HP Array Configuration Utility
User Guide

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About This Guide

This guide provides instructions for using the HP Array Configuration Utility.

Symbols in Text

These symbols may be found in the text of this guide. They have the following meanings.

⚠ **CAUTION:** Text set off in this manner indicates that failure to follow directions could result in damage to equipment or loss of information.

IMPORTANT: Text set off in this manner presents essential information to explain a concept or complete a task.

NOTE: Text set off in this manner presents additional information to emphasize or supplement important points of the main text.

Getting Help

If you have a problem and have exhausted the information in this guide, you can get further information and other help in the following locations.

Technical Support

In North America, call the HP Technical Support Phone Center at 1-800-652-6672. This service is available 24 hours a day, 7 days a week. For continuous quality improvement, calls may be recorded or monitored. Outside North America, call the nearest HP Technical Support Phone Center. Telephone numbers for worldwide Technical Support Centers are listed on the HP website, http://www.hp.com.

Be sure to have the following information available before you call HP:

- Technical support registration number (if applicable)

- Product serial number

- Product model name and number

- Applicable error messages

- Add-on boards or hardware

- Third-party hardware or software

- Operating system type and revision level

HP Website

The HP website has information on this product as well as the latest drivers and flash ROM images. You can access the HP website at http://www.hp.com.

Authorized Reseller

For the name of your nearest authorized reseller:

- In the United States, call 1-800-345-1518.

- In Canada, call 1-800-263-5868.

- Elsewhere, see the HP website for locations and telephone numbers.

Reader's Comments

HP welcomes your comments on this guide. Send your comments and suggestions to
`ServerDocumentation@hp.com`.

1

Getting Started

Features and System Requirements

The HP Array Configuration Utility (ACU) is a browser-based utility with the following features:

- Can be used online (that is, while the operating system is running)

- Has different operating modes, allowing faster configuration or greater control over the configuration options

- Suggests the optimum configuration for an unconfigured system

- Provides on-screen tips for individual steps of a configuration procedure

- Allows online array capacity expansion, logical drive capacity extension, assignment of online spares, and RAID or stripe size migration

The minimum display settings for optimum performance are 1024 x 768 pixels resolution and 256 colors. Refer to the README.TXT file for further information about browser and operating system support.

Installing ACU

Download the ACU Smart Component from the HP website or from the CD that is supplied with the controller, and then install the Smart Component onto the server.

If the server uses a supported Microsoft® Windows® operating system, you are prompted to select the ACU execution mode. The execution mode setting determines whether you can run ACU on this server from a remote network location. You can change the execution mode at any time by selecting **Setup hp Array Configuration Utility** from the **Start** menu.
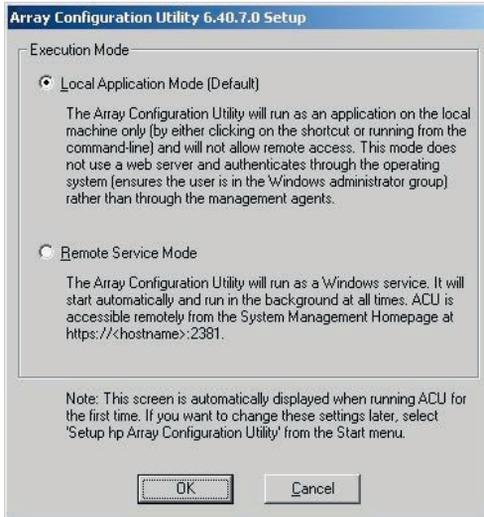
Figure 1-1: Execution mode setup screen

Table 1-1: Comparison of ACU Execution Mode Choices

Local Application Mode	Remote Service Mode
ACU is installed as an executable application.	ACU is installed as a service that starts when the server is powered up.
ACU runs only on the local system, and cannot be run remotely. A web browser is used to render the user interface, but no web server is required.	ACU can be run remotely from another server across a network.
Authentication is handled by the operating system, ensuring that the user is an administrator on the server running ACU.	Authentication is handled through the same mechanism used for Insight Manager agents.

Using ACU

The procedure for using ACU can be summarized as follows:

1. Open ACU.

   You can access ACU in three ways:

   — As a local application

   — As a remote service

   — Through Insight Manager

   Each method for opening ACU involves a different technique. Details of the required technique for each method are given after this summary.

2. Select the controller that you want to configure.

3. If you want to use a Wizard, select it from the panel in the lower right-hand corner of the screen.

4. Configure the controller.

5. Save the configuration changes.

6. Select another controller to configure, or exit ACU.

Opening ACU in Local Application Mode

1. Click **Start** and navigate to **Programs > Compaq System Tools > hp Array Configuration Utility.**

   The browser opens and launches ACU, which then identifies the controllers that are connected to the system. This process could take a minute or two.

2. When controller detection is complete, select a controller from the list on the left-hand side of the screen.

The main ACU configuration screen is displayed.

Figure 1-2: Main ACU configuration screen

Opening ACU in Remote Service Mode

1. Open the browser on the remote server.

2. Enter the following text into the browser address field (where *servername* is the name or IP address of the host):

   http://*servername*:2301

   The **System Management Home Page** opens.

3. Click **Array Configuration Utility** on the left-hand side of the screen.

   ACU opens, and identifies the controllers that are connected to the system. This process could take a minute or two.

4. When controller detection is complete, select a controller from the list on the left-hand side of the screen.

   The main ACU configuration screen (Figure 1-2) is displayed.

Opening ACU through Insight Manager

1. On the server that has ACU loaded, confirm that the utility is running in remote service mode.

2. On the remote server, connect to the Insight Manager server (port :280) and log in.

Getting Started

3. Select **Device Queries.**

4. Under **Device by Type,** select **All Servers.**

5. Connect to the server that is running ACU.

6. Under **Device Links,** select the **System Management Home Page.**

7. Click **Array Configuration Utility** on the left-hand side of the screen.

   ACU opens, and identifies the controllers that are connected to the system. This process could take a minute or two.

8. When controller detection is complete, select a controller from the list on the left-hand side of the screen.
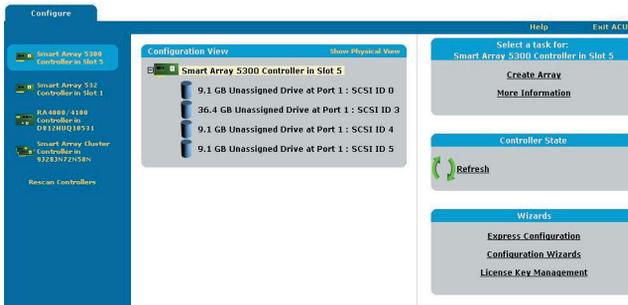
   The main ACU configuration screen (Figure 1-2) is displayed.

Screen Layout

The appearance of a typical ACU screen after this point depends on which of the three possible configuration modes you choose.

- **Standard** mode is the default setting. This mode lets you manually configure all options on the controller.

- **Configuration Wizards** mode guides you through each step of a manual configuration process.

- **Express Configuration** mode allows ACU to automatically configure the controller after you have answered a few simple questions. ACU uses your answers to the questions to determine the optimum default values that it should use for certain configuration options.

Typical Standard Mode Screen

This is the default configuration mode for ACU. All the configuration options for a selected item in the **Configuration View** window are displayed in a frame on the right-hand side of the screen.
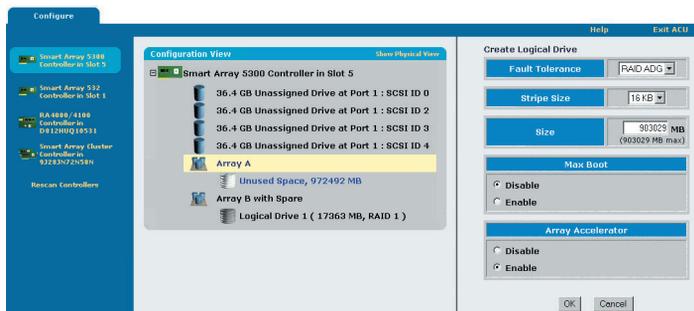
Figure 1-3: Typical standard mode screen

Typical Configuration Wizards Mode Screen
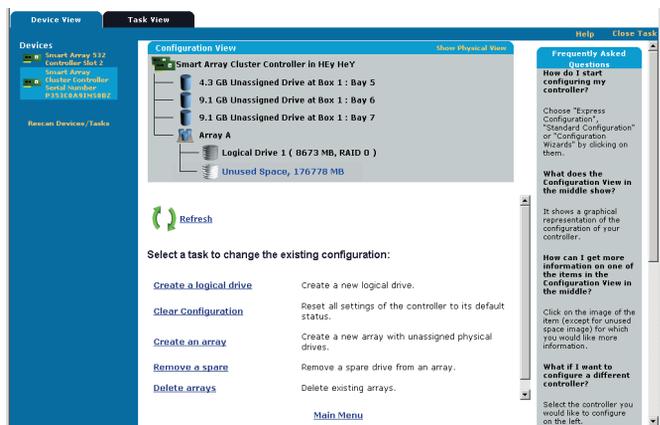
Figure 1-4: Typical wizard mode screen

The Wizard mode screen consists of four regions: the **Devices** list, the **Configuration View** window, the **Main Menu,** and the **FAQ Column.**

- The **Devices** list on the left-hand side of the screen shows all the identifiable controllers that are connected to the system.

- The gray **Configuration View** window in the upper central portion of the screen shows all arrays, logical drives, unused space, and unassigned physical drives that are connected to the selected controller. The logical configuration view is shown by default.

  — To view the physical configuration, click **Show Physical View** in the upper right-hand corner of the window.

  — To get further information about any item in this window, click the icon for the item. A pop-up window is displayed (refer to Figure 1-5 for an example).

Figure 1-5: Typical More Information pop-up window

- The **Main Menu** in the lower central portion of the screen shows the allowable options at this stage.

- The **FAQ Column** on the right-hand side of the screen lists information and tips that are relevant to the current screen. Check this region before clicking **Help** in the upper right-hand corner of the browser screen.

Typical Express Configuration Mode Screen

NOTE: Express mode is listed as a configuration option only if the controller that you select has unused space on an array or physical drives that are not assigned to an array.

Express Configuration mode screens are similar in appearance to Configuration Wizards mode screens, but the directive text is different. In Express Configuration mode, ACU asks you a few simple questions about your configuration preferences and then automatically sets up the optimum configuration based on your answers.

Completing the Configuration Process

Details of the subsequent steps in the configuration process are given in the remainder of this guide.

- If the controller is not configured (it has no arrays or logical drives, only unassigned physical drives), refer to Chapter 2, "Configuring a New Controller."

- If the controller is already configured but you want to reconfigure it, refer to Chapter 3, "Modifying an Existing Configuration."

2

Configuring a New Controller

Open ACU as described in Chapter 1 and select a controller.

NOTE: If you select a controller that is already configured, you will see arrays and logical drives in the **Configuration View** window in addition to any unassigned physical drives that may be present. The configuration procedure in this case is slightly more complex, and is described in the next chapter, "Modifying an Existing Configuration."

ACU now opens the controller-specific configuration screen. By default, this screen is presented in Standard configuration mode. If you want to use a different configuration mode, select a wizard from the lower right-hand panel of the main ACU configuration screen (Figure 1-2). The procedure for using each mode is described in this chapter.

Using Standard Configuration Mode

1. Click an item in the **Configuration View** window. The screen displays a list of the tasks that are available for that item.
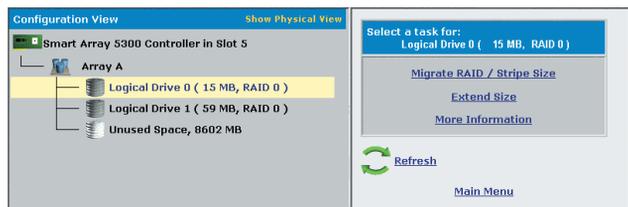
Figure 2-1: Typical task list for a logical drive

The listed (available) tasks are a subset of the total number of tasks that are possible for the selected item. Which of the possible tasks are listed for an item and which are omitted depends on the controller model and configuration. (For example, if the selected controller has no unassigned physical drives, **Create Array** is not an available task.) Table 2-1 lists all the possible tasks for every type of item.

Table 2-1: Possible Tasks in Standard Configuration Mode

Item	Tasks*
Controller	Clear Configuration
	Controller Settings
	Create Array
	Logical Drive Array Accelerator Settings
	Selective Storage Presentation (for MSA1000 and Smart Array Cluster Storage controllers)
	More Information
Array	Assign Spare
	Create Logical Drive
	Delete
	Expand
	Remove Spare
	More Information
Logical drive	Delete
	Extend Size
	Migrate RAID / Stripe Size
	Selective Storage Presentation (for RA4x00 controllers)
	More Information
Unused space	(No tasks are associated with this item)

*The **More Information** task is present for all items except unused space. When you click this task link, a pop-up window is displayed with additional information about the selected item.

2. Click a task link. A list of all possible configuration options for that task is displayed on the right-hand side of the screen (replacing the task list). See the "Description of Screen Regions" section in Chapter 1 ("Getting Started") for an example of this type of screen.

3. Set the configuration options the way that you want them to be.

4. Click **OK.**

Using Express Configuration Mode

1. Click **Express Configuration** in the lower right-hand panel of the main ACU configuration screen (Figure 1-2). The Express mode start screen is displayed.
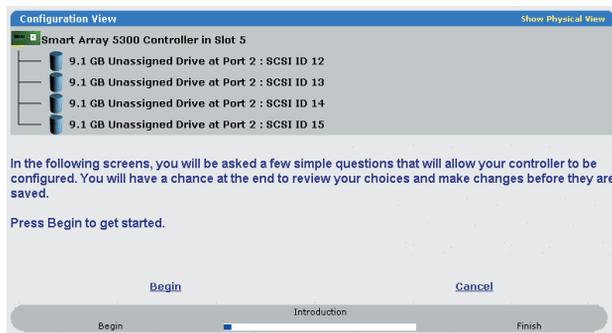
Figure 2-2: Express mode start screen

2. Click **Begin.**

   ACU creates the optimum number of arrays and logical drives from all of the physical drives that are attached to the controller. This process takes a few moments; when it is finished, the screen is updated. The gray **Configuration View** window shows the new configuration, and underneath this window is a list of possible fault tolerance levels for the first logical drive.
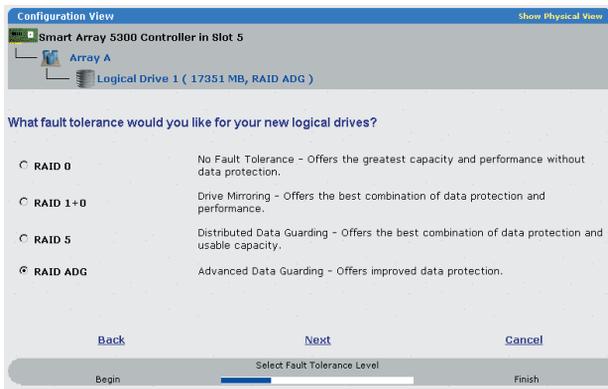
Figure 2-3: Choosing a RAID level

3. Select a RAID level, and then click **Next.**

   If you select a fault-tolerant RAID method, and an unassigned physical drive of the appropriate capacity is available, ACU asks if you want to assign a spare drive. Select a drive to be the spare, and then click **Next.**

   The screen displays the selected configuration and asks you to confirm that it is acceptable.

   — If you discard the suggested configuration, you are returned to the configuration mode selection screen so that you can manually configure the new array.

   — If you accept the suggested configuration, a screen is displayed confirming that ACU has saved the new configuration. At this point, you can refine the configuration using one of the other modes, configure another controller, or exit ACU.

4. Select the appropriate radio button.

5. Click **Finish.**

Using the Configuration Wizards

First create at least one array, and then populate the array with logical drives.

Creating an Array

1. Click **Configuration Wizards** in the lower right-hand panel of the main ACU configuration screen (Figure 1-2).

2. Click **Create an array,** and then click **Begin.**

   The physical drive selection screen is displayed. (If there are many physical drives connected to the controller, use the scrollbars in the **Configuration View** region to see all the physical drives and arrays.) A placeholder for the array that you are about to create is already present on the screen.

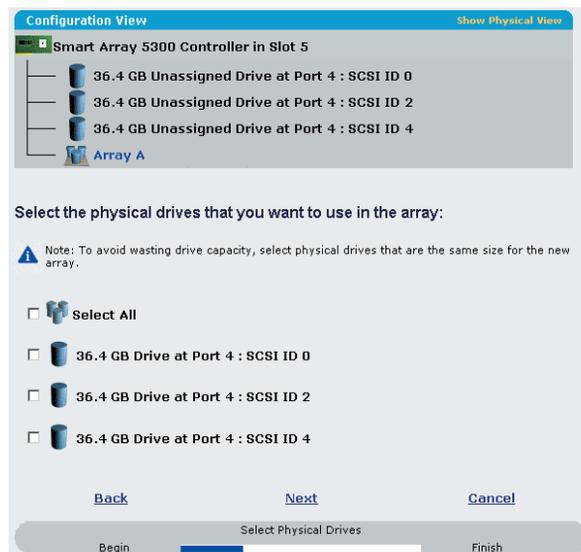**Figure 2-4: Physical drive selection screen**

3. Select the physical drives that you want to use in the array.

   — Use physical drives of comparable capacity.

      ACU uses the same amount of space from each physical drive to build an array. Because this amount cannot exceed the capacity of the smallest physical drive, the extra capacity of any larger drive in the array is unusable.

   — For better system performance, use physical drives that are connected to different ports on the controller.

   — In RAID 5 configurations, keep the risk of logical drive failure low by assigning no more than 14 physical drives to the array.

   Each time that you add a physical drive to the array, the configuration view is updated to show how much free space remains on the array.

4. Click **Next** when you have finished adding physical drives to the array.

5. If an unassigned physical drive of the appropriate capacity is available, ACU asks you whether you want to assign spare drives to the array.

   — If you do not want this array to have a spare, click **No,** and then click **Next.**

   — To assign spare drives to the array, click **Yes,** and then click **Next.** On the next screen, select the drives that you want to be the spares, and then click **Next.**

   IMPORTANT: Assigning several spare drives to an array lets you postpone replacement of faulty drives, but it does **not** increase the fault-tolerance level of any logical drives in the array. For example, a logical drive in a RAID 5 configuration suffers irretrievable data loss if two physical drives fail simultaneously, regardless of the number of spare drives assigned to it.

6. Click **Finish** to confirm the configuration.
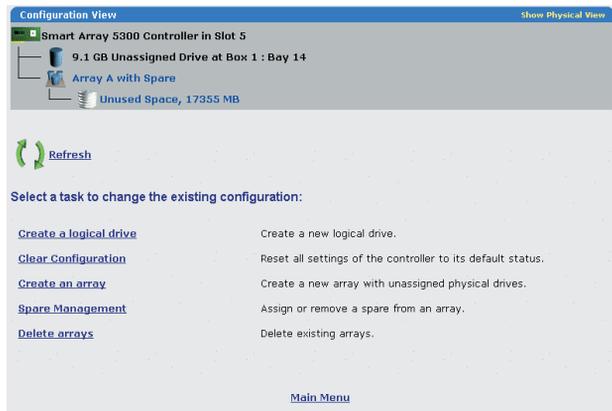
Figure 2-5: Configured array screen (no logical drives)

To create more arrays on the same controller, repeat the previous steps.

Creating a Logical Drive

1. Click **Create a logical drive,** and then click **Begin.**

2. Select an array that has unused space, and then click **Next.** (A logical drive can only be configured on an array that has unused drive space available.)

3. Select the fault tolerance level that you want the logical drive to use, and then click **Next.**

    Only RAID levels that are possible for this configuration are listed. For example, RAID 5 is not listed if the array has only two physical drives.

4. Select the stripe size, and then click **Next.**

    The default stripe size gives optimum performance in a mixed read/write environment. If your system is used in a different environment, refer to the following table to determine what stripe size to set.

Table 2-2: Optimum Stripe Size

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value
Mainly sequential read (such as audio/video applications)	Use larger stripe sizes
Mainly write (such as image manipulation applications)	Use smaller stripe sizes for RAID 5, RAID ADG*
	Use larger stripe sizes for RAID 0, RAID 1+0
*Not all controllers support RAID ADG.	

5. Decide whether to use MaxBoot, and then click **Next.**

   When MaxBoot is selected, 63 sectors are used per track instead of 32. This increase allows a larger boot partition for operating systems such as Microsoft® Windows NT® 4.0 that use cylinders, heads, and sectors of a physical drive to determine the drive size. It also lets you create a larger logical drive, or increase the logical drive size (extend it) at a later time.

   Logical drive performance is likely to decrease with MaxBoot enabled.

6. Set the size that you want the logical drive to be, and then click **Next.**

   The default size shown is the largest possible logical drive size for the RAID level that you chose and the set of physical drives that is being used. Reducing the size of the logical drive liberates drive space, which you can use to build additional logical drives on the same array.

7. If the controller has an array accelerator, a screen is now displayed that lets you disable it for the currently selected logical drive. After you have selected the desired option, click **Next.**

   NOTE: Disabling the array accelerator for a logical drive reserves use of the accelerator cache for other logical drives on the array. This feature is useful if the other logical drives need to have the maximum possible performance (for example, if the logical drives contain database information).

   The gray **Configuration View** window shows the configuration that you have chosen.

8. Check that the configuration is acceptable, and then click **Finish.**
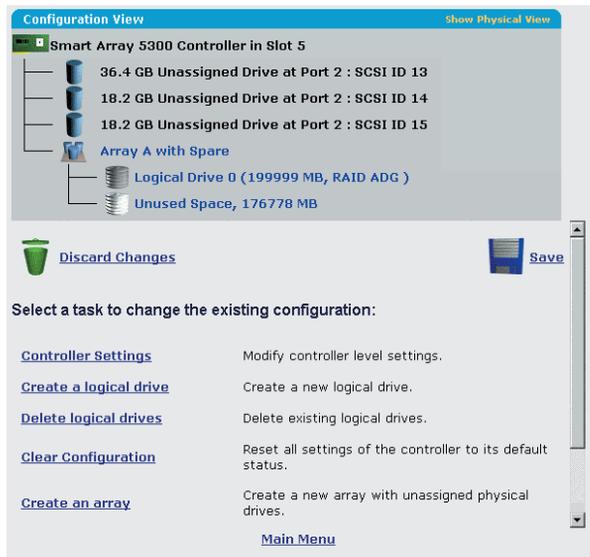

Figure 2-6: New logical drive before saving

9. Click the **Save** icon to commit the changes to the controller, and then click **OK** on the confirmation alert. (If you discard the changes, all changes since the previous save are lost.)

To change the array configuration, refer to Chapter 3, "Modifying an Existing Configuration."

3

Modifying an Existing Configuration

Open ACU as described in Chapter 1 and select a controller. You can now select a configuration mode from the lower right-hand panel if you want to use a wizard, or you can continue in Standard mode. If you select an MSA1000 controller, another link in this panel allows you to configure switches.

Using Standard Configuration Mode

1. Click an item in the **Configuration View** window. The right-hand side of the screen displays a list of the tasks that are available for that item.
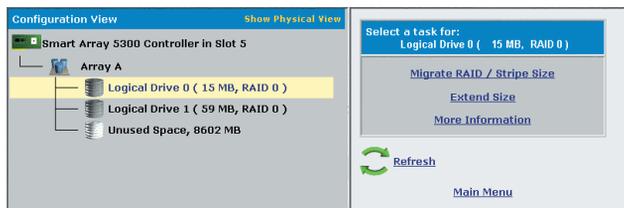
Figure 3-1: Typical task list for a logical drive

The listed (available) tasks are a subset of the total number of tasks that are possible for the selected item. Which of the possible tasks are listed for an item and which are omitted depends on the controller model and configuration. (For example, if the selected controller has no unassigned physical drives, **Create Array** is not an available task.) Table 3-1 lists all the possible tasks for every type of item.

Table 3-1: Possible Tasks in Standard Configuration Mode

Item	Tasks*
Controller	Clear Configuration
	Controller Settings
	Create Array
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	Selective Storage Presentation (for MSA1000 and Smart Array Cluster Storage controllers)
	More Information
Array	Assign Spare
	Create Logical Drive
	Delete
	Expand
	Remove Spare
	More Information
Logical drive	Delete
	Extend Size
	Migrate RAID / Stripe Size
	Selective Storage Presentation (for RA4x00 controllers)
	More Information
Unused space	(No tasks are associated with this item.)

*The **More Information** task is present for all items except unused space. When you click this task link, a pop-up window is displayed with additional information about the selected item.

2. Click a task link. A list of all possible configuration options for that task is displayed on the right-hand side of the screen (replacing the task list). Refer to the "Description of Screen Regions" section in Chapter 1, "Getting Started," for an example of this type of screen.

3. Set the configuration options as you want them to be.

4. Click **OK.**

Using Express Configuration Mode

NOTE: Express mode is listed as a configuration option only if the controller that you select has unused space on an array or physical drives that are not assigned to an array.

1. Click **Express Configuration,** and then click **Begin.**

   If there are unassigned physical drives on the controller, you can create a new array or expand an existing array. Make your choice, and then click **Next.**

   IMPORTANT: The expansion process takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While array expansion is occurring, no other expansion, extension, or migration can occur simultaneously on the same controller.

   The screen displays the optimum configuration for the controller and asks you to confirm that it is acceptable.

2. Select the appropriate radio button, and then click **Finish.**

Using the Configuration Wizards

The options listed in the menu region of the screen depend on the controller model and configuration. For example, the **Expand array** option is listed only if there is at least one unassigned physical drive connected to the controller.

The possible menu options are:

- Clear Configuration

- Controller Settings

- Create an array

- Create a logical drive

- Delete arrays

- Delete logical drives

- Expand array

- Extend logical drive

- Migrate a logical drive

- Spare Management

- Selective Storage Presentation

Clear Configuration

This task deletes all logical drives connected to the controller, reconfigures the arrays into independent (unassigned) physical drives, and resets all controller settings to their default values.

1. Click **Clear Configuration,** and then click **Begin.**

   A warning screen is displayed to remind you that you will lose all data on the logical drive.

2. Click **Delete** to continue.

3. Click **Finish** to accept the changes.

4. Click **Save** to apply the changes to the system, and then click **OK** on the confirmation alert.

The physical drives are now available for reconfiguration.

Controller Settings

The default controller settings provided by ACU are adequate for many purposes. However, this task lets you alter the priority settings for array expansion and rebuild. You can also disable the array accelerator (if one is present) or change the ratio of read cache to write cache (if the controller has battery-backed cache).

To change the controller settings:

1. Click **Controller Settings,** and then click **Begin.**

The next two screens let you change the expand priority and the rebuild priority settings. These settings determine how much importance you want an array expansion or rebuild to have relative to normal I/O operations.

— With **low** priority, the expansion or rebuild takes place only when the array controller is not busy handling normal I/O requests. This setting has minimal effect on normal I/O operations. However, there is an increased risk that data will be lost if another physical drive fails while the rebuild or expansion is in progress.

— With **high** priority, the rebuild or expansion occurs at the expense of normal I/O operations. Although system performance is affected, this setting provides better data protection because the array is vulnerable to additional drive failures for a shorter time.

— At the **medium** priority setting, expansion or rebuild occurs for half of the time, and normal I/O requests are handled during the rest of the time.

2. Set the expand priority to high, medium, or low, and then click **Next.**

3. Set the rebuild priority, and then click **Next.**

4. If the controller has an array accelerator, a screen is now displayed that lets you disable it for particular logical drives. Select whether to disable the array accelerator for any logical drives, and then click **Next.**

   NOTE: Disabling the array accelerator for a particular logical drive reserves use of the accelerator cache for other logical drives on the array. This feature is useful if the other logical drives need to have the maximum possible performance (for example, if the logical drives contain database information).

5. If the controller has a battery-backed cache, a screen is now displayed that lets you change the read/write cache ratio. Select the ratio that you want the controller to use, and then click **Next.**

   NOTE: This ratio determines the amount of memory allocated to read and write operations. Different types of applications have different optimum ratios. You can change the ratio only if the controller has a battery-backed cache (only battery-backed cache can be used for write cache) and if there are logical drives configured on the controller.

6. Click **Finish** to accept the changes.

7. Click **Save** to apply the changes to the system, and then click **OK** on the confirmation alert.

Create an Array

1. Click **Create an array,** and then click **Begin.**

2. Select the physical drives that you want to use in the array.

   — Use physical drives of comparable capacity.

      ACU uses the same amount of space from each physical drive to build an array. Because this amount cannot exceed the capacity of the smallest physical drive, the extra capacity of any larger drive in the array is unusable.

   — For better system performance, use physical drives that are attached to different ports on the controller.

   — In RAID 5 configurations, keep the risk of logical drive failure low by assigning no more than 14 physical drives to the array.

   Each time that you add a physical drive to the array, the configuration view is updated to show how much free space remains on the array.

3. Click **Next** when you have finished adding physical drives to the array.

   If a spare or unassigned physical drive of the appropriate capacity is available, ACU asks you whether you want to assign a spare drive to the array.

   — If you do not want this array to have a spare, click **No,** and then click **Next.**

   — To assign spare drives to the array, click **Yes,** and then click **Next.** On the next screen, select the drives that you want to assign as spares, and then click **Next.**

   IMPORTANT: Assigning several spare drives to an array lets you postpone replacement of faulty drives, but it does **not** increase the fault-tolerance level of any logical drives in the array. For example, a logical drive in a RAID 5 configuration suffers irretrievable data loss if two physical drives fail simultaneously, regardless of the number of spare drives assigned to it.

   NOTE: A spare can be shared by several arrays.

4. Click through the remaining screens to confirm the configuration.

Create a Logical Drive

1. Click **Create a logical drive,** and then click **Begin.**

2. Select an array that has unused space, and then click **Next.**

3. Select the fault-tolerance level that you want the logical drive to use, and then click **Next.**

   Only RAID levels that are possible for this configuration are listed. For example, RAID 5 is not listed if the array has only two physical drives.

4. Select the stripe size, and then click **Next.**

   The default stripe size gives optimum performance in a mixed read/write environment. If your system is used in a different environment, refer to the following table to determine what stripe size to set.

Table 3-2: Optimum Stripe Size

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value
Mainly sequential read (such as audio/video applications)	Use larger stripe sizes for best performance
Mainly write (such as image manipulation applications)	Use smaller stripe sizes for RAID 5, RAID ADG*
	Use larger stripe sizes for RAID 0, RAID 1+0
*Not all controllers support RAID ADG.	

5. Decide whether to use MaxBoot, and then click **Next.**

   When MaxBoot is selected, 63 sectors are used per track instead of 32. This increase allows a larger boot partition for operating systems such as Microsoft® Windows NT® 4.0 that use cylinders, heads, and sectors of a physical drive to determine the drive size. It also lets you create a larger logical drive, or increase the logical drive size (extend it) at some later time.

   Logical drive performance is likely to decrease with MaxBoot enabled.

6. Set the size that you want the logical drive to be, and then click **Next.**

The default size shown is the largest possible logical drive size for the RAID level that you chose and the set of physical drives that is being used. Reducing the size of the logical drive liberates drive space, which you can then use to build additional logical drives on the same array.

7. If the controller has an array accelerator, a screen is now displayed that lets you disable it for the currently selected logical drive. Make your choice, and then click **Next.**

   NOTE: Disabling the array accelerator for a logical drive reserves use of the accelerator cache for other logical drives on the array. This feature is useful if the other logical drives need to have the maximum possible performance (for example, if the logical drives contain database information).

   The gray **Configuration View** window shows the configuration that you have chosen.

8. Check that the configuration is acceptable, and then click **Finish.**

9. Click the **Save** icon to commit the changes to the controller, and then click **OK** on the confirmation alert. (If you discard the changes, all changes since the previous save are lost.)

Delete Arrays

This task deletes logical drives on an array and converts the array into a group of unassigned physical drives. You can then reconfigure the unassigned physical drives into one or more new arrays, or you can use the liberated physical drive space for expansion of another array on the same controller.

1. Click **Delete arrays,** and then click **Begin.**

2. Select the arrays that you want to delete, and then click **Next.** A warning screen is displayed to remind you that you will lose all data on the array.

3. Click **Delete** to continue, and then click **Finish** to accept the changes.

4. Click **Save** to apply the changes to the system, and then click **OK** on the confirmation alert.

Delete Logical Drives

This task deletes the selected logical drive and converts it into unused drive space. You can then use this unused drive space to:

- Create new logical drives.

- Migrate the RAID level or stripe size of an existing logical drive.

- Extend an existing logical drive on the same array, if the operating system allows logical drive extension.

To delete a logical drive:

1. Click **Delete logical drives,** and then click **Begin.**

2. Select the logical drives that you want to delete, and then click **Next.** A warning screen is displayed to remind you that you will lose all data on the logical drive.

3. Click **Delete** to continue, and then click **Finish** to accept the changes.

4. Click **Save** to apply the changes to the system, and then click **OK** on the confirmation alert.

Expand Array

NOTE: Expand array is listed only if there is an unassigned physical drive on the controller. The unassigned drive must also have a capacity no less than that of a drive in an existing array. If these conditions are not fulfilled, install at least one suitable physical drive on the controller, and then click **Refresh.**

This task increases the storage capacity of an existing array. You can use the additional storage space to:

- Create new logical drives.

- Migrate the RAID level or stripe size of existing logical drives.

- Extend existing logical drives on the array, if the operating system allows logical drive extension.

IMPORTANT: The expansion process takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While array expansion is taking place, no other expansion, extension, or migration can occur simultaneously on the same controller.

1. Click **Controller Settings** and check that the expand priority setting is acceptable.

2. Back up all data on the array. Although array expansion is unlikely to cause data loss, observing this precaution provides additional data protection.

3. Click **Expand array,** and then click **Begin.**

4. Choose the array that you want to expand, and then click **Next.**

5. Select the physical drives that you want to add to the array, and then click **Next.**

6. Click **Finish** to accept the changes.

   At this point (before clicking **Save** in the next step), you can create logical drives on the unused space created by the expansion. You can also arrange to expand another array on the same controller by repeating the previous steps. However, the controller can expand only one array at a time; remaining array expansions are queued.

7. Click **Save.**

   The controller now rearranges (re-stripes) the existing logical drives and their data so that they extend over all the physical drives in the enlarged array.

To check the progress of an array expansion, click the icon for that array in the **Configuration View** window. A **More Information** pop-up window is displayed that describes the drive status.

Extend Logical Drive

This option increases the storage capacity of a logical drive by adding unused space on an array to a logical drive on the same array. The unused space is obtained either by array expansion (refer to the "Expand Array" section in this chapter), or by deleting another logical drive on the same array.

Not all operating systems support online logical drive extension through ACU. Also, **offline** logical drive extension is possible for some operating systems by backing up data, reconfiguring the array, and restoring data from backup. Check the operating system documentation for current information.

IMPORTANT: The extension process takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While logical drive extension is taking place, no other expansion, extension, or migration can occur simultaneously on the same controller.

1. Back up all data on the logical drive. Although logical drive extension is unlikely to cause data loss, observing this precaution provides additional data protection.

2. Click **Extend logical drive,** and then click **Begin.**

3. Select the logical drive that you want to extend, and then click **Next.**

4. Type the new size of the logical drive into the size field.

5. Click **Finish.**

   At this point (before clicking **Save** in the next step), you can arrange to extend another logical drive on the same controller by repeating the previous steps. However, the controller can extend only one logical drive at a time; remaining extensions are queued.

6. Click **Save.** Logical drive extension begins.

To check the progress of a logical drive extension, click the icon for that logical drive in the **Configuration View** window. A **More Information** pop-up window is displayed that describes the drive status.

Migrate a Logical Drive

This option lets you alter the stripe size (data block size) or RAID level, or both, for a selected logical drive. There might need to be unused drive space available on the array for the migration to be possible, depending on the initial and final settings for the stripe size and RAID level.

IMPORTANT: The migration process takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While migration is taking place, no other expansion, extension, or migration can occur simultaneously on the same controller.

1. Back up all data on the logical drive. Although migration is unlikely to cause data loss, observing this precaution provides additional data protection.

2. Click **Migrate a logical drive,** and then click **Begin.**

3. Select the logical drive, and then click **Next.**

4. Select the new RAID level, and then click **Next.**

   Only RAID levels that are possible for this configuration are shown. For example, RAID 5 is not listed if the array has only two physical drives.

5. Select the stripe size, and then click **Finish** to accept the changes. (Only stripe sizes that are possible for this configuration are shown.)

   At this point (before clicking **Save** in the next step), you can arrange to migrate another logical drive on the same controller by repeating the previous steps. However, the controller can migrate only one logical drive at a time; remaining migrations are queued.

6. Click **Save.** Migration begins.

To check the progress of a migration, click the icon for that logical drive in the **Configuration View** window. A **More Information** pop-up window is displayed that describes the drive status.

Spare Management

NOTE: An array can have several spares, and any spare can be shared by several arrays.

1. Click **Spare Management,** and then click **Begin.**

2. Select the array that needs to have spare drives added or removed.

3. Select the drives that you want to assign as spares, and deselect the appropriate checkboxes for spares that you want to remove.

   IMPORTANT: Assigning several spares to an array lets you postpone replacement of faulty drives, but it does **not** increase the fault-tolerance level of any logical drives in the array. For example, a logical drive in a RAID 5 configuration suffers irretrievable data loss if two physical drives fail simultaneously, regardless of the number of spare drives assigned to it.

4. Click **Next.**

5. Click **Finish** to accept the changes.

6. Click **Save,** and then click **OK** on the confirmation alert.

Selective Storage Presentation (SSP)

This menu option is only available for MSA1000, RA4x00, and Smart Array Cluster Storage controllers. It lets you determine which host controllers can access which particular logical drives. This feature prevents data corruption that may occur when different servers using different operating systems access the same data.

RA4x00 Controllers

1. Click **Selective Storage Presentation,** and then click **Begin.**

2. Select the logical drive for which you want to change the access settings, and then click **Next.**

   A screen is displayed that lets you enable or disable SSP.

   — Disabling SSP lets all host controllers gain access to the logical drive.

   — Enabling SSP lets you select the hosts that are to have access to the logical drive.

3. Select the appropriate radio button, and then click **Next.**

   If you select **Enable,** the screen lists all identified host controllers. Select the host controllers that are to have access to the logical drive, rename the connections if necessary, and then click **Next.**

Figure 3-2: Typical SSP screen for the RA4x00

4.   Click **Finish.**

MSA1000 and Smart Array Cluster Storage Controllers

1.   Click **Selective Storage Presentation,** and then click **Begin.**

     A screen is displayed that lets you enable or disable SSP.

     — Disabling SSP lets all host controllers gain access to all logical drives.

     — Enabling SSP lets you decide which hosts are to have access to which logical
        drives.

2.   Select the appropriate radio button, and then click **Next.**

     If you select **Enable,** the screen lists all identified host controllers. Select the host
     controllers that need to have access to each logical drive, define the host mode
     for each controller, rename the connections if necessary, and then click **Next.**
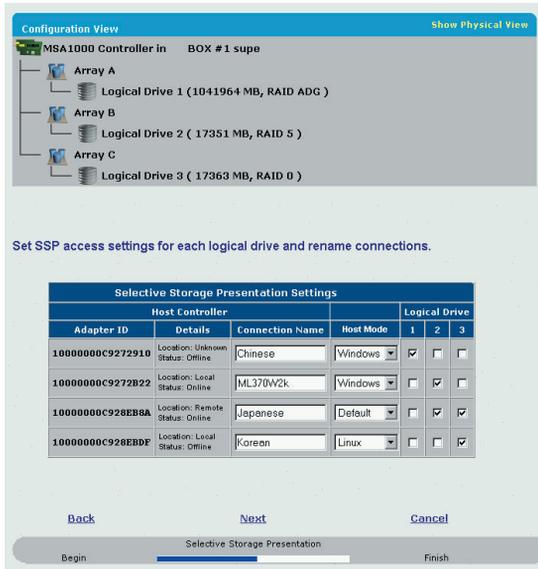
Figure 3-3: Typical SSP screen for the MSA1000

3. Click **Finish.**

Configuring Switches

If the selected controller supports switch configuration, the menu link for this feature is displayed in the **Wizards** panel in the lower right-hand corner of the main ACU configuration screen (Figure 1-2).

1. Use the PING command to confirm that the connections between the management server running ACU and the LAN management ports on the switches are reliable.

2. Click **Switch Configuration** (in the **Wizards** panel).

3.   Select the switch that you wish to configure, and then click **Next.**
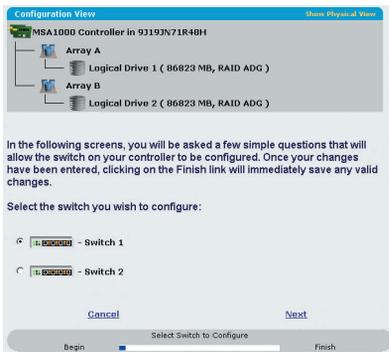
Figure 3-4: Selecting a switch to configure

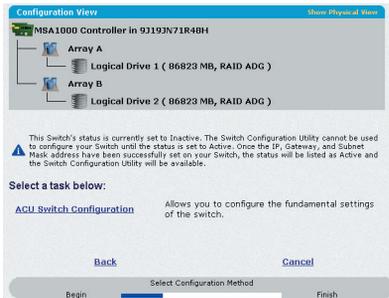4.   Click **ACU Switch Configuration.**

Figure 3-5: Activating the switch

5.   Set the switch parameters (IP address, default gateway, subnet mask, and community strings), and then click **Finish** to save the settings.

Figure 3-6: Setting switch parameters

The screen now displays a URL for launching the **Switch Configuration Utility.** This utility is a Java applet that allows you to further configure the switch. You may need to load the most current Java plug-in to be able to use the applet.
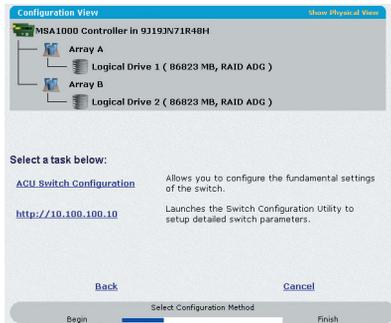
6. Click the URL link.

Figure 3-7: Launching the Switch Configuration Utility

7. Follow the on-screen prompts and instructions to use the switch configuration utility.

4

Scripting in ACU

Scripting support is provided in ACU to allow you to configure array controllers in a customized, predictable, and unattended manner.

Each line of text in an ACU script file is written in the format `option=value` and can be in either uppercase or lowercase letters. For greater clarity when reading or writing the script, you can leave lines blank. You can also create a comment by typing a semicolon; ACU ignores all text on the same line after a semicolon.

Operating Modes

Scripting in ACU has two modes of operation:

- In **Capture** mode, the configuration of all internal and external array controllers that are connected to a server is saved to a script file. You can then use the script file to replicate the array configuration on other servers that have similar storage resources.

  NOTE: You can also perform array replication by using the HP Array Configuration Replicator (ACR). However, the two utilities are not functionally identical. ACU can read unmodified capture files from ACR, but ACR cannot necessarily use ACU files.

- In **Input** mode, the array configuration that is specified in a script file is applied to a target system. The script file can be an unmodified or modified capture file, or you may write the script file from scratch.

Input mode is subdivided into **Automatic** and **Custom** configuration modes.

— In **Automatic** mode, you can enter the values for a few critical options and allow ACU to use default values for all other options.

— In **Custom** mode, you can specify every detail of the array configuration.

Command Line Syntax

In **Capture** mode:

```
CPQACUXE -C [DRIVE:][PATH]FILENAME
```

If you do not specify a capture file name, ACU gives the file the default name of ACUCAPT.INI and places it in the ACU working directory.

In **Input** mode:

```
CPQACUXE -I [DRIVE:][PATH]FILENAME
```

If you do not specify an input file name, ACU gives the file the default name ACUINPUT.INI and places it in the ACU working directory.

If any errors occur during either process, these errors are noted in the file ERROR.INI that is logged to the default working directory.

Sample Custom Input Script

The following script gives all possible values for each option.

- If an **option** is shown in bold type, you must enter a value for that option.

- If a **value** is shown in bold type, ACU uses that value as a default setting.

- An asterisk next to a line denotes that the line is not required in Automatic mode.

You can use this script as a template for your own script.

```
Action = Configure|Reconfigure
Method = Custom|Auto
Controller = All|Slot [N]|WWN [N]|SerialNumber [N]
```

```
ClearConfigurationWithDataLoss = Yes|No
LicenseKey = XXXXX-XXXXX-XXXXX-XXXXX-XXXXX
DeleteLicenseKey = XXXXX-XXXXX-XXXXX-XXXXX-XXXXX
RAIDArrayID = "XXXXXXXXXXXXXXXXXXXX"
ReadCache = 0|10|20|25|30|40|50|60|70|75|80|90|100
WriteCache = 0|10|20|25|30|40|50|60|70|75|80|90|100
RebuildPriority = Low|Medium|High
ExpandPriority = Low|Medium|High
SurfaceScanDelay = N
* SSPState = Enable|Disable
* Array = A|B|C|D|E|F|G|…Z|a|b|c|d|e|f
OnlineSpare = Port:ID,Port:ID…|Box:Bay,Box:Bay…|None
* Drive = Port:ID,Port:ID…| Box:Bay,Box:Bay…
* LogicalDrive = 1|2|3|…32
RAID = 0|1|4|5|ADG
* Size = [N]|Max
* Sectors = 32|63
* StripeSize = 8|16|32|64|128|256
* ArrayAccelerator = Enable|Disable
* ResourceVolumeOwner = N
* LogicalDriveSSPState = Enable|Disable
* SSPAdaptersWithAccess = [N],[N]…|None
```

Script File Options

There are four categories of options in ACU script files: Control, Controller, Array, and Logical Drive. Each category has several scripting options, but not all of the options need to be user-defined for a particular operation. ACU can use default values in some cases, while in other cases a given option may not be relevant for a particular controller or operating mode.

Table 4-1: Description of Option Categories In ACU Scripting

Category	Options	Comments
Control	Action Method	These options define the overall behavior of ACU when it processes the scripts and creates configurations. Control options can occur only once in a script file, and must be the first options listed.
Controller	Controller ClearConfigurationWithDataLoss LicenseKey DeleteLicenseKey RAIDArrayID ReadCache WriteCache RebuildPriority ExpandPriority SurfaceScanDelay SSPState	Options in this category define the controller that is to be configured (or the controller that has had its configuration captured). The Controller option must be at the beginning of this option section in the script, but other options in this category can be scripted in any order. One script can be used to configure several controllers if all controllers are to be configured identically, or if each controller is defined separately. When defining each controller configuration separately, all other category options for a defined controller must be entered before starting a new controller listing.

continued

Table 4-1: Description of Option Categories In ACU Scripting *continued*

Category	Options	Comments
Array	Array OnlineSpare Drive	These options define an array that is to be configured on the controller that is identified previously in the script. (If no controller is previously identified, ACU sends an error message.) The Array option must be at the beginning of this option section in the script, but other options in this category can be scripted in any order.
Logical drive	LogicalDrive RAID Size Sectors StripeSize ArrayAccelerator LogicalDriveSSPState SSPAdaptersWithAccess	These options define a logical drive that is to be configured on an array that is defined previously in the script. (If no array is previously defined, ACU sends an error message.) The LogicalDrive option must be at the beginning of this option section in the script, but other options in this category can be scripted in any order.

The options listed in the table are described in more detail in the following section.

Control Category

Action

You must specify an Action mode.

- In **Configure** mode, you can only create new arrays; you cannot modify any existing arrays. The controller must have unassigned physical drives for this mode to be available.

- In **Reconfigure** mode, you can use ACU to modify existing arrays. This procedure does not destroy data, unless you specifically want the data to be deleted. In this mode, ACU does not change an existing option setting unless you specifically script a different value for that option.

Reconfigure mode allows you to set up an array expansion, logical drive extension, or migration.

Method

Automatic is the default value for this option. If you want to use **Custom** mode, you must specify it.

In **Automatic** mode, ACU may perform an expansion, extension, or migration without user intervention, depending on the settings that you make for other options.

Controller Category

Controller

You must enter a value for this option, since it identifies the controller that is to be configured.

- **All:** Configure all detected controllers in the system identically.

- **Slot [N]:** Configure the internal controller with slot number N.

- **WWN [N]:** Configure the external controller with World-Wide Name (WWN) N.

- **SerialNumber [N]:** Configure the shared storage controller with serial number N.

ClearConfigurationWithDataLoss

The default setting for this option is **No.** Clearing the configuration causes data loss because it deletes all logical drives on the controller. If you clear a configuration, you can write commands later in the script file to create a new configuration from the liberated drive capacity.

LicenseKey

This option allows you to enter a 25-character license key that is required to activate some controller features. Hyphens can be entered, but are not required.

DeleteLicenseKey

This option allows you to uninstall an existing controller feature by entering the 25-character license key for the feature. Hyphens can be entered, but are not required.

RAIDArrayID

Enter the user-defined character string that identifies the controller. Any of the following characters can be used in the string:

a-z A-Z 0-9 ! @ # * ( ) , - _ + : . / [space]

You do not need to use quotation marks around the string, but doing so allows the string to begin with a space character. However, the string cannot end with a space character.

Currently, only shared-storage controllers such as the RA4x00, MSA1000, and Smart Array Cluster Storage support the RAIDArrayID option. The RA4x00 controller uses a 24-character string, while other applicable controllers use a 20-character string.

ReadCache, WriteCache

Enter a number between 0 and 100 to specify the percentage of cache that is to be allocated to drive reads or writes. The default value for both options is 50.

Table 4-2: Allowable Cache Ratios

Controller type	RA4x00 with 16 MB cache	RA4x00 with 48 MB cache	All other controllers	
Read/write cache ratio			With battery-backed cache	Without battery-backed cache
100:0	Y	Y	Y	Y
90:10	Y	Y	--	--
80:20	Y	Y	--	--
75:25	--	--	Y	--
70:30	Y	Y	--	--

continued

Table 4-2: Allowable Cache Ratios *continued*

Controller type	RA4x00 with 16 MB cache	RA4x00 with 48 MB cache	All other controllers	
Read/write cache ratio			With battery-backed cache	Without battery-backed cache
60:40	Y	Y	--	--
50:50	Y	Y	Y	--
40:60	--	Y	--	--
30:70	--	Y	--	--
25:75	--	Y	Y	--
0:50*	Y	--	--	--
0:75*	--	Y	--	--
0:100	--	--	Y	--

*The cache ratio percentages do not total 100 in these cases because the additional 16-MB or 48-MB cache modules are not used; only the battery-backed write cache is used.

RebuildPriority, ExpandPriority

There are three possible settings: low, medium, and high. The default setting for an unconfigured controller is **Low.**

SurfaceScanDelay

Enter a number between 1 and 30 to specify the duration of the surface scan delay in seconds.

SSPState

If you do not specify a value for this option, the existing setting remains unchanged.

NOTE: Currently, only shared-storage controllers such as the RA4x00, MSA1000, and Smart Array Cluster Storage support SSP. The SSPState option is valid only for controllers that enable SSP on a controller basis. RA4x00 controllers support SSP that is enabled on a logical drive basis, and use the LogicalDriveSSPState command instead.

If you enable SSP, you must also specify an adapter for one or more logical drives by using the `SSPAdaptersWithAccess` command. Otherwise, SSP is automatically disabled.

Array Category

Array

This entry identifies the array that is being created or reconfigured. You can use any letter in the range A–Z or a–f to specify the array ID.

- If you are using the **Configure** Action mode, a new array is created. The array letter specified must be the next available array letter in the existing configuration.

- In **Reconfigure** mode, the array letter may identify an existing array, or it can identify the next available array letter in the existing configuration to create a new array.

OnlineSpare

- In Automatic mode, the choices are **Yes** and **No.**

    — In **Configure** mode, the default setting is **Yes.**

    — In **Reconfigure** mode, ACU ignores this option and keeps any spares that the existing configuration already has.

- In **Custom** mode, you can specify exactly which drives are to be used as spares. If you specify **None,** any existing spares are removed from the array.

    — In **Configure** mode, the default value is **None.**

    — In **Reconfigure** mode, any existing spares in the array are kept if you do not specify a value for the `OnlineSpare` option.

Drive

List each physical drive that you want to use in the array. Use whichever convention (Port and ID, or Box and Bay) is applicable, and follow the formatting suggested in the sample script.

In **Automatic** mode, all available drives are used.

> **NOTE:** Any extra physical drives that you add to the list are used to expand the array, as long as the capacity of the added drives is at least as great as that of existing drives in the array. You cannot remove drives from the array unless the `ClearConfigurationWithDataLoss` option is set to **Yes.**

Logical Drive Category

LogicalDrive

Specify the ID number of the logical drive that is to be created or modified.

- In **Configure** mode, you can enter only the ID number of the next possible logical drive in the sequence for the existing configuration.

- In **Reconfigure** mode, you can also enter the ID number of an existing logical drive.

RAID

Specify the RAID level that you want for the logical drive.

- In **Configure** mode, the default setting is the highest RAID level that the configuration can support.

- In **Reconfigure** mode, the default setting is the existing RAID level for that logical drive. If you specify a different RAID setting, then ACU either ignores the new setting (in **Automatic** mode) or attempts to migrate the logical drive to the specified RAID level (in **Custom** mode).

Size

Enter the capacity that you want the logical drive to have, in megabytes. The default size for new logical drives is **MAX.** In this case, ACU creates a logical drive of the maximum possible size from the physical drives that you assigned to the array.

In **Reconfigure** mode, the default setting is the existing size of the logical drive. If you enter a larger value, ACU extends the logical drive to the new size if there is unused drive capacity on the same array, as long as the operating system supports logical drive extension. You cannot reduce the size of the logical drive.

> $\triangle$ **CAUTION:** Back up all data before extending a logical drive.

Sectors

This entry specifies the number of sectors that are to comprise each track. If you enter 32, Max Boot is disabled; if you enter 63, Max Boot is enabled.

- For new logical drives, the default setting is 63 if the logical drive is larger than 502 GB. Otherwise, the default setting is 32.

- For an existing logical drive, the default setting is the existing setting.

Logical drive performance is likely to decrease with MaxBoot enabled.

StripeSize

This option specifies the stripe size for the logical drive in kilobytes. Any of the values listed in the sample script can be used for RAID 0 or RAID 1, whereas the maximum stripe size for RAID 4, RAID 5, or RAID ADG is 64 KB.

If you do not specify a StripeSize value for a new logical drive, ACU uses a default value that is determined by the RAID level that you chose for the logical drive. For RAID 0 or RAID 1, the default stripe size is 128 KB, whereas for RAID 4, RAID 5, or RAID ADG the default stripe size is 16 KB. (However, for RAID 5 on a Smart Array 6400 Series Controller, the default stripe size is 64KB.)

In **Reconfigure** mode, the default setting is the existing stripe size for the specified logical drive. If you specify a stripe size that is different from the existing value, then ACU attempts to migrate the logical drive to the stripe size that you specify.

ArrayAccelerator

This entry specifies whether the array accelerator is enabled or disabled for the specified logical drive. The default setting is **Enabled.**

LogicalDriveSSPState

This option is valid only for controllers that enable SSP on a logical drive basis (at present, this applies only to the RA4x00). For other controllers that support SSP, refer to the SSPState command.

- For existing logical drives, the default setting is the current logical drive setting.

- For new logical drives, the default setting is **Disabled.**

SSPAdaptersWithAccess

Enter values here to identify the SSP adapters that you want to have access to a logical drive. This command is processed only if either SSPState or LogicalDriveSSPState is set to **Enable.** Otherwise, this command is ignored.

Error Reporting

Any errors that are encountered during ACU scripting are logged to ERROR.INI. This error file displays the error message and if possible indicates the controller, array, and logical drive that are associated with the error.

The error reporting in ACU scripting is not as specific as the error reporting in the ACU GUI. Instead, it is designed to give an advanced user enough information to understand what went wrong so that they can correct the problem and continue. Some of the possible error messages are listed in the following table.

Table 4-3: ACU Scripting Error Messages

Message	Comment or explanation (if not self-explanatory)
(text) is not a controller command	--
(text) is not a logical drive command	--
(text) is not a supported command	--
(text) is not an array command	--
(text) command expected	The specified command is missing or in the incorrect place in the file.
Array not specified	Some commands in the script require an array, but no array is specified in the script file.
Array requires an odd number of drives	This error message occurs if you attempt to add an odd number of drives to an existing array that has RAID 1 logical drives, and the controller does not support RAID level migration.
Cannot change array spare	The current configuration does not allow the number of spares in the array to be changed.
Cannot change logical drive array accelerator setting	The current controller configuration does not allow the array accelerator setting to be changed.
Cannot change logical drive sectors	You cannot change the Max Boot setting on a configured logical drive because doing so causes data loss.
Cannot change SSP settings	--
Cannot create array	Either there are no unassigned physical drives on the controller, or the controller already has the maximum number of arrays or logical drives.
Cannot create logical drive	Either there is no free space on the array, or the maximum number of logical drives has already been reached.
Cannot expand array	Either the controller does not support expansion, or the current configuration of the controller does not allow expansion.

continued

Table 4-3: ACU Scripting Error Messages *continued*

Message	Comment or explanation (if not self-explanatory)
Cannot extend logical drive	The controller does not support extension, or the current configuration does not allow extension. For example, if there is no free space on an array, extension is not supported.
Cannot migrate logical drive RAID	The controller does not support RAID migration, or the current configuration of the controller does not allow migration.
Cannot migrate logical drive stripe size	The controller does not support stripe size migration, or the current configuration of the controller does not allow migration.
Cannot remove physical drives from existing array	You have inadvertently omitted one or more physical drives from the drive list when reconfiguring an existing array. ACU does not allow this because removing physical drives from a configured array causes data loss.
Controller *(text)* is invalid	The controller specifications are not entered correctly.
Controller does not support controller SSPState. Use the LogicalDriveSSPState command to set SSP states for each logical drive.	--
Controller does not support license keys	--
Controller does not support logical drive SSP states. Use the SSPState command to set the controller SSP state.	--
Controller does not support RAIDArrayID	--
Controller does not support SSP	--
Controller has maximum number of license keys	--
Controller is locked by another machine or user	--

continued

Table 4-3: ACU Scripting Error Messages *continued*

Message	Comment or explanation (if not self-explanatory)
Controller requires non-failed physical drives to set license keys	--
Controller requires physical drives to set license keys	--
Could not detect controller *(text)*	--
Error communicating with controller	--
Error saving controller	There is a problem saving one or more controller configurations.
Failure opening capture file *(text)*	--
Failure opening input file *(text)*	--
Internal error	An internal ACU error has occurred, and some error is not being identified properly.
Invalid array accelerator setting	The specified array accelerator setting is invalid or is not supported with the current configuration.
Invalid array	The array ID is invalid.
Invalid ClearConfigurationWithDataLoss parameter	--
Invalid Controller	--
Invalid expand priority	The specified expand priority is not supported, or the controller does not allow expansion and therefore does not support the Expand Priority feature.
Invalid license key	--
Invalid logical drive	The logical drive ID is not valid.
Invalid Method	Invalid Method value.
Invalid physical drive	The physical drive listed for the array is not a valid physical drive, or it is a physical drive that is not capable of being placed in the array.

continued

Table 4-3: ACU Scripting Error Messages *continued*

Message	Comment or explanation (if not self-explanatory)
Invalid RAIDArrayID	The entered RAIDArrayID is invalid. Use characters from the set a–z A–Z 0–9 ! @ # * ( ) , - _ + : . / [space]. The ID cannot end with a space character or exceed the maximum number of characters allowed by the controller.
Invalid RAID	The specified RAID level is invalid or is not possible with the current configuration.
Invalid read cache/write cache ratio	The specified cache ratio is not supported by either the controller or the current controller configuration.
Invalid rebuild priority	--
Invalid Sectors	The specified Max Boot setting is invalid, or is not supported with the current configuration.
Invalid Size	The specified size is invalid or is not possible with the current configuration.
Invalid Spare	The spare drive listed for the array is not a valid spare drive, or it is a drive that is not capable of being placed on the array as a spare.
Invalid SSP adapter ID	--
Invalid SSP state	--
Invalid stripe size	The specified stripe size is either invalid, not supported with the current RAID level, or not supported with the current configuration.
Invalid SurfaceScanDelay	--
License key is not a controller feature license key	The entered license key is not a controller feature license key.
Logical drive not specified	Some commands require a logical drive, but no logical drive is specified in the script file.
More than one *(text)* command cannot exist in the same section	The specified command should be used only once per section.
New array ID already exists	This error occurs in Configure mode when the array ID in the script file already exists in the configuration. You can only use Configure mode to create **new** arrays.

continued

Table 4-3: ACU Scripting Error Messages *continued*

Message	Comment or explanation (if not self-explanatory)
New array ID does not match the next available array ID	The array ID that you specified in the script file does not match the ID of the newly created array. For example, the script generates this error if you have only an array A and the script file specifies creation of array C (missing array B).
New logical drive ID already exists	This error occurs in Configure mode when the logical drive ID in the script file already exists in the configuration. You can only use Configure mode to create **new** logical drives.
New logical drive ID does not match the next available logical drive ID	The logical drive ID that you specified in the script file does not match the ID of the newly created logical drive. For example, the script generates this error if you have only logical drive 1 and the script file specifies creation of logical drive 3 (missing logical drive 2).
	This error may occur when using an input file with logical drive numbers that are not sequential. In this case, change the logical drive numbers so that they are sequential in the input file.
No controllers detected	This error applies to input mode only. If no controllers are detected in capture mode, the capture file is empty.
Slot information is not available	You cannot run Input mode on internal controllers that do not have slot information online. For Microsoft Windows, this means that the System Management Driver has to be loaded.
Too many coinciding expansion, migration, or extension operations	ACU does not support multiple simultaneous expansions, migrations, or extensions without saving the configuration between operations. Limit the number of such configuration changes in this script.

A

Drive Arrays and Fault Tolerance

What Is a Drive Array?

The capacity and performance of a single physical (hard) drive is adequate for home users. However, business users demand higher storage capacities, higher data transfer rates, and greater protection against data loss when drives fail.

Connecting extra physical drives (P*n* in the figure) to a system increases the total storage capacity, but has no effect on the efficiency of read/write (R/W) operations. Data can still be transferred to only one physical drive at a time.
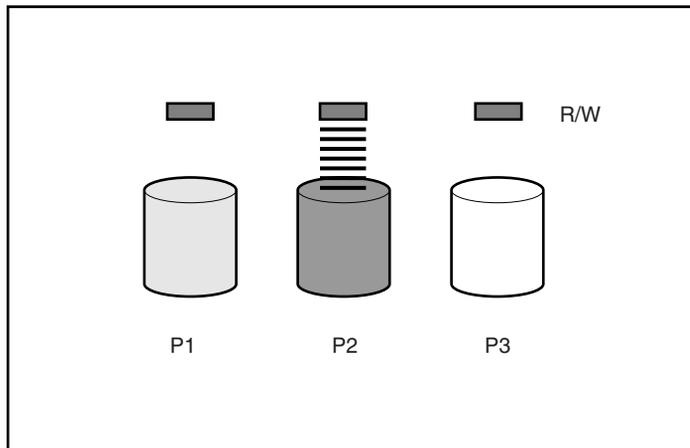
Figure A-1: Physical drives added to system

With an array controller installed in the system, the capacity of several physical drives can be combined into one or more virtual units called **logical drives** (also called logical volumes and denoted by L*n* in the figures in this section). Then, the read/write heads of all the constituent physical drives are active simultaneously, reducing the total time required for data transfer.
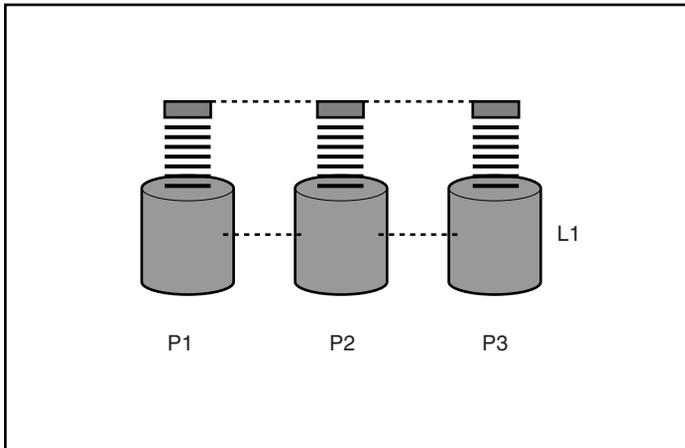
Figure A-2: Physical drives configured into a logical drive (L1)

Because the read/write heads are active simultaneously, the same amount of data is written to each drive during any given time interval. Each unit of data is called a **block** (denoted by B*n* in Figure A-3), and adjacent blocks form a set of data **stripes** (S*n*) across all the physical drives that comprise the logical drive.
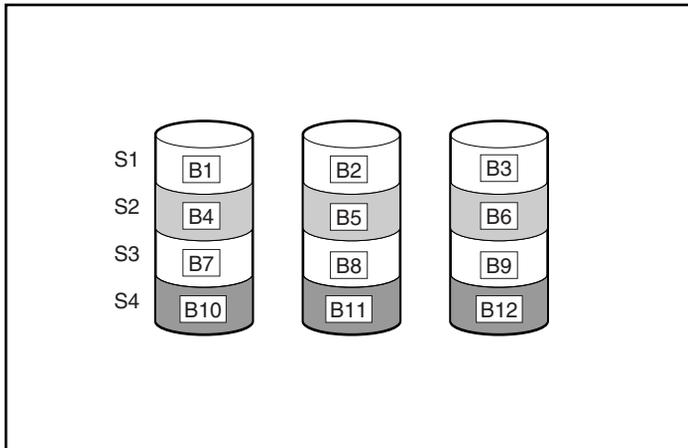
Figure A-3: Data striping (S1-S4) of data blocks B1-B12

For data in the logical drive to be readable, the data block sequence must be the same in every stripe. This sequencing process is performed by the array controller, which sends the data blocks to the drive write heads in the correct order.

A natural consequence of the striping process is that each physical drive in a given logical drive will contain the same amount of data. If one physical drive has a larger capacity than other physical drives in the same logical drive, the extra capacity is wasted because it cannot be used by the logical drive.

The group of physical drives containing the logical drive is called a **drive array,** or just **array** (denoted by A*n* in Figure A-4). Since all the physical drives in an array are commonly configured into just one logical drive, the term array is also often used as a synonym for logical drive. However, an array can contain several logical drives, each of a different size.
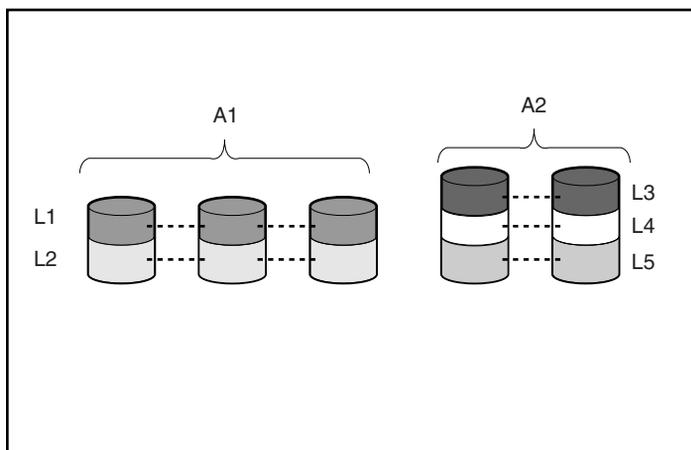
Figure A-4: Two arrays (A1, A2) containing five logical drives spread across five physical drives

Each logical drive in an array is distributed across all of the physical drives within the array. A logical drive can also extend across more than one port on the same controller, but it cannot extend across more than one controller.

Drive failure, although rare, is potentially catastrophic. For arrays that are configured as shown in the previous figure, failure of any physical drive in the array causes every logical drive in the array to suffer irretrievable data loss. To protect against data loss due to physical drive failure, logical drives are configured with **fault tolerance.** For more information, refer to "Fault-Tolerance Methods."

For any configuration except RAID 0, further protection against data loss can be achieved by assigning a drive as an **online spare** (or **hot spare**). This drive contains no data and is connected to the same controller as the array. When any other physical drive in the array fails, the controller automatically rebuilds information that was originally on the failed drive to the online spare. The system is thus restored to full RAID-level data protection, although it now no longer has an online spare. (However, in the unlikely event that another drive in the array fails while data is being rewritten to the spare, the logical drive will still fail.)

When you configure an online spare, it is automatically assigned to all logical drives in the same array. Additionally, you do not need to assign a separate online spare to each array. Instead, you can configure one hard drive to be the online spare for several arrays if the arrays are all on the same controller.

Fault-Tolerance Methods

Several fault-tolerance methods exist. Those most often used with Smart Array controllers are hardware-based RAID methods.

Two alternative fault-tolerance methods that are sometimes used are also described in the section "Alternative Fault-Tolerance Methods." However, hardware-based RAID methods provide a much more robust and controlled fault-tolerance environment, so these alternative methods are seldom used.

Hardware-Based Fault-Tolerance Methods

The hardware-based methods that are recommended for use with Smart Array controllers are:

- RAID 0—Data Striping only (no fault tolerance)

- RAID 1+0—Drive Mirroring

- RAID 5—Distributed Data Guarding

- RAID ADG—Advanced Data Guarding

RAID 0—No Fault Tolerance

A RAID 0 configuration (refer to Figure A-3 for an example) provides data striping, but there is no protection against data loss when a drive fails. However, it is useful for rapid storage of large amounts of noncritical data (for printing or image editing, for example) or when cost is the most important consideration.

Advantages

- Has the highest write performance of all RAID methods.

- Has the lowest cost per unit of stored data of all RAID methods.

- All drive capacity is used to store data (none needed for fault tolerance).

Disadvantages

- All data on the logical drive is lost if a physical drive fails.

- Cannot use an online spare.

- Can only preserve data by backing it up to external drives.

RAID 1+0—Drive Mirroring

In a RAID 1+0 configuration, data is duplicated to a second drive.
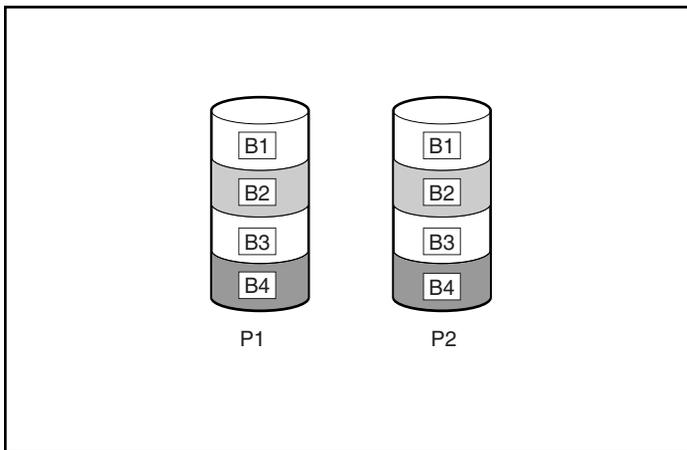
Figure A-5: Drive mirroring of P1 to P2

When the array has more than two physical drives, drives are mirrored in pairs.
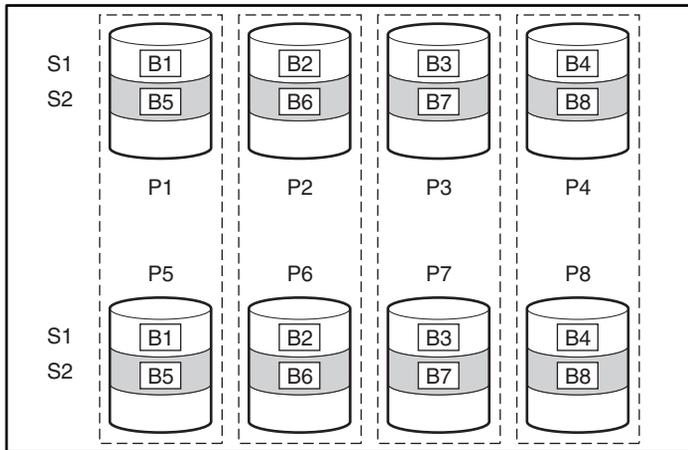
Figure A-6: Mirroring with more than two physical drives in the array

In each mirrored pair, the physical drive that is not busy answering other requests answers any read requests that are sent to the array. (This behavior is called **load balancing.**) If a physical drive fails, the remaining drive in the mirrored pair can still provide all the necessary data. Several drives in the array can fail without incurring data loss, as long as no two failed drives belong to the same mirrored pair.

This fault-tolerance method is useful when high performance and data protection are more important than the cost of physical drives.

NOTE: When there are only two physical drives in the array, this fault-tolerance method is often referred to as RAID 1.

Advantages

- Has the highest read and write performance of any fault-tolerant configuration.

- No data is lost as long as no failed drive is mirrored to another failed drive (up to half of the physical drives in the array can fail).

Disadvantages

- This method is expensive (many drives are needed for fault tolerance).

- Only half of the total drive capacity is usable for data storage.

RAID 5—Distributed Data Guarding

In a RAID 5 configuration, data protection is provided by **parity data** (denoted by P*x,y* in the figure). This parity data is calculated stripe by stripe from the user data that is written to all other blocks within that stripe. The blocks of parity data are distributed evenly over every physical drive within the logical drive.
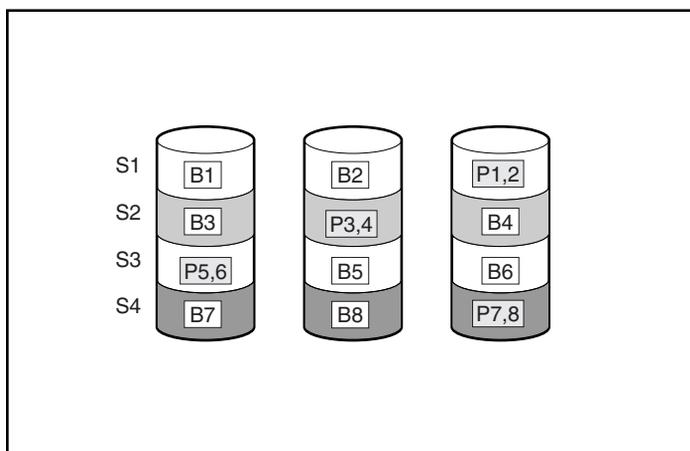
Figure A-7: Distributed data guarding, showing parity information (Px,y)

When a physical drive fails, data that was on the failed drive can be calculated from the remaining parity data and user data on the other drives in the array. This recovered data is usually written to an online spare in a process called a **rebuild.**

This configuration is useful when cost, performance, and data availability are equally important.

Advantages

- Has high read performance.

- Data is not lost if only one physical drive fails.

- More drive capacity is usable than with RAID 1+0—parity information requires only the storage space equivalent to one physical drive.

Disadvantages

- Has relatively low write performance.

- Data is lost if a second drive fails before data from the first failed drive is rebuilt.

RAID ADG—Advanced Data Guarding

NOTE: Not all controllers support RAID ADG.

RAID ADG, like RAID 5, generates and stores parity information to protect against data loss caused by drive failure. With RAID ADG, however, two different sets of parity data are used (denoted by Px,y and Qx,y in the figure), allowing data to still be preserved if two drives fail. Each set of parity data uses a capacity equivalent to that of one of the constituent drives.
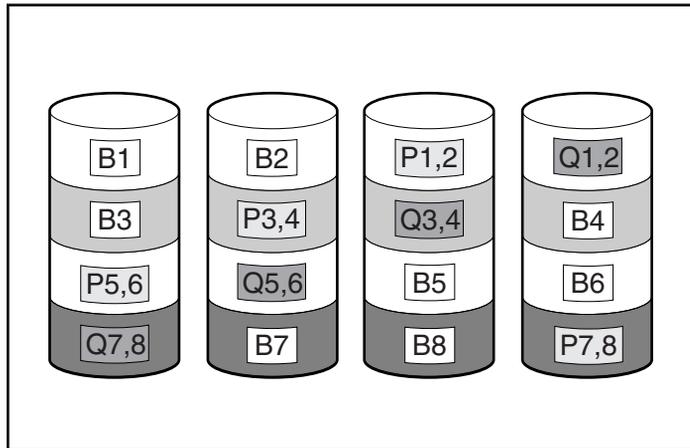
Figure A-8: Advanced data guarding (RAID ADG)

This method is most useful when data loss is unacceptable, but cost is also an important factor. The probability that data loss will occur when an array is configured with RAID ADG is less than it would be if it were configured with RAID 5.

Advantages

- Has a high read performance.

- Allows high data availability—any two drives can fail without loss of critical data.

- More drive capacity is usable than with RAID 1+0—parity information requires only the storage space equivalent to two physical drives.

Disadvantage

The main disadvantage of RAID ADG is a relatively low write performance (lower than RAID 5), because of the need for two sets of parity data.

Comparison of RAID methods

Table A-1 summarizes the important features of the different kinds of RAID methods described here. The decision chart in Table A-2 may help you to determine which option is best for your situation.

Table A-1: Summary of RAID Methods

	RAID 0	RAID 1+0	RAID 5	RAID ADG*
Alternative name	Striping (no fault tolerance)	Mirroring	Distributed Data Guarding	Advanced Data Guarding
Usable drive space**	100%	50%	67% to 93%	50% to 96%
Usable drive space formula	n	$n/2$	$(n\text{-}1)/n$	$(n\text{-}2)/n$
Minimum number of physical drives	1	2	3	4
Tolerates failure of one physical drive?	No	Yes	Yes	Yes

continued

Table A-1: Summary of RAID Methods *continued*

	RAID 0	**RAID 1+0**	**RAID 5**	**RAID ADG***
Tolerates simultaneous failure of more than one physical drive?	No	Only if no two failed drives are in the same mirrored pair	No	Yes
Read performance	High	High	High	High
Write performance	High	Medium	Low	Low
Relative cost	Low	High	Medium	Medium

*Not all controllers support RAID ADG.

**Values for usable drive space are calculated with these assumptions: (1) all physical drives in the array have the same capacity; (2) online spares are not used; (3) no more than 14 physical drives are used per array for RAID 5; (4) no more than 56 drives are used with RAID ADG.

Table A-2: Choosing a RAID Method

Most Important	**Also Important**	**Suggested RAID Level**
Fault tolerance	Cost effectiveness	RAID ADG*
	I/O performance	RAID 1+0
Cost effectiveness	Fault tolerance	RAID ADG*
	I/O performance	RAID 5 (RAID 0 if fault tolerance is not required)
I/O performance	Cost effectiveness	RAID 5 (RAID 0 if fault tolerance is not required)
	Fault tolerance	RAID 1+0

*Not all controllers support RAID ADG.

Alternative Fault-Tolerance Methods

Your operating system may also support software-based RAID or controller duplexing.

- **Software-based RAID** resembles hardware-based RAID, except that the operating system works with logical drives as if they were physical drives. To protect against data loss caused by physical drive failure, each logical drive must be in a different array from the others.

- **Controller Duplexing** uses two identical controllers with independent, identical sets of drives containing identical data. In the unlikely event of a controller failure, the remaining controller and drives will service all requests.

Neither of these alternative fault-tolerance methods supports online spares or automatic data recovery, nor do they support auto-reliability monitoring or interim data recovery.

If you decide to use one of these alternative fault-tolerance methods, configure your arrays with RAID 0 for maximum storage capacity and refer to your operating system documentation for further implementation details.

B

Probability of Logical Drive Failure

The probability that a logical drive will fail depends on the RAID level setting and on the number and type of physical drives in the array. If the logical drive does not have an online spare, the following results apply:

- A RAID 0 logical drive fails if only one physical drive fails.

- A RAID 1+0 logical drive fails if any two failed physical drives are mirrored to each other.

    — The **maximum** number of physical drives that can fail **without** causing failure of the logical drive is $n/2$, where n is the number of hard drives in the array. In practice, a logical drive usually fails before this maximum is reached. As the number of failed physical drives increases, it becomes increasingly likely that the newly failed drive is mirrored to a previously failed drive.

    — The **minimum** number of physical drive failures that can cause the logical drive to fail is two. This situation occurs when the two failed drives are mirrored to each other. As the total number of drives in the array increases, the probability that the only two failed drives in an array are mirrored to each other decreases.

- A RAID 5 logical drive fails if two physical drives fail.

- A RAID ADG logical drive fails when three physical drives fail.

At any given RAID level, the probability of logical drive failure increases as the number of physical drives in the logical drive increases. This is illustrated more quantitatively in Figure B-1. The data for this graph is calculated from the mean time between failure (MTBF) value for a typical physical drive, assuming that no online spares are present. If an online spare is added to any of the fault-tolerant RAID configurations, the probability of logical drive failure is further decreased.
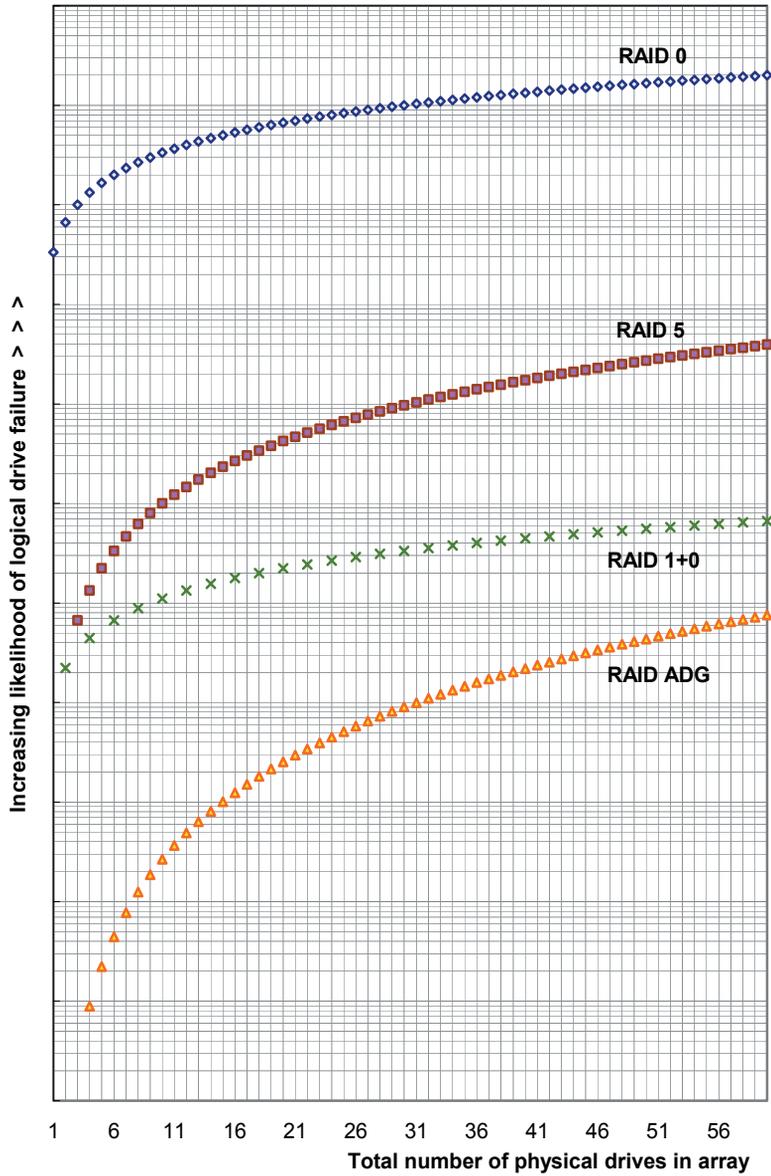
Figure B-1: Relative probability of logical drive failure

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