP resource instance.

Below is an example of the properties page that will appear for an IP resource.



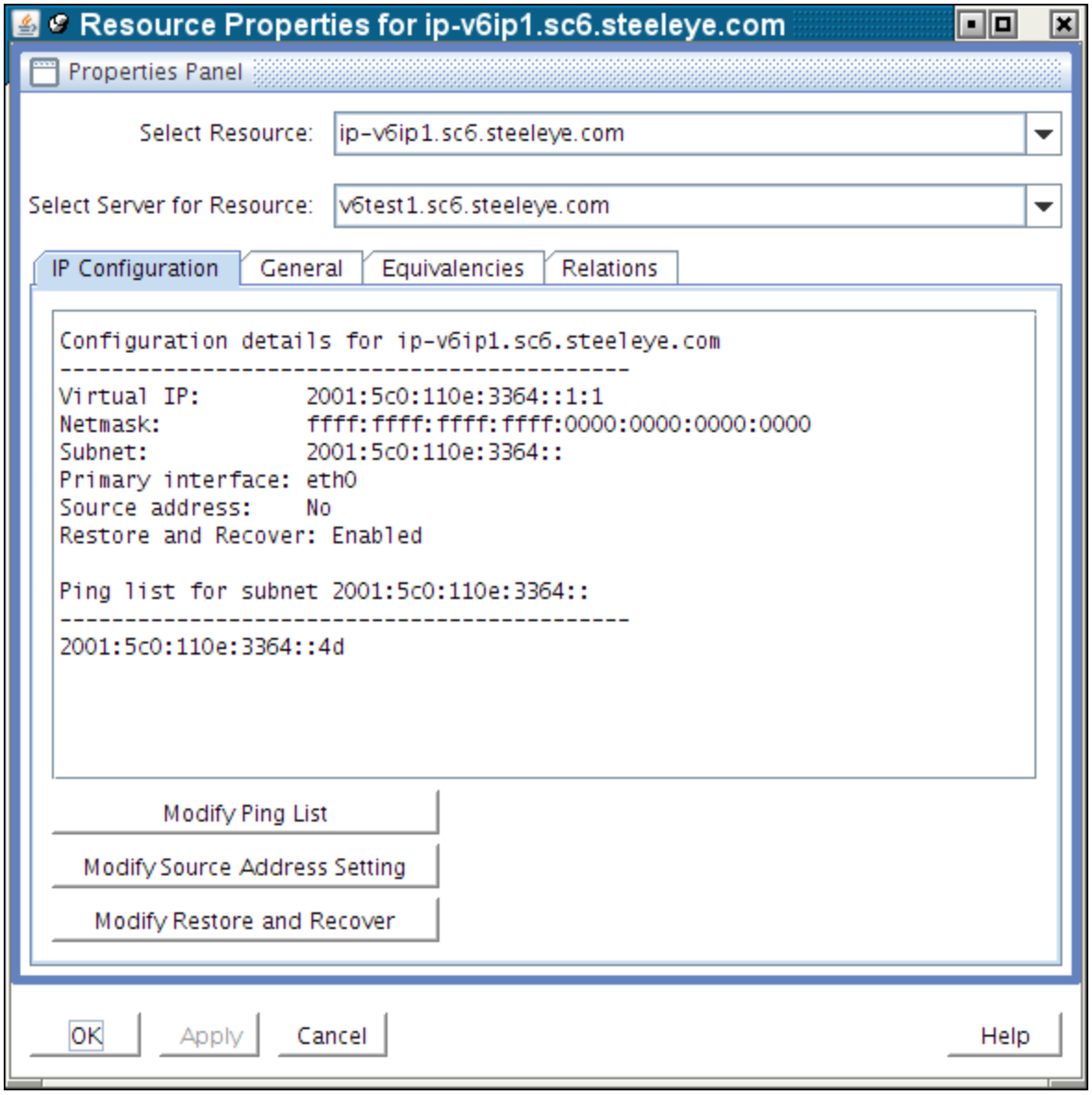
The resulting properties page contains four tabs. The first of those tabs, labeled **IP Configuration**, contains configuration information that is specific to IP resources. The remaining three tabs are available for all LifeKeeper resource types.

The IP Configuration tab displays the following information elements about the selected IP resource.

Virtual IP	The virtual IP address associated with this IP resource.
Netmask	The netmask for the virtual IP address. This value determines how much of the address makes up the subnet portion.
Subnet	The logical subnet address for the virtual IP address, including the number of bits included in the subnet portion of the address.

Primary interface	The network interface on which the virtual IP address should be configured when it is active.
Source address setting	Specifies whether the virtual IP address should be configured as the source address for outbound IP traffic onto its associated subnet.
Ping List	The optional list of IP addresses to be pinged during IP health checks for this IP resource (and others on the same subnet), as an alternative to the normal broadcast ping mechanism.

In the example above, there is no Ping List configured for this IP resource. When a Ping List is configured, the resulting properties page looks like the following example.

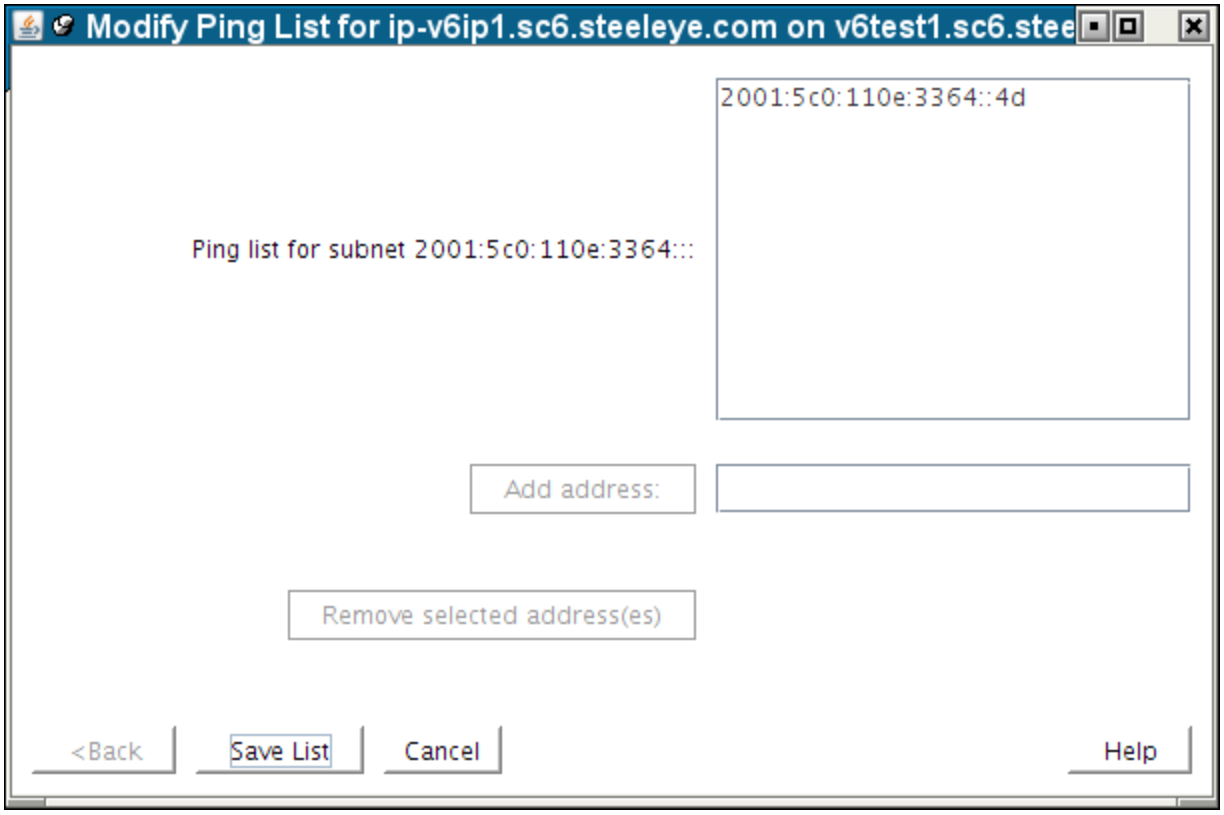


The **Modify Ping List** and **Modify Source Address Setting** buttons can be used to perform modifications to those configuration items, as described in the sections below.

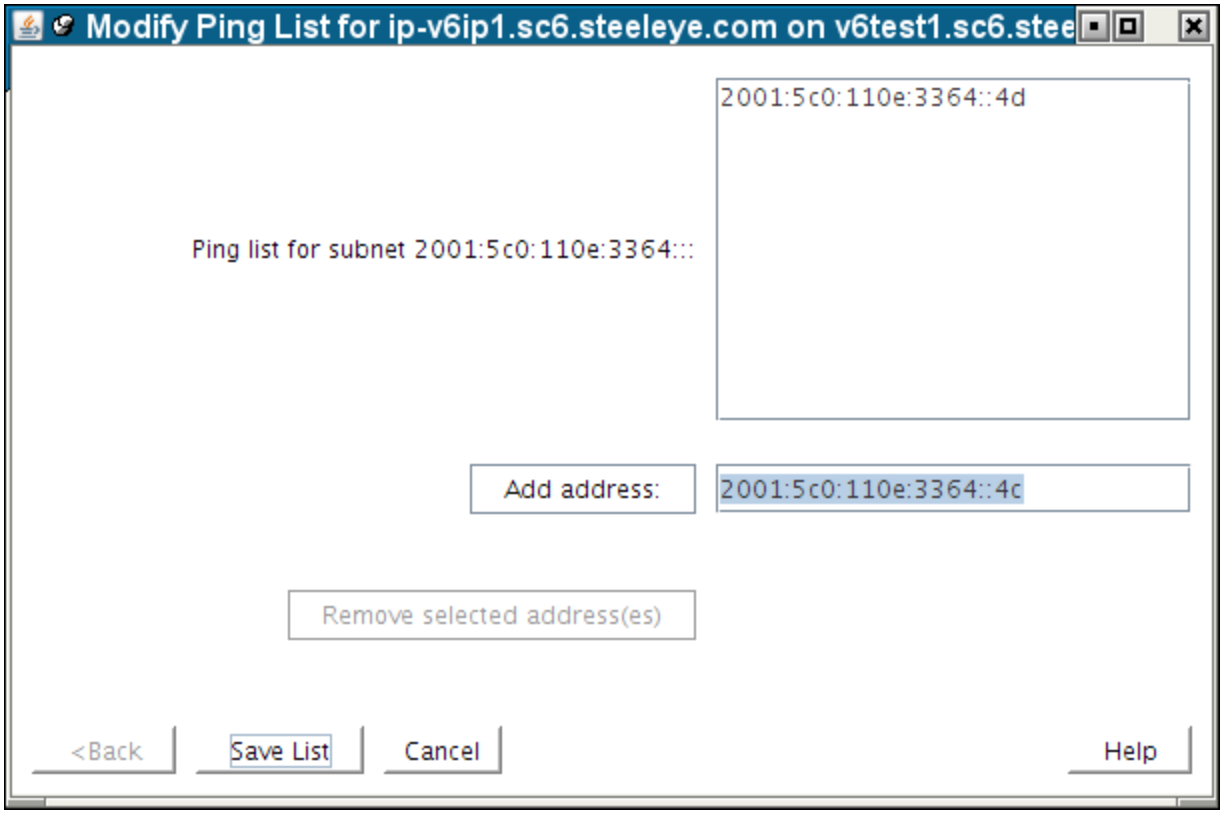
Modifying the Ping List

For a description of the use and function of the Ping List for an IP resource, see the topic IP Resource Monitoring.

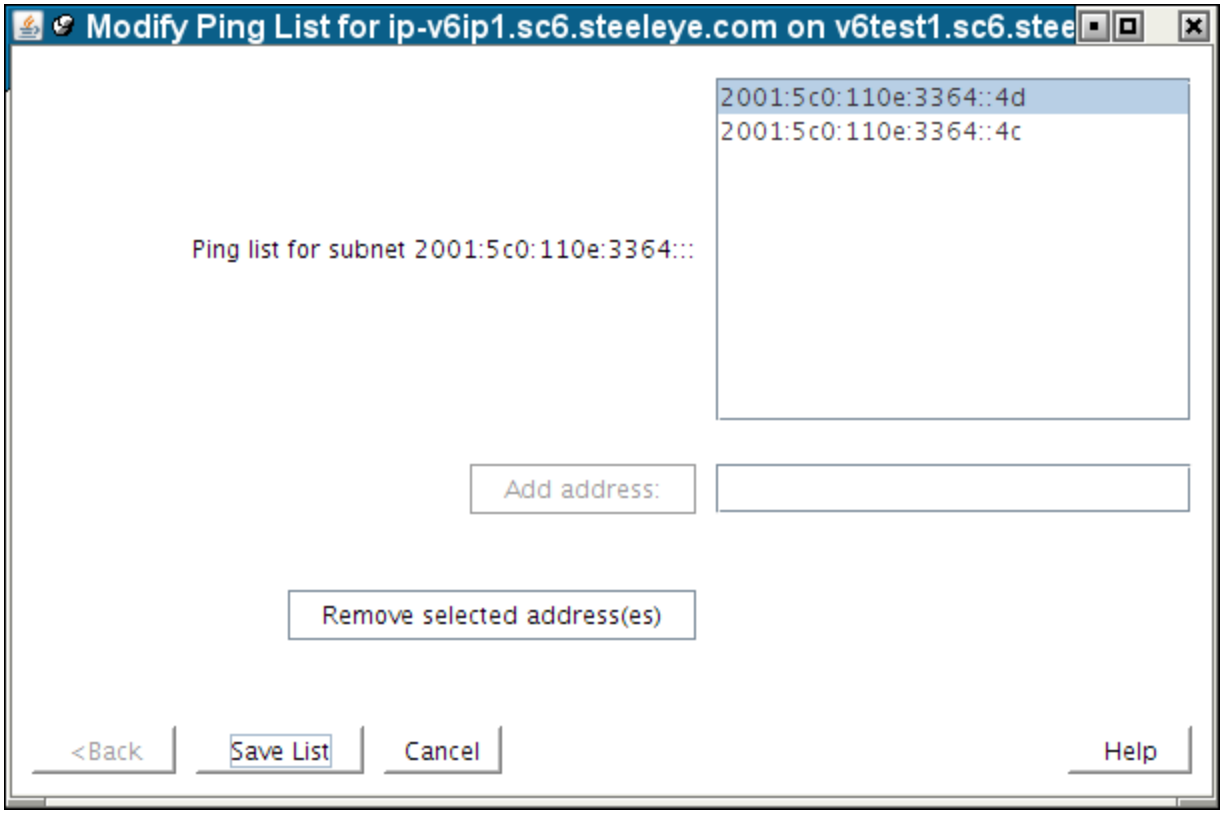
To create a Ping List for an IP resource, or to modify an existing list, click the **Modify Ping List** button on the **IP Configuration properties page**. This brings up a dialog window similar to the following example.

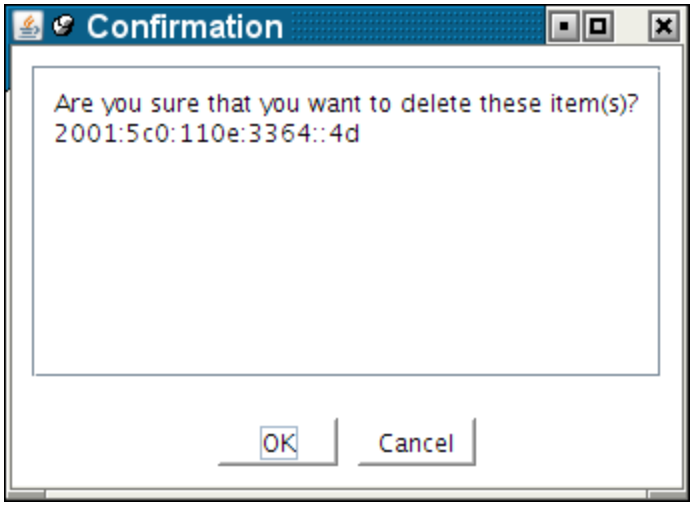


To add an address to the Ping List, type the address in the field next to the **Add address:** button, and push the button, as shown in the following two images. Note that the **Add address:** button is grayed out until you begin typing an address in the field.

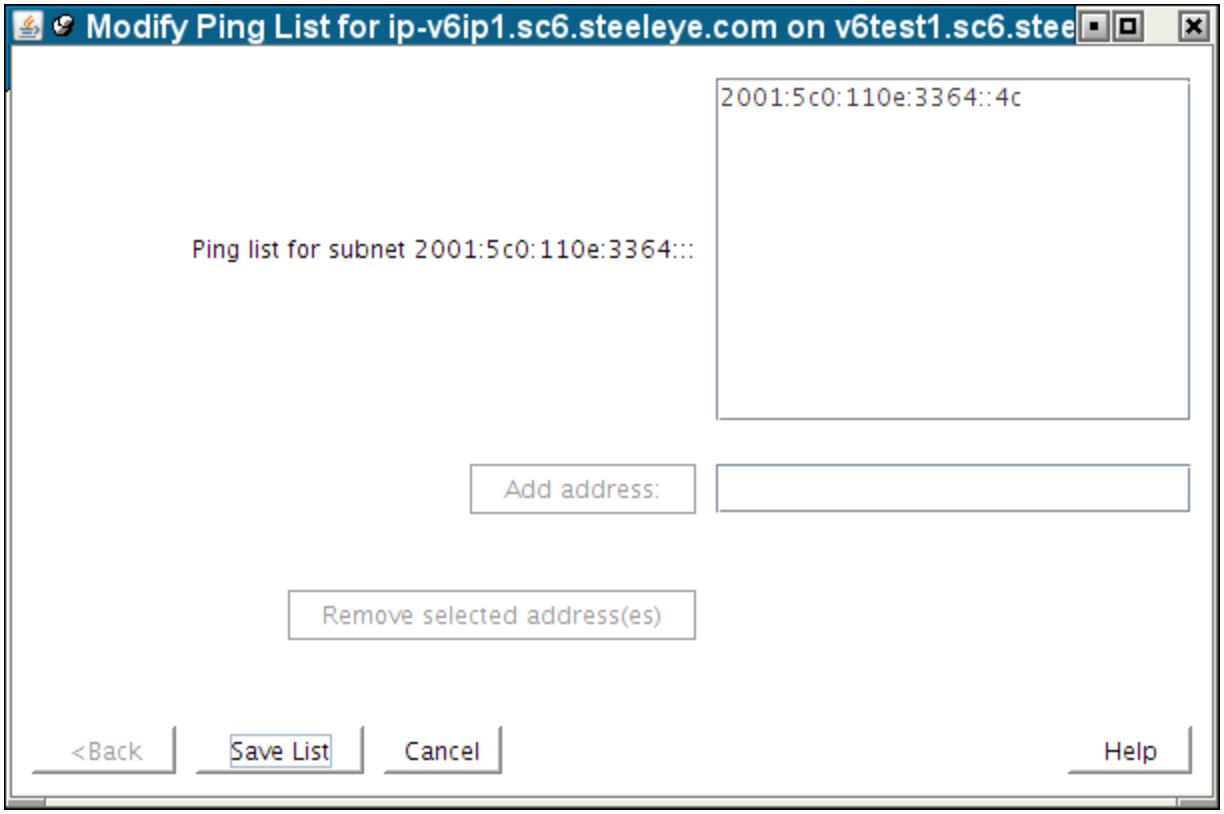


To remove one or more addresses from the Ping List, click to select the addresses to be removed and click the **Remove selected address(es)** button. The **Remove selected address(es)** button is also grayed out until at least one address in the list has been selected.

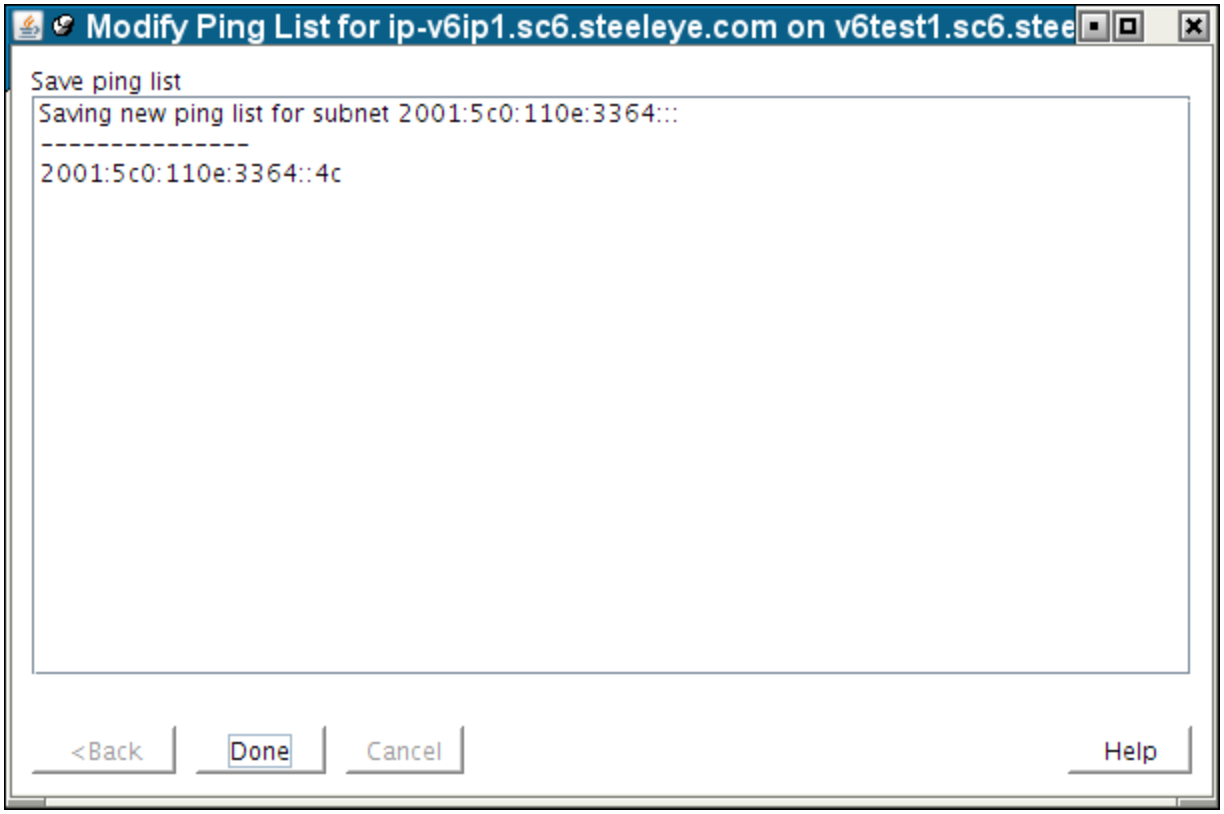




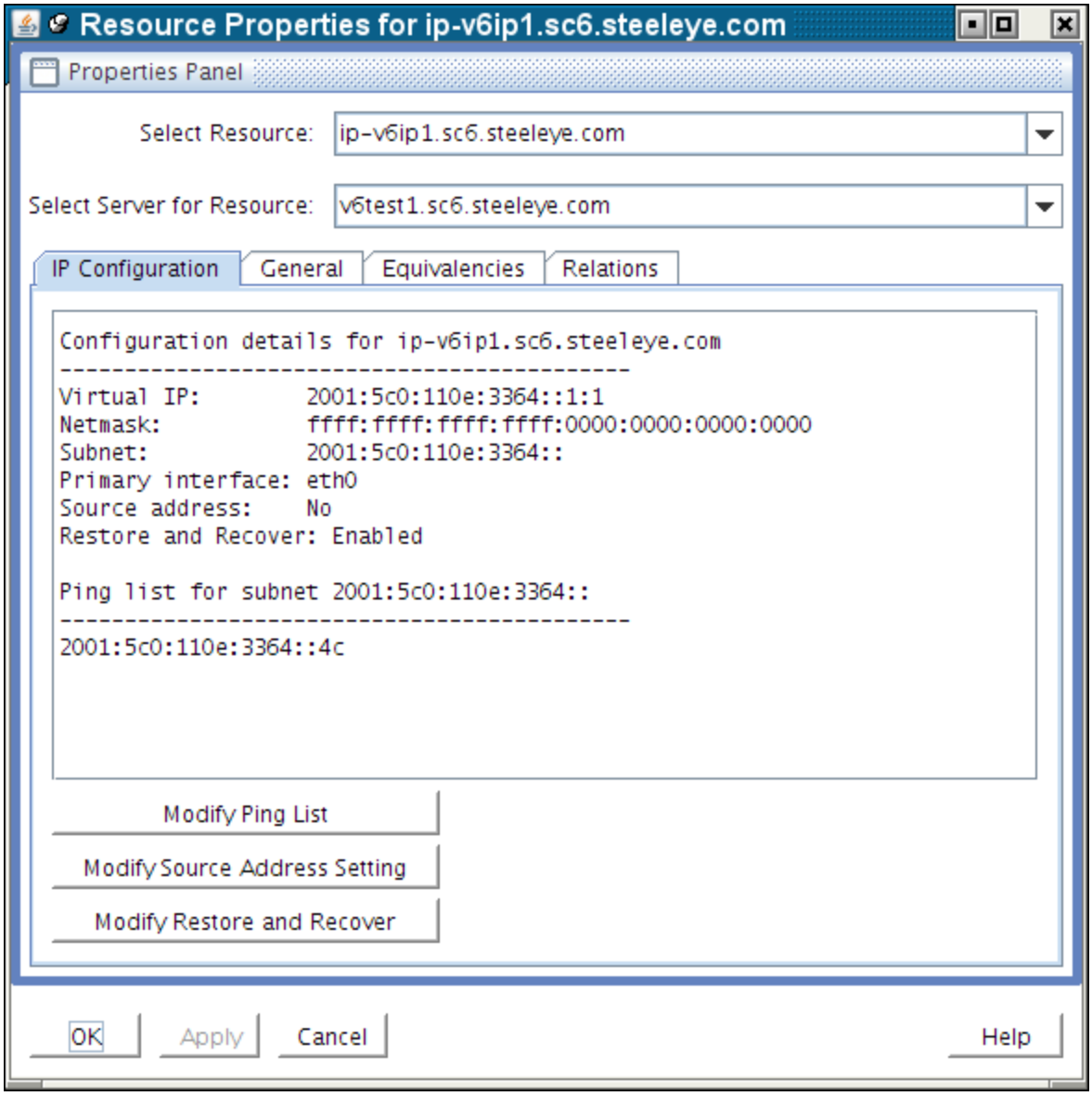
Click **OK** to confirm that you want to remove the indicated addresses.



To save the modified list, click **Save List**. This produces the following confirmation window.



Click **Done** to close the window, bringing you back to the **IP Configuration properties page**, where you can see the modified Ping List.



Important Notes About Using a Ping List

A *Ping List* for an IP resource is unique to the LifeKeeper system on which it is configured. If the IP resource is extended to another LifeKeeper system after the Ping List has been created, the Ping List will be copied to the other system as a part of the extension. However, if the IP resource has already been extended, the Ping List must be configured individually for each system on which the IP resource is defined. Ping List modifications can be made to an IP resource regardless of its state, so there is no need to perform switchovers of the IP resource in order to modify the Ping List on each system.

If there are multiple IP resources defined on the same logical subnet, all of those IP resources share a common Ping List. This is reflected in the IP Configuration properties page and the dialogs associated with modifying the Ping List, where the list is identified as being for the subnet associated with the IP resource.

Once a Ping List has been defined for an IP resource, all health checks for that resource will use the Ping List mechanism rather than the default broadcast ping mechanism. To revert back to the broadcast ping mechanism, you must delete the Ping List by removing all of the address entries in the list.

LifeKeeper performs no validation of the IP addresses entered into a Ping List, other than ensuring the validity of the formatting of the addresses. It is important that you ensure that the addresses you are entering actually exist on your network, can be pinged from the LifeKeeper systems, and are expected to be active at all times. You should not choose addresses that exist on the LifeKeeper systems themselves, because local pings to such addresses may be successful regardless of the actual status of the network interface on which the monitored IP resource is defined.

As mentioned above, the definition of a Ping List for an IP resource on a given system causes LifeKeeper to automatically use the Ping List mechanism rather than a broadcast ping for that resource and all other IP resources on the same subnet. It is not necessary to disable the broadcast ping mechanism using the NOBCASTPING setting described in the Adjusting IP Recovery Kit Tunable Values topic. However, if you have a configuration in which there are no systems available on the network to respond to a broadcast ping, you may have to use the NOBCASTPING=1 setting initially in order get the IP resource created, before you can then define a Ping List using the procedure described above. Once the Ping List has been created, you can revert back to the default NOBCASTPING=0 setting.

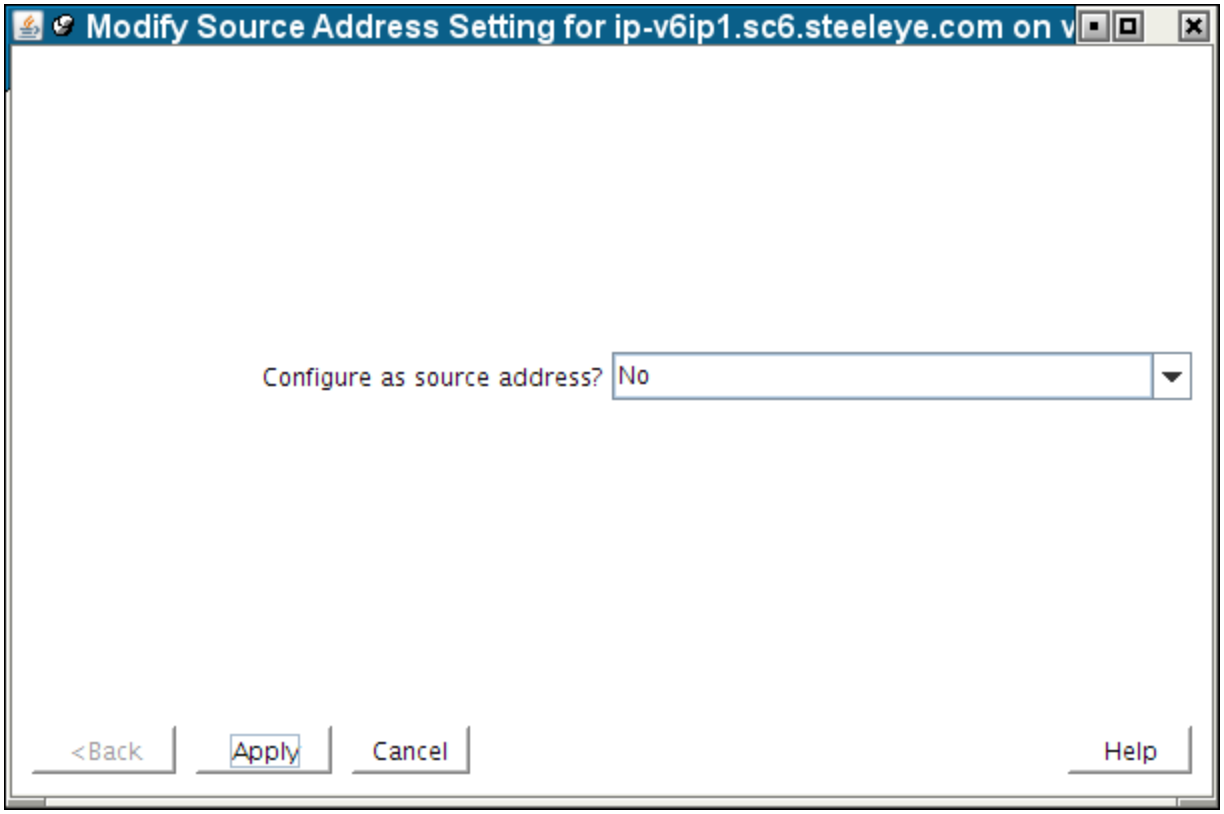
Modifying the Source Address Setting

The Source Address Setting for an IP resource determines whether the virtual IP address should be used as the source address for outgoing traffic onto the subnet associated with that IP resource, when the IP resource is in-service. This value defaults to No, which means that if the virtual IP address is on the same subnet as the primary IP address for the network interface, outgoing traffic onto the subnet will normally appear to be coming from that primary IP address. This is usually appropriate for most configurations, because the virtual IP address is generally used as an incoming connection point for clients, meaning that all connections in which the virtual IP address is used are initiated as incoming traffic.

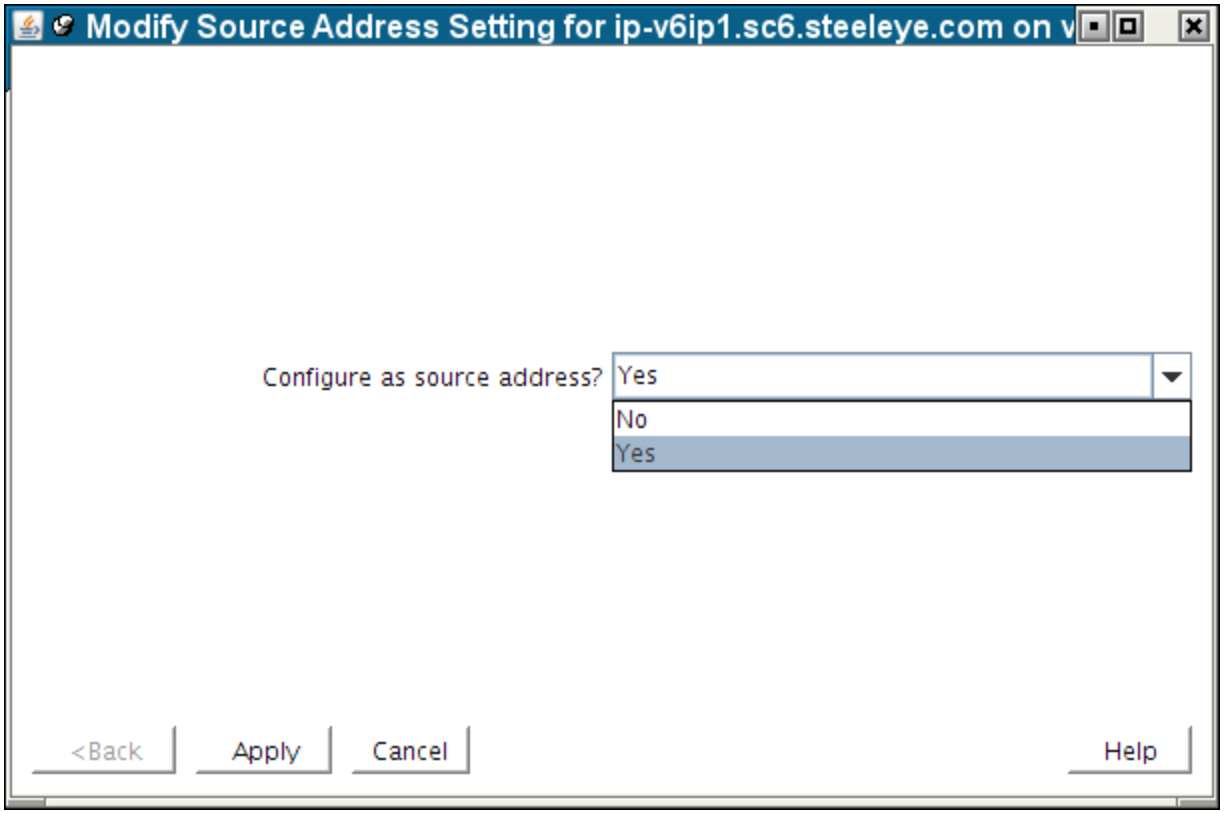
However, there may be situations or configurations in which it is important for connections initiated from the LifeKeeper system to appear to be coming from the virtual IP address. By changing the Source Address Setting for the IP resource to Yes, when the IP resource is brought in-service, the TCP/IP routes on the system are modified such that this will be the case.

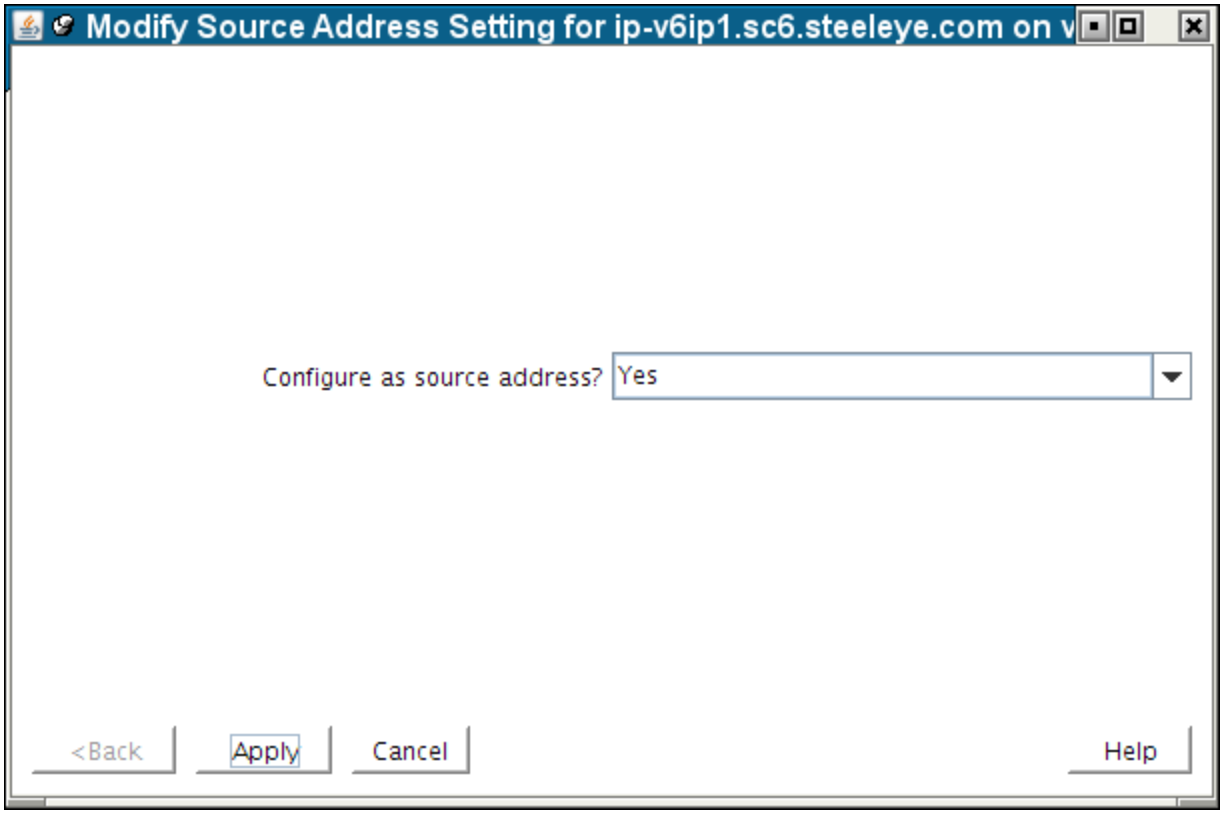
Note that if the virtual IP address is on its own distinct logical subnet from the permanent IP addresses on the system, all outgoing traffic onto that subnet will always come from the virtual IP address without any modifications to the Source Address Setting.

To modify the Source Address Setting for an IP resource, click the Modify Source Address Setting button on the IP Configuration properties page. This brings up a dialog window similar to the following example.



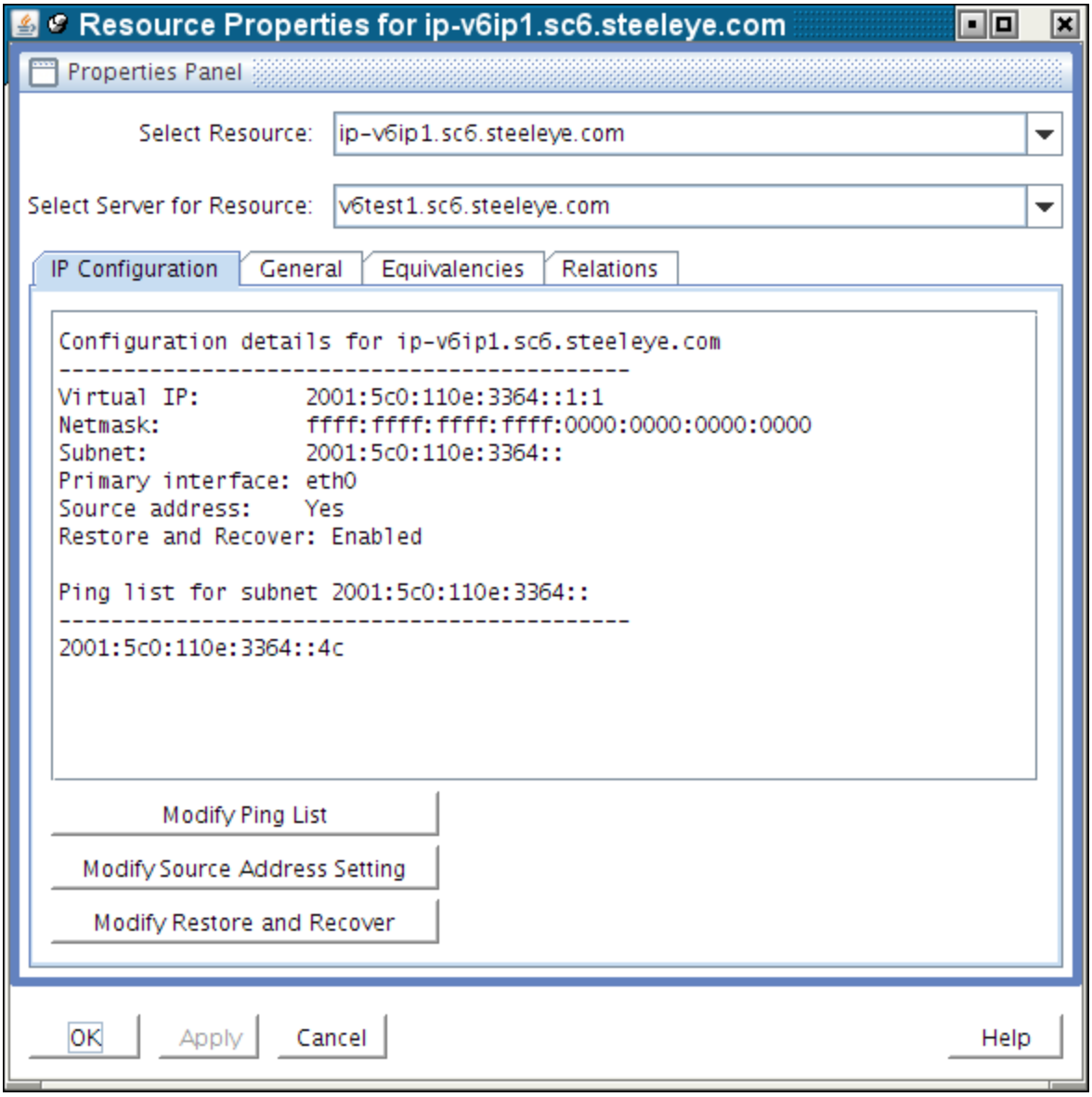
To change the setting, use the dropdown list to select the new value, either **Yes** or **No**.


Modify Source Address Setting for ip-v6ip1.sc6.steeleye.com on v
Configure as source address?
Yes
No
Yes
<Back
Apply
Cancel
Help



Click **Apply** to save the new setting. This produces the following confirmation window.

Clicking **Done** will close the window and take you back to the **IP Configuration properties page**, where you can see the modified setting.



Important Notes About the Source Address Setting

The **Source Address Setting** for an IP resource is unique to the LifeKeeper system on which it is configured. If the IP resource is extended to another LifeKeeper system after the **Source Address Setting** has been modified, the setting will be copied to the other system as a part of the extension. However, if the IP resource has already been extended, the **Source Address Setting** modification must be made individually for each system on which the IP resource is defined.

It only makes sense for at most one IP resource on a given subnet to have its Source Address Setting set to Yes, because only a single IP address can actually be the source address for outgoing traffic onto the subnet.

If there are multiple IP resources on the same subnet with a setting of Yes, the most recent resource to be brought in-service will override any others and become the source address for outgoing traffic onto the subnet.

The **Source Address Setting** only affects the local TCP/IP configuration when the IP resource is brought into service. So if the resource is already active when the setting is changed, the resource must be taken out-of-service and then back in-service before the change is reflected in the TCP/IP configuration.

The **Source Address Setting** only affects IPv4 addresses. This setting has no effect on an IPv6 address.

Modifying Restore and Recover

The **Restore and Recover setting** for an IP resource should be set to Disable in a Multi-Site Cluster environment where the disaster recovery system is on a different subnet.

This feature allows a user to choose to **Enable** or **Disable** the default restore and recovery behavior for an existing IP address resource. If configured with the **Enable** option, the IP address will be brought in-service as normal and the regular monitoring and recovery process will occur. The **Enable** option is the current default behavior for an IP address restore.

If the **Restore and Recover** option is set to **Disable**, the resource will come in-service, but the IP address will not be brought active on the network or network adapter. This setting allows hierarchies in a Multi-Site Cluster (or WAN) environment that depend on an IP to be brought in-service on the Disaster Recovery (DR) system where it may be difficult to configure the IP on the DR system due to the WAN configuration.

This setting can be selected after the resource is created and extended.

Important consideration for Active IP addresses (ISP): Setting the action to **Disable** on an ISP and active IP address does not take the active IP out of service.