

HP Array Configuration Utility User Guide



February 2004 (Sixth Edition)
Part Number 239449-006

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Audience Assumptions

This guide is for the person who installs, administers, and troubleshoots servers and storage systems. HP assumes you are qualified in the servicing of computer equipment and trained in recognizing hazards in products with hazardous energy levels.

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Getting Started

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Features and System Requirements

The HP Array Configuration Utility (ACU) is a browser-based utility that:

- Can be used online (that is, while the operating system is running)
- Has different operating modes, enabling 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
- Enables online array capacity expansion, logical drive capacity extension, assignment of online spares, and RAID or stripe size migration

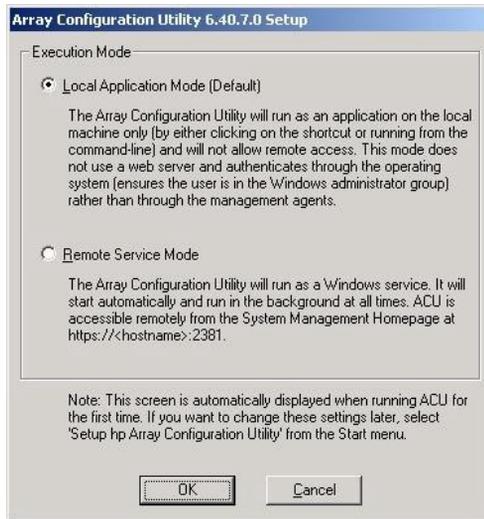
The minimum display settings for optimum performance are 1024 x 768 pixels resolution and 256 colors. Refer to the README.TXT file for further information about browser and operating system support.

Installing ACU

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

Setting the Execution Mode for Microsoft Windows

During the installation process on a server using a supported Microsoft® Windows® operating system, you are prompted to select the Execution Mode setting. This setting determines whether you can run ACU on the 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.

Comparison of ACU Execution Modes

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 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.

Local Application Mode	Remote Service Mode
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 Systems Insight Manager agents.

Summary of Procedure for Using ACU

1. Open ACU.

You can access ACU in the following ways:

- As a local application (this method is available only on Microsoft® Windows® platforms) ("Opening ACU in Local Application Mode" on page [7](#))
 - Through a browser ("Opening ACU in Browser Mode" on page [8](#))
 - Through Systems Insight Manager ("Opening ACU through Systems Insight Manager" on page [9](#))
 - Through scripting ("Scripting in ACU" on page [43](#))
 - Through the interactive command line interface ("Using the Command Line Interface" on page [10](#))
2. Select the controller that you want to configure.
 3. If you are using a GUI, select the configuration mode ("Screen Layout" on page [10](#)).
 4. Configure the controller.
 5. Save the configuration changes.
 6. Select another controller to configure, or exit ACU.

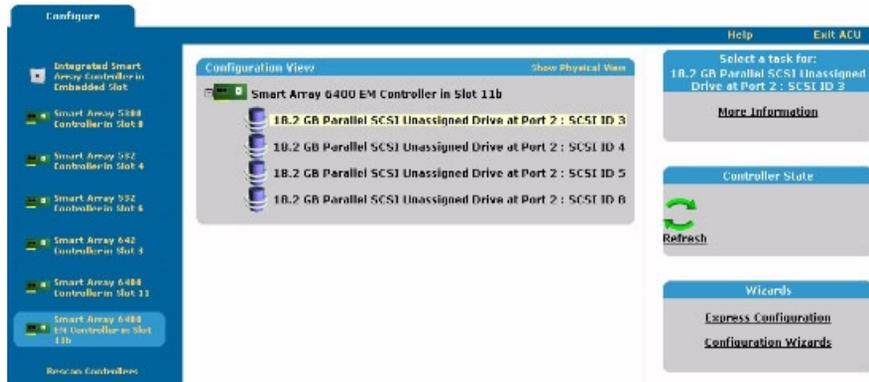
Opening ACU in Local Application Mode

1. Click **Start**, and navigate to **Programs > HP 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.

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

The main ACU configuration screen appears.



Opening ACU in Browser Mode

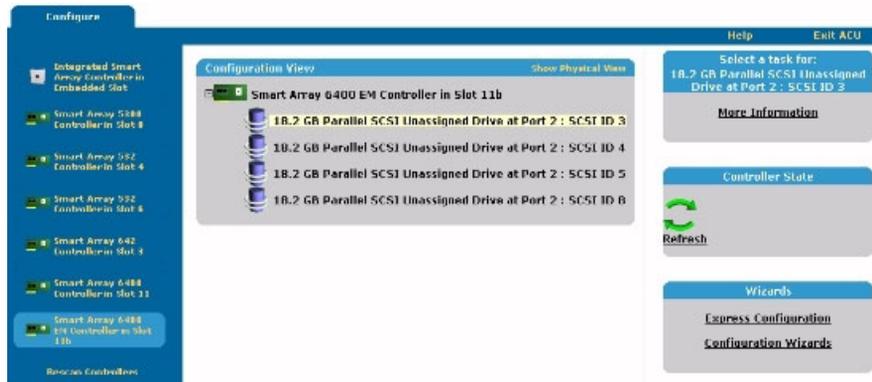
- Open ACU on the host.
- If you intend to configure a remote server, confirm that the ACU Execution mode is set to Remote Service ("Setting the Execution Mode for Microsoft Windows" on page 6).
- Open the browser, either locally (on the host) or on the remote server.
- Enter the following text into the browser address field (where *servername* is the name or IP address of the host):

http://servername:2301

The System Management Home Page opens.

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

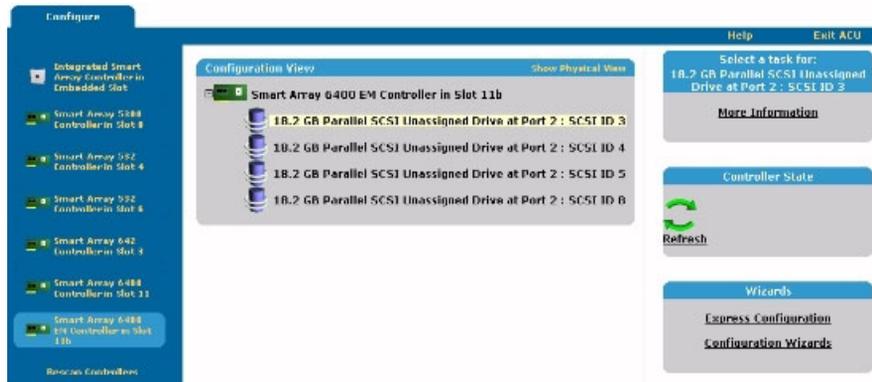
The main ACU configuration screen appears.



Opening ACU through Systems Insight Manager

1. On the server that has ACU loaded, confirm that the utility is running in Remote Service mode ("Setting the Execution Mode for Microsoft Windows" on page 6).
2. On the remote server, connect to the Systems Insight Manager server (port :280) and log in.
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 appears.



Using the Command Line Interface

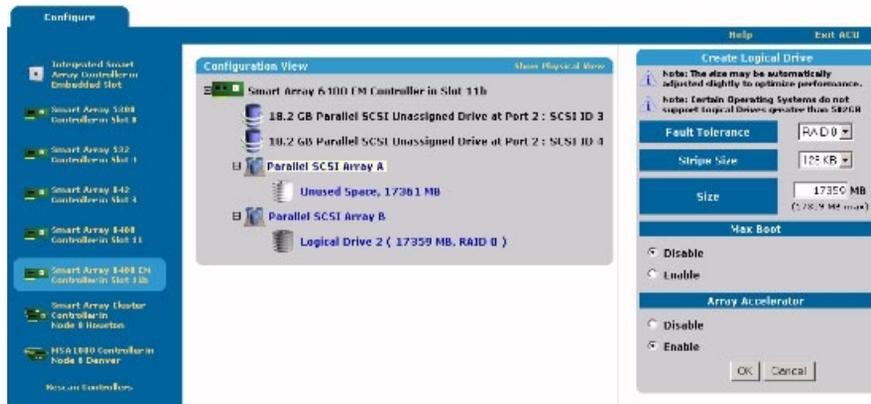
The ACU CLI is an interactive command line interface for configuring array controllers. For detailed information about using the ACU CLI, navigate to the ACU installation directory from a console window and enter `hpacucli - help`.

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 ("Typical Standard Mode Screen" on page [11](#)) is the default setting. This mode enables you to manually configure all options on the controller.
- Configuration Wizards mode ("Typical Configuration Wizards Mode Screen" on page [11](#)) guides you through each step of a manual configuration process.
- Express Configuration mode ("Typical Express Configuration Mode Screen" on page [13](#)) enables 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 panel are displayed in a frame on the right-hand side of the screen.

Typical Configuration Wizards Mode Screen



The Wizard mode screen consists of four regions: the Devices list, the Configuration View panel, 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 panel 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 panel.
 - To get further information about any item in this panel, click the icon for the item. A pop-up window appears.



- 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 ("Typical Configuration Wizards Mode Screen" on page [11](#)), 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 "Configuring a New Controller (on page [15](#))."
- If the controller is already configured but you want to reconfigure it, refer to "Modifying an Existing Configuration (on page [25](#))."

Configuring a New Controller

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Choosing a Configuration Mode

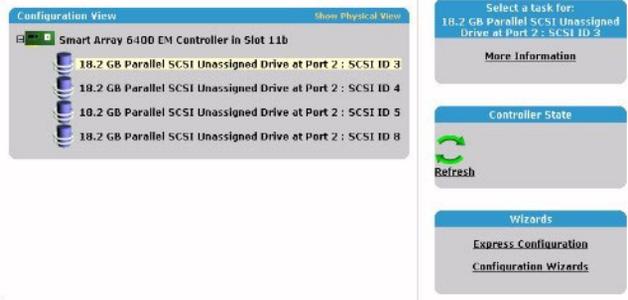
Open ACU as described in "Getting Started (on page [5](#))" and select a controller.

NOTE: If you select a controller that is already configured, you will see arrays and logical drives in the Configuration View panel 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 "Modifying an Existing Configuration (on page [25](#))."

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. The procedure for using each mode is described in the rest of this section.

Using Standard Configuration Mode

1. Click an item in the Configuration View panel. The right-hand side of the screen displays a list of the tasks that are available for that item.



The tasks listed for the item 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.) The table ("Possible Tasks in Standard Configuration Mode" on page 16) lists all the possible tasks for every type of 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.
3. Set the configuration options the way that you want them to be.
4. Click **OK**.

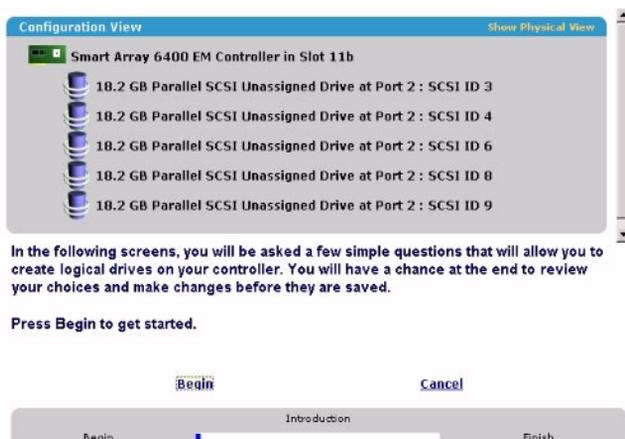
Possible Tasks in Standard Configuration Mode

Menu Item	Possible 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

Menu Item	Possible Tasks
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	Create Logical Drive More Information

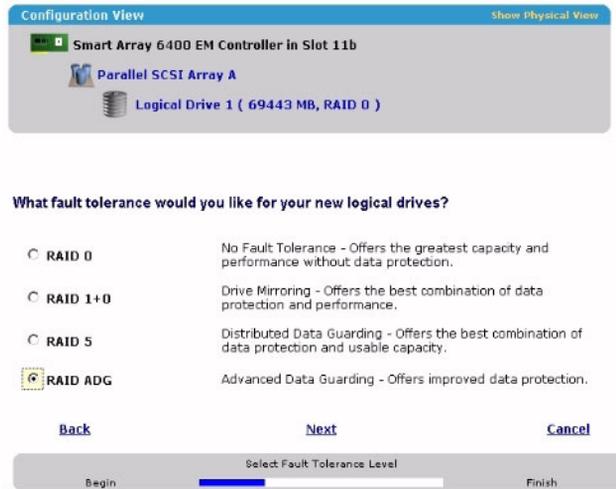
Using Express Configuration Mode

1. Click **Express Configuration** in the lower right-hand panel of the main ACU configuration screen. The Express mode start screen appears.



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 panel shows the new configuration, and underneath this panel is a list of possible fault tolerance levels for the first logical drive.

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

4. 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 spare drives to the array.

- If you do not want this array to have a spare, click **No**, and then click **Next**.
- To assign spares 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 one or more spare drives to an array enables you to 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.

The panel displays the new configuration and asks you to confirm that it is acceptable.

- If you discard the configuration, you are returned to the main ACU configuration screen so that you can manually configure the new array.
 - If you accept the configuration, the next screen displays confirmation 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.
5. Select the appropriate radio button to accept or discard the configuration.
 6. Click **Finish**.

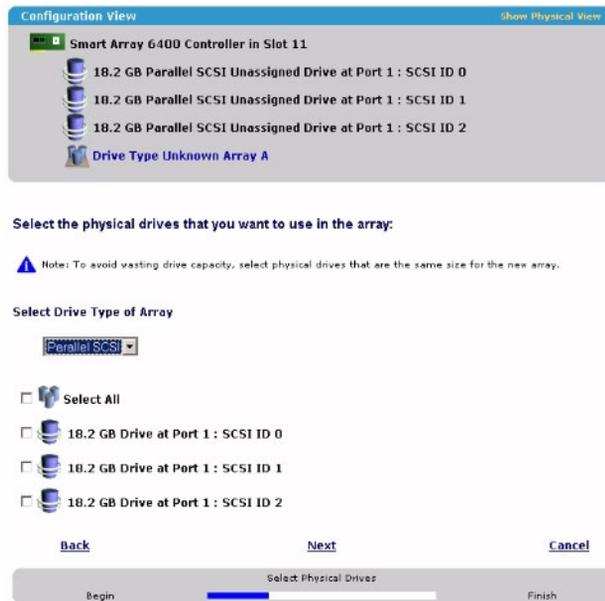
Using the Configuration Wizards

When using the wizards, you first create at least one array ("Creating an Array" on page [19](#)), and then you populate the array with logical drives ("Creating a Logical Drive" on page [21](#)).

Creating an Array

1. Click **Configuration Wizards** in the lower right-hand panel of the main ACU configuration screen.
2. Click **Create an array**, and then click **Begin**.

The Configuration View panel displays a placeholder for the array that you are about to create. (If there are many physical drives connected to the controller, use the scrollbars in the Configuration View panel to see all the physical drives and arrays.)



3. Select the type of drive that you will use in the array.
4. 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.

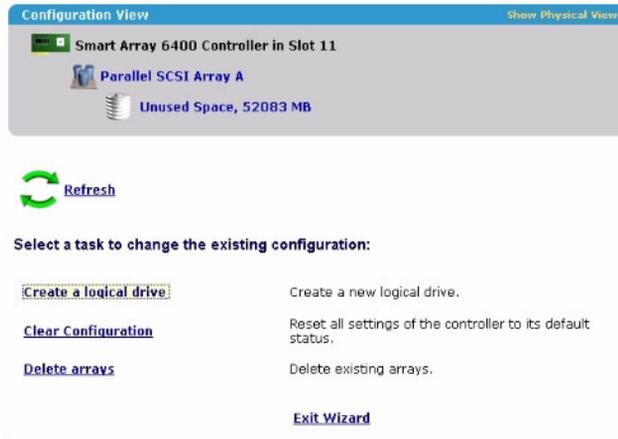
Each time that you add a physical drive to the array, the configuration view is updated to show how much free space remains on the array.

5. Click **Next** when you have finished adding physical drives to the array.
6. 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 one or more spare drives to an array enables you to 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.

7. Click **Finish** to confirm the configuration. The drives are now configured as unused space on the new array.



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**. (The array must have unused space for logical drive creation to be possible.)

The screen displays a list of the fault tolerance levels that are possible for this configuration. For example, RAID 5 is not listed if the array has only two physical drives.

3. Select a fault tolerance level, and then click **Next**.
4. Select a 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.

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value.
Mainly sequential read (such as audio/video applications)	Use a larger stripe size.
Mainly write (such as image manipulation applications)	Use a smaller stripe size for RAID 5 or RAID ADG*. Use a larger stripe size for RAID 0 or RAID 1+0.

***NOTE:** Not all controllers support RAID ADG.

The next screen gives you the option to enable MaxBoot. When MaxBoot is enabled, 63 sectors are used per track instead of 32. This increased number of sectors 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 enables you to 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.

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

The next screen enables you to set the size of the logical drive. 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.

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

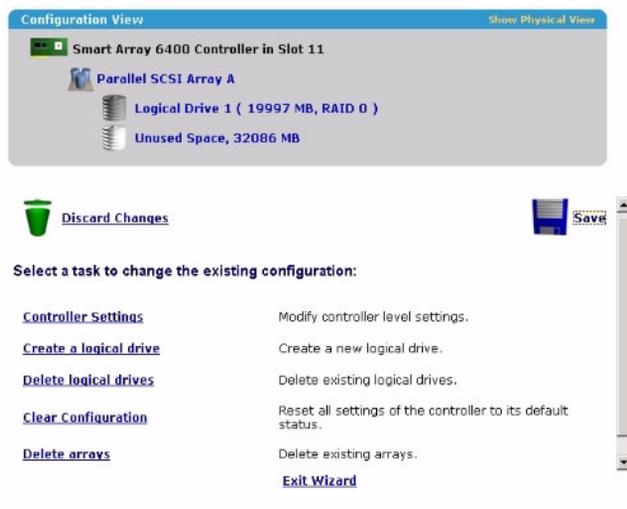
If the controller has an array accelerator, a screen now appears that gives you the option of disabling it for the currently selected logical drive.

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 you want the other logical drives to have the maximum possible performance (for example, if the logical drives contain database information).

7. Select the option that you want, and then click **Next**.

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

8. Verify 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 click **Discard Changes**, all changes since the previous save are lost.)

Modifying an Existing Configuration

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Choices Available after Opening ACU

Open ACU as described in "Getting Started (on page [5](#))," and select a controller.

At this point, you can continue operating in Standard mode, or you can select a wizard from the lower right-hand panel. If the controller that you selected is an MSA1000, another link in this panel leads to a screen that enables you to configure switches.

Modifying a Configuration using Standard Configuration Mode

1. Click an item in the Configuration View panel. The right-hand side of the screen displays a list of the tasks that are available for that item.



The tasks listed for the item 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.) The table ("Possible Tasks in Standard Configuration Mode" on page [16](#)) lists all the possible tasks for every type of 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.
3. Set the configuration options the way that you want them to be.
4. Click **OK**.

Modifying a Configuration Using Express 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: An array expansion, logical drive extension, or logical drive migration takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While this process 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**.

Modifying a Configuration 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 (on page [27](#))
- Controller Settings (on page [28](#))
- Create an array (on page [29](#))
- Create a logical drive (on page [30](#))
- Delete arrays (on page [32](#))
- Delete logical drives (on page [33](#))
- Expand array (on page [33](#))
- Extend logical drive (on page [34](#))
- Migrate a logical drive (on page [35](#))
- Spare Management (on page [36](#))
- Selective Storage Presentation (on page [37](#))

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**.

ACU displays a warning screen 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 that ACU provides are adequate for many purposes. When necessary, however, you can use the Controller Settings task to:

- Alter the priority that the system gives to an array expansion or rebuild
- Disable the array accelerator (if one is present)
- 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 enable you to change the settings for the expand priority and the rebuild priority. 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**.

If the controller has an array accelerator, a screen now appears that gives you the option of disabling it for particular logical drives.

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 you want the other logical drives to have the maximum possible performance (for example, if the logical drives contain database information).

4. Select the logical drives for which the array accelerator should be disabled, and then click **Next**.

If the controller has a battery-backed cache, a screen now appears that enables you to change the read/write cache ratio. 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.

5. Select the ratio that you want the controller to use, and then click **Next**.
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 type of drive to be used in the array.
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 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.

4. Click **Next** when you have finished adding physical drives to the array.
5. 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 one or more spare drives to an array enables you to 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: An array can have several spares, and any spare can be shared by several arrays.

6. 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**. (The array must have unused space for logical drive creation to be possible.)

The screen displays a list of the fault tolerance levels that are possible for this configuration. For example, RAID 5 is not listed if the array has only two physical drives.

3. Select a fault tolerance level, and then click **Next**.
4. Select a 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.

Type of Server Application	Suggested Stripe Size Change
Mixed read/write	Accept the default value.
Mainly sequential read (such as audio/video applications)	Use a larger stripe size.
Mainly write (such as image manipulation applications)	Use a smaller stripe size for RAID 5 or RAID ADG*. Use a larger stripe size for RAID 0 or RAID 1+0.

***NOTE:** Not all controllers support RAID ADG.

The next screen gives you the option to enable MaxBoot. When MaxBoot is enabled, 63 sectors are used per track instead of 32. This increased number of sectors 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 enables you to 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.

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

The next screen enables you to set the size of the logical drive. 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.

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

If the controller has an array accelerator, a screen now appears that gives you the option of disabling it for the currently selected logical drive.

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 you want the other logical drives to have the maximum possible performance (for example, if the logical drives contain database information).

7. Select the option that you want, and then click **Next**.

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

- Verify that the configuration is acceptable, and then click **Finish**.



- Click the **Save** icon to commit the changes to the controller, and then click **OK** on the confirmation alert. (If you click **Discard 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 ("Create an Array" on page 29), or you can use the liberated physical drive space for expansion of another array ("Expand Array" on page 33) on the same controller.

- Click **Delete arrays**, and then click **Begin**.
- Select the arrays that you want to delete, and then click **Next**. ACU displays a warning screen to remind you that you will lose all data on the array.
- Click **Delete** to continue, and then click **Finish** to accept the changes.
- 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 ("Create a Logical Drive" on page [30](#)).
- Migrate the RAID level or stripe size of an existing logical drive ("Migrate a Logical Drive" on page [35](#)).
- Extend existing logical drives on the same array ("Extend Logical Drive" on page [34](#)), 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**. ACU displays a warning screen 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: The Expand Array task 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 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 ("Create a Logical Drive" on page [30](#)).
- Migrate the RAID level or stripe size of existing logical drives ("Migrate a Logical Drive" on page [35](#)).
- Extend existing logical drives on the array ("Extend Logical Drive" on page [34](#)), if the operating system allows logical drive extension.

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

1. Click **Controller Settings**, and verify 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 panel. A More Information pop-up window opens that describes the array 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 expanding an array ("Expand Array" on page [33](#)) or by deleting another logical drive ("Delete Logical Drives" on page [33](#)) on the same array.

Not all operating systems support online logical drive extension through ACU.

Some operating systems allow you to perform logical drive extension **offline** by backing up data, reconfiguring the array, and restoring data from backup. Check the operating system documentation for current information.

IMPORTANT: An array expansion, logical drive extension, or logical drive migration takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While this process is occurring, 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. Enter 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 panel. A More Information pop-up window opens that describes the logical drive status.

Migrate a Logical Drive

This option enables you to alter the stripe size (data block size), RAID level, or both for a selected logical drive. For some combinations of initial and final settings of stripe size and RAID level, the array must contain unused drive space.

IMPORTANT: An array expansion, logical drive extension, or logical drive migration takes about 15 minutes per gigabyte, or considerably longer if the controller does not have a battery-backed cache. While this process is occurring, 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. Only stripe sizes that are possible for this configuration are shown.
6. Click **Finish** to accept the changes.

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.

7. Click **Save**. Migration begins.

To check the progress of a migration, click the icon for that logical drive in the Configuration View panel. A More Information pop-up window opens that describes the logical 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 is to have additional (or fewer) spare drives.
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 one or more spare drives to an array enables you to 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 enables you to determine which host controllers can access which particular logical drives in a storage system. This feature prevents data corruption that can occur when different servers using different operating systems access the same data.

SSP is available only for RA4x00 controllers, Smart Array Cluster Storage controllers, and some MSA controllers. To confirm that a particular MSA storage system supports SSP, refer to the user guide for that system.

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**.

On the next screen that appears, you can enable or disable SSP.

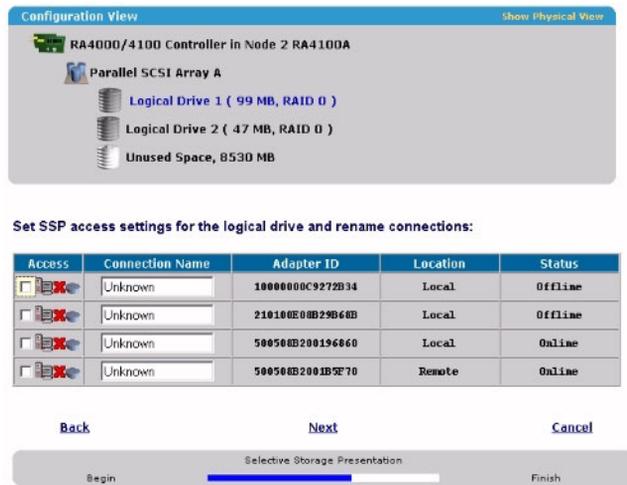
- If you disable SSP, all host controllers have access to the logical drive.
- If you enable SSP, you can decide which hosts are to have access to the logical drive.

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

If you select **Enable**, the screen lists all identified host controllers.

4. Select the host controllers that are to have access to the logical drive, rename the connections if necessary, and then click **Next**.

NOTE: Be sure that every HBA in the system has access to the logical drives for which multi-path will be used.



5. Click **Finish**.

MSA and Smart Array Cluster Storage Controllers

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

On the next screen that appears, you can enable or disable SSP.

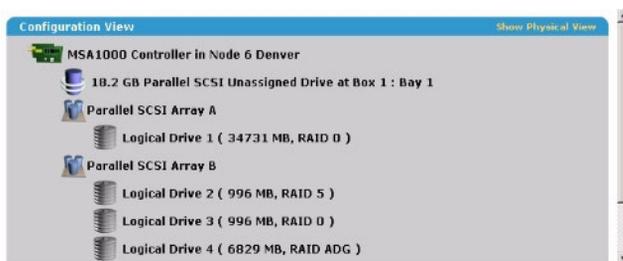
- If you disable SSP, all host controllers have access to all logical drives.
- If you enable SSP, you can decide which hosts are to have access to which logical drives.

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

If you select **Enable**, the screen lists all identified host controllers.

3. Select the host controllers that are to have access to each logical drive, define the host mode for each controller, rename the connections if necessary, and then click **Next**.

NOTE: Be sure that every HBA in the system has access to the logical drives for which multi-path will be used.



Set SSP access settings for each logical drive and rename connections.

Selective Storage Presentation Settings							
Host Controller				Logical Drive			
Adapter ID	Details	Connection Name	Host Mode	1	2	3	4
1000000C9272B34	Location: Local Status: Online	Unknown	Windows	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1000000C9272B0C	Location: Remote Status: Online	Unknown	Linux	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2100000E08B09B68B	Location: Local Status: Offline	Unknown	Default	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2101000E08B29B68B	Location: Local Status: Offline	Unknown	Default	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

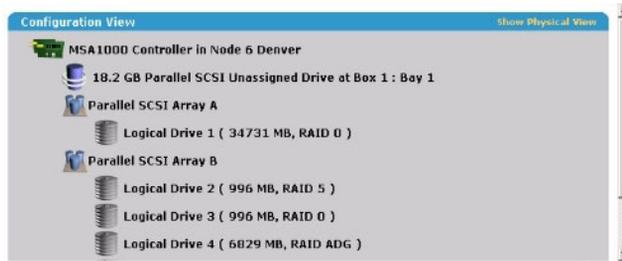
4. Click **Finish**.

Configuring Switches

If the selected controller supports switch configuration, the menu link for this feature is given in the Wizards panel in the lower right-hand corner of the main ACU configuration screen.

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 want to configure, and then click **Next**.

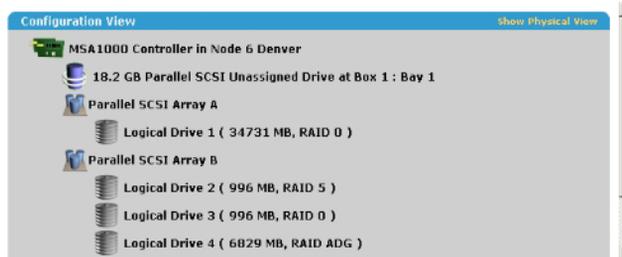


In the following screens, you will be asked a few simple questions that will allow the switch on your controller to be configured. Once your changes have been entered, clicking on the Finish link will immediately save any valid changes.

Select the switch you wish to configure:



4. Click **ACU Switch Configuration**.



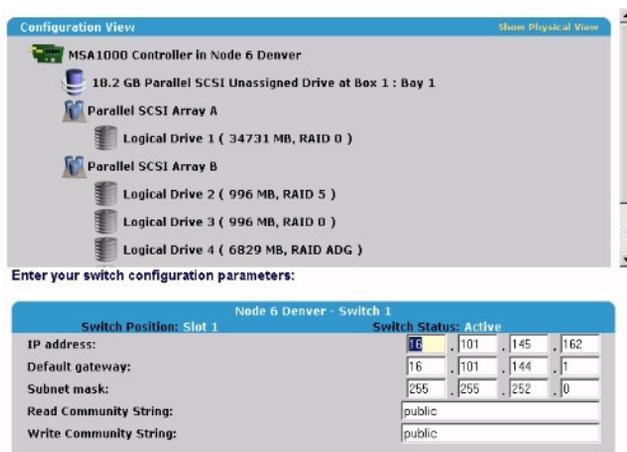
This Switch's status is currently set to Inactive. The Switch Configuration Utility cannot be used to configure your Switch until the status is set to Active. Once the IP, Gateway, and Subnet Mask address have been successfully set on your Switch, the status will be listed as Active and the Switch Configuration Utility will be available.

Select a task below:

[ACU Switch Configuration](#)

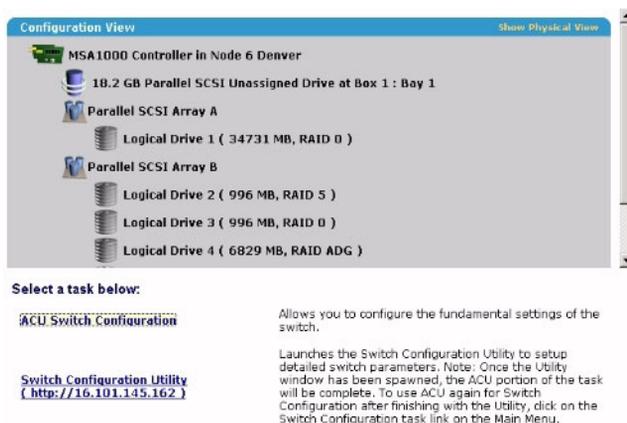
Allows you to configure the fundamental settings of the switch.

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



The screen now displays a URL for launching the Switch Configuration Utility. This utility is a Java™ applet that enables you to further configure the switch. You might need to load the most current Java™ plug-in to be able to use the applet.

- Click the URL link.



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

Scripting in ACU

In This Section

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Introduction to Scripting in ACU

ACU provides scripting support to enable 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. You can improve the clarity of the script by leaving lines blank and by creating comments. To create a comment, enter a semicolon and then the comment text. 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 can 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 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 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 = "XXXXXXXXXXXXXXXXXXXXXXX"
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 you do not always need to assign values to every option. ACU can use default values in some cases, while in other cases, a given option might not be relevant for a particular controller or operating mode.

The options for each category are listed in the table ("Description of Option Categories in ACU Scripting" on page [46](#)), and described in more detail in the rest of this section.

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 section of the script, but you can script other options in this category in any order. You can use one script to configure several controllers if all controllers are to be configured identically, or if you define each controller configuration separately. When you define each controller separately, specify all category options for a particular controller before starting a new controller listing.

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 section of the script, but you can script the other options in this category 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 section of the script, but you can script the other options in this category in any order.

Control Category

The Control category has two options: Action (on page [47](#)) and Method (on page [48](#)).

Action

You must specify an Action mode.

- In Configure mode, you can create new arrays, but you cannot modify existing arrays. The controller must be connected to unassigned physical drives for this mode to be available.
- In Reconfigure mode, you can modify existing arrays. For example, you can set up an array expansion, a logical drive extension, or a migration. These procedures do 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.

Method

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

In Automatic mode, ACU can perform an expansion, extension, or migration without user intervention if the values that you set for other options imply that such an operation is necessary.

Controller Category

The following options are available under the Controller category:

- Controller (on page [48](#))
- ClearConfigurationWithDataLoss (on page [49](#))
- LicenseKey ("LicenseKey, DeleteLicenseKey" on page [49](#))
- DeleteLicenseKey ("LicenseKey, DeleteLicenseKey" on page [49](#))
- RAIDArrayID (on page [49](#))
- ReadCache ("ReadCache, WriteCache" on page [49](#))
- WriteCache ("ReadCache, WriteCache" on page [49](#))
- RebuildPriority ("RebuildPriority, ExpandPriority" on page [50](#))
- ExpandPriority ("RebuildPriority, ExpandPriority" on page [50](#))
- SurfaceScanDelay (on page [50](#))
- SSPState (on page [51](#))

Controller

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

- All—Configure all detected controllers in the system identically.
- Slot [N]—Configure the internal controller in slot number N.

- **WWN [N]**—Configure the external controller that has the World Wide Name N.
- **SerialNumber [N]**—Configure the shared storage controller that has serial number N.

ClearConfigurationWithDataLoss

The default value 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, DeleteLicenseKey

These options enable you to enter a 25-character license key to activate or uninstall some controller features. 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. The allowable cache ratios depend on the controller model and whether it has battery-backed cache, as described in the table ("Allowable Cache Ratios" on page [50](#)).

Allowable Cache Ratios

NOTE: Y indicates that the specified cache ratio is allowed for that type of controller, while -- indicates that the ratio is not allowed.

Read:write ratio	RA4x00 with 16MB Cache	RA4x00 with 48MB Cache	All Other Controllers with Battery-backed Cache	All Other Controllers 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	--	--
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	--

***NOTE:** 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

This option has three possible values: Low, Medium, and High. The default value 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

There are two settings for this option: Enable and Disable. If you do not specify a value for the SSP State, the existing setting remains unchanged.

NOTE: The SSPState option is valid only for controllers that enable SSP on a controller basis, such as the MSA1000 or the Smart Array Cluster Storage controllers. RA4x00 controllers support SSP that is enabled on a logical drive basis, and use the LogicalDriveSSPState option ("LogicalDriveSSPState" on page [54](#)) instead.

If you enable SSP, you must also specify an adapter for one or more logical drives by using the SSPAdaptersWithAccess option ("SSPAdaptersWithAccess" on page [55](#)). Otherwise, SSP is automatically disabled.

Array Category

These options are available under the Array category:

- Array (on page [51](#))
- OnlineSpare (on page [51](#))
- Drive (on page [52](#))

Array

Enter a letter in the range A–Z or a–f to identify the array that is to be created or reconfigured, bearing in mind these additional limitations:

- In Configure mode, ACU creates a new array. The letter value that you specify must be the next available letter in the sequence, considering the number of existing arrays on the controller.
- In Reconfigure mode, ACU can either create a new array or reconfigure an existing array. In this case, the letter value that you specify can identify an existing array, or it can correspond to the next available array letter in the existing configuration.

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, the default setting keeps any existing spares in the array.

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: You can use this option to add drives to an existing array (that is, to expand the array), as long as the capacity of the added drives is no less than that of the smallest existing drive in the array. You can also use this option to remove drives from an array if you first set the value of the `ClearConfigurationWithDataLoss` option to Yes.

Logical Drive Category

These options are available in the Logical Drive category:

- LogicalDrive (on page [53](#))
- RAID (on page [53](#))
- Size (on page [53](#))
- Sectors (on page [53](#))
- StripeSize (on page [54](#))
- ArrayAccelerator (on page [54](#))
- LogicalDriveSSPState (on page [54](#))
- SSPAdaptersWithAccess (on page [55](#))

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 setting 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.



CAUTION: Back up all data before extending a logical drive.

Sectors

This option specifies the number of sectors that are to comprise each track. Enter 32 to disable MaxBoot or 63 to enable it.

- 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.



CAUTION: Back up all data before extending a logical drive.

ArrayAccelerator

This option specifies whether the array accelerator is enabled or disabled for the specified logical drive. The default value 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). Other controllers that support SSP use the SSPState option ("SSPState" on page [51](#)).

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

SSPAdaptersWithAccess

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

NOTE: Be sure that every HBA in the system has access to the logical drives for which multi-path will be used.

Error Reporting

Any errors that are encountered during ACU scripting are logged to ERROR.INI. This error file describes the error 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 table ("ACU Scripting Error Messages" on page [55](#)).

ACU Scripting Error Messages

Message	Comment or Explanation (if not self-explanatory)
(<i>text</i>) is not a controller command	--
(<i>text</i>) is not a logical drive command	--
(<i>text</i>) is not a supported command	--
(<i>text</i>) is not an array command	--
(<i>text</i>) 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.

Message	Comment or Explanation (if not self-explanatory)
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 MaxBoot setting on a configured logical drive because doing so causes data loss.
Cannot change SSP settings	--
Cannot create array	The controller either has no unassigned physical drives, or it 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.
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 (<i>text</i>) 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	--

Message	Comment or Explanation (if not self-explanatory)
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	--
Controller requires non-failed physical drives to set license keys	--
Controller requires physical drives to set license keys	--
Could not detect controller (<i>text</i>)	--
Error communicating with controller	--
Error saving controller	There is a problem saving one or more controller configurations.
Failure opening capture file (<i>text</i>)	--
Failure opening input file (<i>text</i>)	--
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	--

Message	Comment or Explanation (if not self-explanatory)
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.
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 for a feature that the controller does not support.
Logical drive not specified	Some commands require a logical drive, but no logical drive is specified in the script file.
More than one (<i>text</i>) 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.

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 can 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 you must load the System Management Driver.
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.

Probability of Logical Drive Failure

In This Section

Factors Involved in Logical Drive Failure.....[61](#)

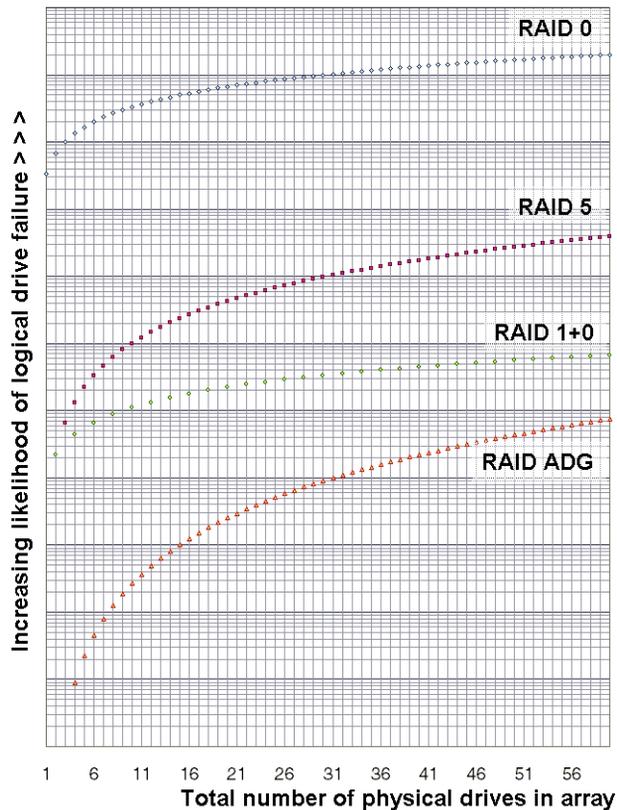
Factors Involved in Logical Drive Failure

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 the graph ("Probability of Logical Drive Failure vs. Number of Drives in Array" on page 62). The data for this graph is calculated from the 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.

Probability of Logical Drive Failure vs. Number of Drives in Array



Drive Arrays and Fault-Tolerance Methods

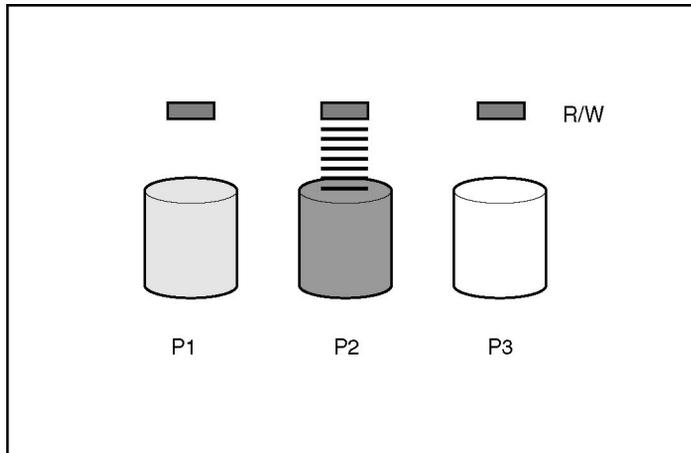
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Fault-Tolerance Methods.....	66

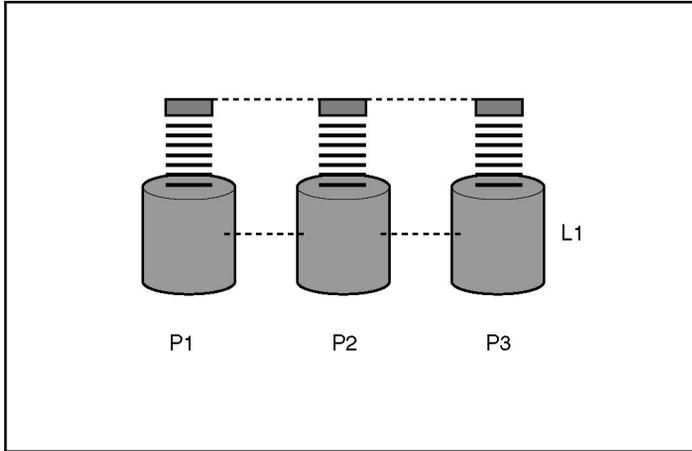
Drive Arrays

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.

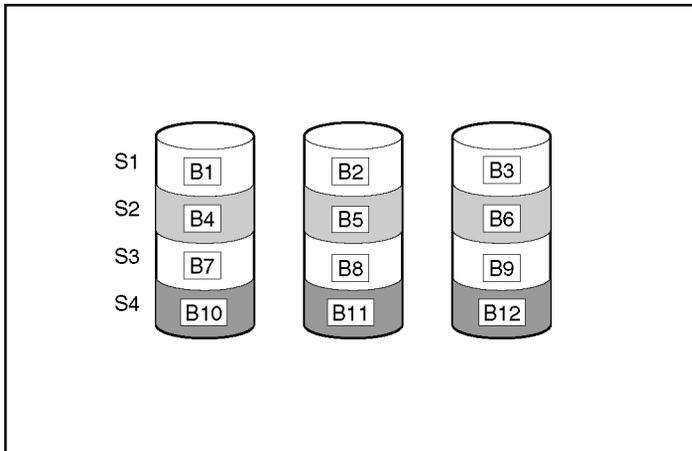
Connecting extra physical drives (P_n in the figure) to a system increases the total storage capacity but has no effect on the efficiency of read/write (R/W) operations. Data can still be transferred to only one physical drive at a time.



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.



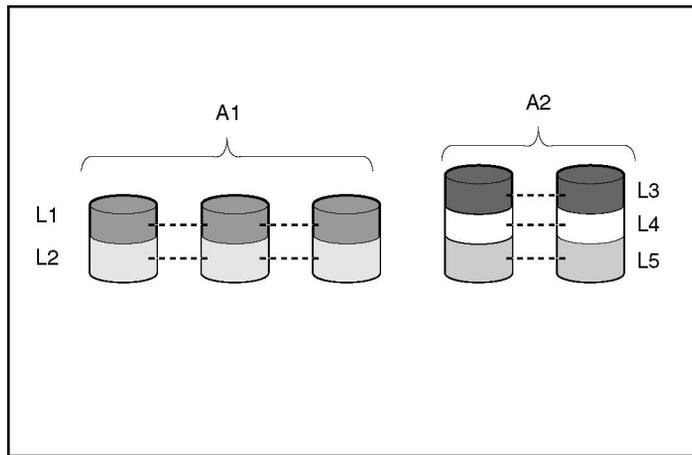
Because the read/write heads are active simultaneously, the same amount of data is written to each drive during any given time interval. Each unit of data is called a **block** (denoted by B_n in the figure), and adjacent blocks form a set of data **stripes** (S_n) across all the physical drives that comprise the logical drive.



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 the figure). Because all the physical drives in an array are commonly configured into just one logical drive, the term array is often used as a synonym for logical drive. However, an array can contain several logical drives, each of a different size.



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** ("Fault-Tolerance Methods" on page [66](#)).

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 ("Alternative Fault-Tolerance Methods" on page [72](#)). However, hardware-based RAID methods provide a much more robust and controlled fault-tolerance environment, so these alternative methods are seldom used.

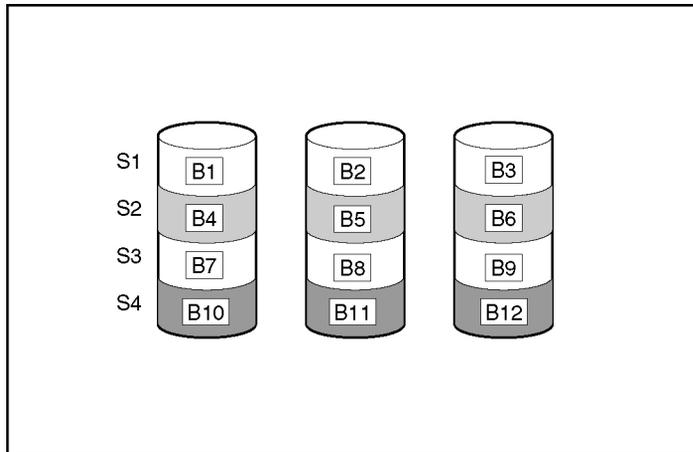
Hardware-Based Fault-Tolerance Methods

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 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:

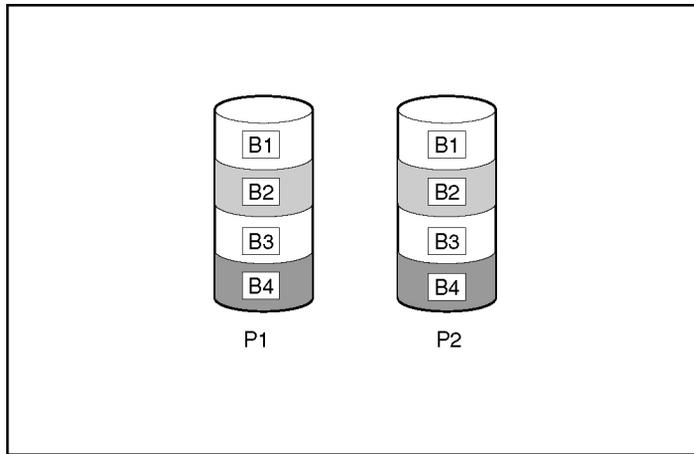
- Has the highest write performance of all RAID methods.
- Has the lowest cost per unit of stored data of all RAID methods.
- All drive capacity is used to store data (none is needed for fault tolerance).

Disadvantages:

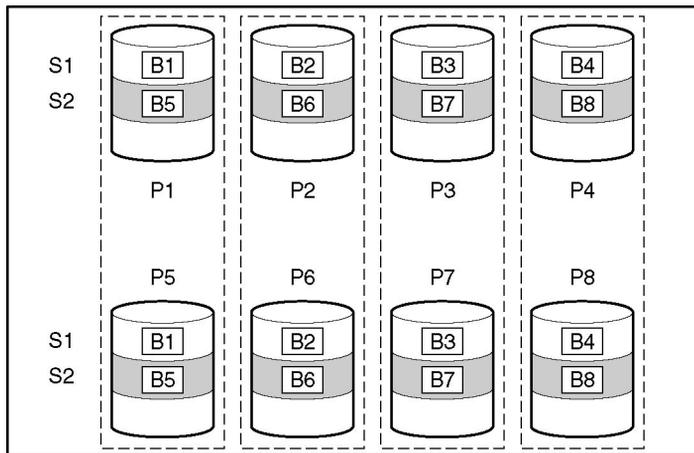
- All data on the logical drive is lost if a physical drive fails.
- Cannot use an online spare.
- Can only preserve data by backing it up to external drives.

RAID 1+0—Drive Mirroring

In a RAID 1+0 configuration, data is duplicated to a second drive.



When the array has more than two physical drives, drives are mirrored in pairs.



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:

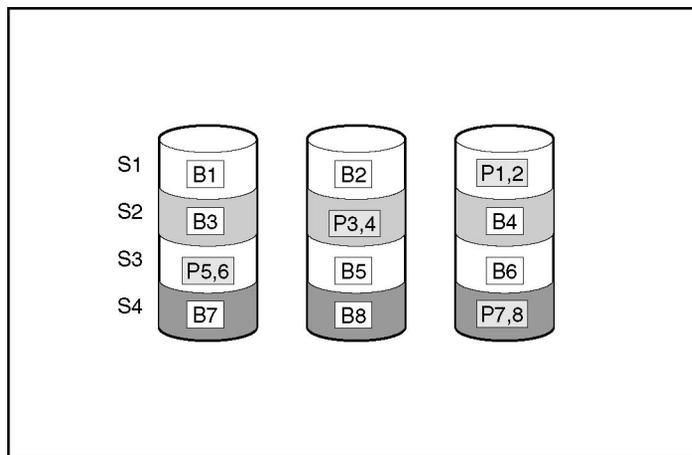
- Has the highest read performance of any fault-tolerant configuration.
- No data is lost when a drive fails, as long as no failed drive is mirrored to another failed drive (up to half of the physical drives in the array can fail).

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.



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 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.

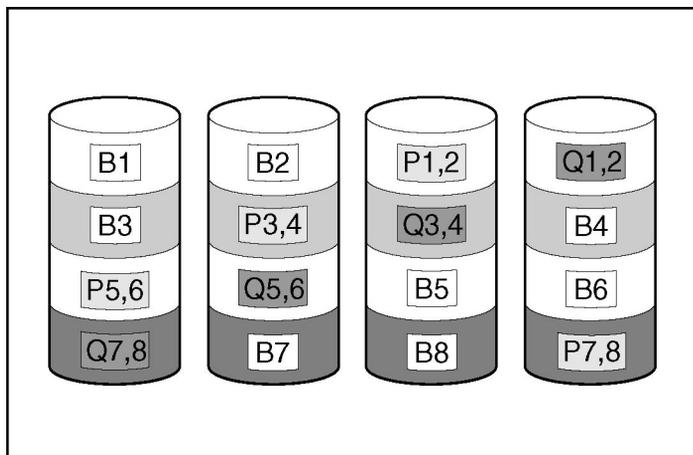
Disadvantages:

- 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 $P_{x,y}$ and $Q_{x,y}$ 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.



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.

Disadvantages:

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.

Comparing the Hardware-Based RAID Methods

NOTE: Not all controllers support RAID ADG.

Item	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	$n/2$	$(n-1)/n$	$(n-2)/n$
Minimum number of physical drives	1	2	3	4
Tolerates failure of one physical drive?	No	Yes	Yes	Yes
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

Item	RAID 0	RAID 1+0	RAID 5	RAID ADG
Relative cost	Low	High	Medium	Medium

***NOTE:** 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; and (4) no more than 56 drives are used with RAID ADG.

Selecting a RAID Method

NOTE: Not all controllers support RAID ADG.

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

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 methods, configure your arrays with RAID 0 for maximum storage capacity and refer to your operating system documentation for further implementation details.

Acronyms and Abbreviations

ACR

Array Configuration Replicator

ADG

Advanced Data Guarding

CLI

Command Line Interface

HBA

host bus adapter

MSA

Modular Smart Array

RAID

redundant array of inexpensive (or independent) disks

SA

Smart Array

SSP

selective storage presentation

WWN

World Wide Name

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