IBM ioMemory VSL 3.2.8

User Guidefor Microsoft Windows

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Legal Notices

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Introduction

Overview

Congratulations on your purchase of an IBM solid-state storage device. This guide explains how to install, troubleshoot, and maintain the software for your IBM High IOPS Adapters.

NOTE-

Throughout this manual, when you see a reference to an **IBM High IOPS Adapter**, you may substitute your particular device(s), such as an Second Generation IBM High IOPS Adapter or each of the two IBM High IOPS Adapters of an IBM High IOPS Duo Adapter.

Attention!

Products with Multiple Devices

Some products, such as an IBM High IOPS Duo Adapter, are actually comprised of **multiple IBM High IOPS Adapters**. If your product consists of multiple IBM High IOPS Adapters, you will manage each IBM High IOPS Adapter as an independent device.

For example, if you have an IBM High IOPS Duo Adapter, you can independently attach, detach, and/or format each of the two IBM High IOPS Adapters. Each of the two devices will be presented as an individual device to your system.

About the IBM High IOPS Platform

The IBM High IOPS platform combines ioMemory VSL software (VSL stand for Virtual Storage Layer) with IBM High IOPS hardware to take enterprise applications and databases to the next level.

Performance

The IBM High IOPS platform provides consistent microsecond latency access for mixed workloads, multiple gigabytes per second access and hundreds of thousands of IOPS from a single product. The sophisticated IBM High IOPS architecture allows for nearly symmetrical read and write performance with best-in-class low queue depth performance, making the IBM High IOPS platform ideal across a wide variety of real world, high-performance enterprise environments.

The IBM High IOPS platform integrates with host system CPUs as flash memory to give multiple (and mostly idle) processor cores, direct and parallel access to the flash. The platform's cut-through architecture gives systems more work per unit of processing, and continues to deliver performance increases as CPU power increases.

Endurance

The IBM High IOPS platform offers best-in-class endurance in all capacities, which is crucial for caching and write-heavy databases and applications.

Reliability

The IBM High IOPS platform eliminates concerns about reliability like NAND failures and excessive wear. The all-new intelligent, self-healing feature called Adaptive Flashback provides complete, chip-level fault tolerance. Adaptive Flashback technology enables an IBM High IOPS product to repair itself after a single chip or a multi-chip failure without interrupting business continuity.

System Requirements

Please read the *IBM ioMemory VSL Release Notes* for more information on this release.

Hardware Requirements

- **Hardware Requirements**: These depend on your device (including device capacity, generation, and configuration). Please see the *IBM High IOPS Adapter Hardware Installation Guide* for requirements on the following:
  - PCIe Slot
  - Cooling
  - Power
- **Supported Devices**: Also see the *IBM High IOPS Adapter Hardware Installation Guide* for a list of supported IBM High IOPS Adapters.
- **RAM Requirements**: The *IBM ioMemory VSL Release Notes* contains memory (RAM) requirements for this version of the software.

For specific IBM High IOPS System x server configuration information and requirements, refer to the following URL: http://www.ibm.com/support/entry/portal/docdisplay?lndocid=SERV-IOPS

Supported Windows Operating Systems

- Microsoft Windows Server 2008 R2 SP1 64-Bit
- Microsoft Windows Server 2012
- Microsoft Windows Server 2012 R2

Attention!

This version of the ioMemory VSL software supports Microsoft Windows Server 2008 R2 and later. If you are using Microsoft Windows Server 2008 SP2, you should use ioMemory VSL version 3.2.6.

Upgrading Legacy Adapters (IMPORTANT)

Please read these IBM High IOPS Adapter compatibility considerations.

Multiple High IOPS adapters are installed in a single system:

When multiple High IOPS Adapters are installed in the same server, all devices must operate with the same version of software. High IOPS adapters require matching firmware, drivers and utilities. This is a very important consideration when adding a new Second Generation High IOPS Adapter in a server where Legacy Adapters are deployed.

When Upgrading Legacy Adapters operating with a previous generation of software (1.2.x or v2.x), you must back up the data on the adapter before upgrading to prevent data loss. After upgrading the ioMemory VSL to version 3.x, the legacy adapters will not logically attach to the system until the firmware is also

updated. Detailed instructions for upgrading software is provided in See Upgrading Devices from VSL 2.x to 3.x on page 75.

Upgrading from version 1.2.x or 2.x software to 3.x:

Upgrading Legacy adapters from 1.2.x software to version 3.1.1 offers a number of significant changes and improvements, however there are some important considerations

When performing an upgrade from 1.2.x to 3.x, you must perform a staged upgrade (upgrade to the 2.x software and firmware before upgrading to 3.x). The device driver name has also changed from fio-driver (version 1.2.x) to iomemory-vsl (2.x and above).

The upgrade process from 2.x to 3.x will require the adapter to be formatted. Formatting will remove all existing data from the card and the data must be restored after the update completes. Users must back up their data before proceeding with the upgrade process to version 3.x.

The firmware upgrade process updates and modifies important hardware settings that are not compatible with 1.2.x or 2.2.3 versions of software. Once updated, the card cannot be black-leveled to the previous versions of software. Please see the "change history" documentation for a complete list of new features, enhancements, and fixes.

Replacing a failed legacy High IOPS card and "mandatory" update requirements:

As the supply of legacy adapters diminishes from inventory, it becomes more likely that warranty replacement cards will transition to the newer versions of the High IOPS adapters. Replacement High IOPS cards and may require firmware updates to support the new or existing cards in the server.

Any situation when mixing the flash NAND technology occurs, the minimum version of software supported by the latest generation of hardware prevails. A mandatory upgrade of software is required to support the latest generation of hardware with backward compatibility to legacy cards in the server.

Change History's Update Recommendations:

Change histories files provide an ongoing list of changes to a series of software compatible with a family of hardware. Please review the change histories using the following guidelines as to how IBM recommends or suggests updates to code levels at the website below:

http://www.ibm.com/support/entry/portal/docdisplay?brand=5000008&lndocid=HELP-FIX

ioMemory VSL Software Installation

Attention!

Every IBM High IOPS Adapter in a system must be upgraded to the appropriate firmware.

For example, if you have a system running ioMemory VSL software version 2.2.3 with IBM High IOPS Adapters previously installed, and you want to install new Second Generation IBM High IOPS Adapters (that require the latest version of the firmware), then you will need to upgrade all of the existing devices with firmware that supports this version of the ioMemory VSL software. Follow the upgrade path in the *IBM ioMemory VSL Release Notes* to determine the upgrade sequence.

Attention!

Upgrade Previous Devices First

If you have IBM High IOPS Adapters configured for ioMemory VSL software version 2.x or earlier, you must upgrade their firmware before installing new devices in the system. See See Upgrading Devices from VSL 2.x to 3.x on page 75 for the upgrade instructions.

If you have IBM High IOPS Adapters installed and in a RAID configuration, please read See Upgrading the Software with a RAID Configuration on page 31 before you upgrade the software and/or firmware.

Installation Overview

1. Download the latest version of the software at http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**).

2. If you are installing this version of ioMemory VSL software on a system with Legacy IBM High IOPS Adapters configured with firmware for ioMemory VSL software version 2.x, you must carefully follow the instructions in the See Upgrading Devices from VSL 2.x to 3.x on page 75. (Follow those instructions instead of the normal installation instructions.)

3. If you have a previous version of the ioMemory VSL software installed, you will need to uninstall the ioMemory VSL software and the utilities.

4. Install the latest version of the ioMemory VSL software and command-line utilities.

NOTE-

For information on capturing an installation log for troubleshooting purposes, see the following [Microsoft KB article|http://support.microsoft.com/kb/314881].

- **Extracting the MSI File**: If you require the MSI file, you may extract it using the following command:

```
<installname>.exe
```

For example, you may need the MSI file to deploy the software via Group Policy on a Windows Server.

5. Determine if you need to upgrade the firmware to the latest version, see See Upgrading the Firmware on page 15.

6. Configure the device(s) by following the configuration instructions, for example See Adding a Filesystem on page 20, See Creating a RAID Configuration on page 21, etc.

Installing the Software

Attention!

Do not install new Second Generation IBM High IOPS Adapters with previously installed Legacy IBM High IOPS Adapters (that are configured for ioMemory VSL software version 2.x) without first completing the instructions in [Appendix J- Upgrading Devices from VSL 2.x to 3.x].

1. Review the *IBM ioMemory VSL Release Notes* available for this version of the software for additional steps that may be needed to complete the install.

2. For new device installations, make sure you have properly installed the device(s) before you install the ioMemory VSL software.

3. Log in as Administrator or have Administrator rights.

4. If needed, uninstall the existing ioMemory VSL software, utilities, etc., using **Programs and Features**, or **Add or Remove Programs** (depending on your version of Windows), in the **Control Panel**.

5. Restart the computer.

NOTE-

The ioMemory VSL installation program will attempt to remove previous versions of the software, however if it fails and a previous version is removed by the user after the newest version is installed, the ioMemory VSL software will no longer load after a restart. In that case, you need to a) run the Repair option in the installation program, from **Programs and Features** (or **Add or Remove Programs**) in the Control Panel, and b) restart the computer.

6. Download the ioMemory VSL installation program for Windows from http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**) to your desktop or a convenient directory.

   - `<installname>_WinServ2008R2_2012.exe`

NOTE-

Also download the `fio-firmware-highiops-<version>.<date>.fff` firmware archive file for this release and save it in the same location.

7. Run the ioMemory VSL installation program.
8. Click **Next**.
9. To select a different folder for the installation, browse to the folder and click **OK**. The default folder is `C:\Program Files\IBM HIGH IOPS`.
    - The installer also creates a folder for the VSL utilites. The default path is `C:\Program Files\Common Files\VSL Utils`
10. Follow the onscreen prompts to complete the install.
11. Choose **Finish** on the finish screen of the installer.

Attention!

You may be prompted to reboot your system to complete the installation process. If you are not prompted to reboot, you should still reboot your system after completing the installation. If Windows does not recognize the IBM High IOPS Adapter(s) after rebooting, you may need to manually install the ioMemory VSL software for the device(s). See See Manual Installation on page 59 for information on manual installation.

Attention!

Pagefile Support

If your IBM High IOPS Adapter is configured for pagefile support, you may need to reboot a second time before Windows can create a permanent pagefile.

NOTE-

You may also install the IBM Flash Management Console (optional GUI management software). IBM Flash Management Console and documentation are available as a separate download.

NOTE-

IBM High IOPS Adapters cannot be used as hibernation devices.

Once the system restarts, proceed to See Upgrading the Firmware on page 15.

Silent Install Option

Attention!

Uninstall Previous

If the you have a version of the ioMemory VSL software previously installed, you must uninstall it first (see the information on a **Silent Uninstall** below). You can must manually reboot the computer after installing the new version with the silent install option. This step must be performed prior using any ioMemory VSL utilities or functionality.

If you are installing remotely or with scripts, you can use the silent install option (`/quiet`) when you run the installation program in the command-line interface.

In the command-line interface, navigate to the folder that contains the `.exe` installer file, and run this command:

```
<installname>.exe /quiet
```

Where the `<installname>.exe` is the name of the installer file.

This option installs the ioMemory VSL software using its default settings, eliminating the need to "click Next" or select settings during install.

Attention!

Be sure to use the `/quiet` parameter. The command-line quiet install parameter has changed and the installer no longer supports the abbreviated parameter (`/qn`). If you pass the `/qn` parameter to the installer, the installer will ignore the parameter and the installer GUI will launch.

Silent Uninstall

You may silently uninstall the ioMemory VSL software with this command:

```
<installname>.exe /uninstall /quiet
```

Upgrading the Firmware

With the ioMemory VSL software loaded, you need to check to ensure that the IBM High IOPS Adapter's firmware is up-to-date and then update the firmware if needed. You can do this with either the command-line utilities or the optional IBM Flash Management Console (GUI).

NOTE-

Make sure you have downloaded the firmware archive file that goes with this version of the ioMemory VSL software.

Attention!

There is a specific upgrade path that you must take when upgrading an IBM High IOPS Adapter. Consult the *IBM ioMemory VSL Release Notes* for this ioMemory VSL software release before upgrading IBM High IOPS Adapters.

Attention!

Do not attempt to downgrade the firmware on any IBM High IOPS Adapter, doing so may void your warranty.

When installing a new IBM High IOPS Adapter along with existing devices, you must upgrade all of the currently installed devices to the latest available versions of the firmware and ioMemory VSL software before installing the new devices. Consult the *IBM ioMemory VSL Release Notes* for this ioMemory VSL software release for any upgrade considerations.

Attention!

Upgrading Guest OS

If you are using your IBM High IOPS Adapter within a guest OS (for example, using VMDirectPathIO), you must power cycle the host server after you upgrade the device(s). Just restarting the virtual machine will not apply the the firmware update.

Command-line Interface

More information on these command-line utilities is available in See Command-line Utilities Reference on page 38. All command-line utilities require Administrator rights.

1. Run the `fio-status` utility and examine the output. See See fio-status on page 48 for usage information.
    - If any device is in minimal mode and the reason is outdated firmware.
    - If the a device is not in minimal mode, but the firmware listed for that device is a lower number than the latest firmware version available with this version of the ioMemory VSL software, then the firmware is old, but not outdated.
2. If the firmware is old or outdated, update it using the `fio-update-iodrive` utility. See See fio-update-iodrive on page 53 for complete information and warnings.

Optional GUI - IBM Flash Management Console

You can use the IBM Flash Management Console software to check the status of your IBM High IOPS Adapters. If the IBM Flash Management Console indicates that the device's firmware is outdated, you can also use the IBM Flash Management Console to upgrade the device firmware. Consult the IBM Flash Management Console documentation for more information on installing and using the software.

Configuration

Once you have your IBM High IOPS Adapter and ioMemory VSL software installed and loaded, and the firmware on the device is current, you may need to configure the device and/or software. This section outlines some of the common configurations that you may need to consider.

Setting the ioMemory VSL Options

You can configure the ioMemory VSL software using various module parameters. Individual module parameters are described throughout this guide. For a complete list of all parameters and how to implement them see See fio-config on page 41.

Virtual Controller Configuration

Depending on your use case and application, you may benefit from configuring supported devices to use Virtual Controller technology.

When configured, each physical IBM High IOPS Adapter is split into two (virtual) logical devices. Splitting the IBM High IOPS Adapter into two virtual devices has the following implications:

- **Latency**: There is no affect on latency.
- **Throughput**: The total peak I/O bandwidth of the device is approximately the same.
- **IOPS**: Depending on the use of the virtual devices (especially the average I/O size), the peak IOPS for each virtual device is about the same for a non-split device. In other words, the combined peak IOPS of the two virtual devices can be nearly double that of a non-split device. For details, see in the *Maintenance* section.
- **Capacity**: Due to virtualization overhead, the combined capacity of the two virtual devices is slightly less than that of a single-controller device. See the *IBM ioMemory VSL Release Notes* for a list of compatible devices and their Virtual Controller capacities.

Converting your IBM High IOPS Adapter to a Virtual Controller configuration will split the IBM High IOPS Adapter into two logical devices.

For 512B I/Os, the combined IOPS performance of the two virtual devices is approximately double that of a single-controller device. For 4KiB I/Os, there is more than an 80% improvement in IOPS performance with virtual devices. For 16kB and larger I/Os, there is no improvement of total IOPS performance over a non-Virtual Controller configuration.

Latency in the virtual devices is unaffected, and the combined bandwidth of the two virtual devices is the same as it would be without the split. Due to the overhead of an additional device, the combined capacity of the two virtual devices is slightly less than that of a single-controller device.

Splitting a single physical device into multiple virtualized devices, or merging multiple virtualized devices back to a single physical device, requires a low-level format, which will erase all of the data on the device. Be sure to back up all of your data.

Supported Devices

Only relatively new devices (with few writes performed) may be split or merged. Devices with too much wear are unsuitable for converting to or from a Virtual Controller configuration. Merging virtual devices may also result in additional wear (depending on the wear differences of the two virtual devices).

To be suitable for splitting or merging, devices (including Virtual Controller devices) must have 90% or more of their remaining rated endurance of Petabytes Written (PBW). This rating as well as the current percentage remaining is visible in `fio-status` with the `-a` option. For example:

```
fio-status /dev/fct1 -a
...
Rated PBW: 17.00 PB, 99.95% remaining
```

In the above example, the device is suitable for conversion because it has more than 90% of the rated PBW remaining.

If you attempt to merge or split a device that does not support Virtual Controller technology or a device that has too much wear, the update utility will not allow the conversion and the firmware upgrade will not take place. See the Release Notes for a list of devices that support Virtual Controller technology and their capacities after the conversion.

Multi-device Products

For products with more than one IBM High IOPS Adapter, such as an IBM High IOPS Duo Adapter, you must configure all of the IBM High IOPS Adapters to Virtual Controller technology at the same time. All of the devices must also be merged at the same time. For example, the two IBM High IOPS Adapters in an IBM High IOPS Duo Adapter will be converted into four virtual devices. The utility will not allow a conversion if you attempt to split or merge only one physical device in a multi-device product.

Splitting Controllers

Be sure to use firmware that supports Virtual Controller technology. Consult the Release Notes to determine if the firmware for that release supports Virtual Controller technology.

1. Back up all of your data. Because a low-level format is needed to complete the conversion, all of the user data on your device will be erased.

2. Use the `fio-update-iodrive` command-line utility to configure an IBM High IOPS Adapter to use Virtual Controller technology:

    - Use the `--split` option to split the controller.

    - Use the `-d` option to specify a device, otherwise all installed devices that can be split will be split.

    - Specify the firmware path, and check the *IBM ioMemory VSL Release Notes* to make sure the firmware supports Virtual Controller technology.

Example:

```
fio-update-iodrive --split -d /dev/fct0 <firmware-path>
```

After rebooting, each physical device will be split into two virtual devices. Each IBM High IOPS Adapter will therefore split into two logical devices, each with a unique device path. For example, `/dev/fct0` may become `/dev/fct0` and `/dev/fct1`. You will manage each device as a unique device.

3. Reboot.
4. Load the ioMemory VSL driver.
5. Run `fio-status` to determine which devices need to be formatted.
6. Low-level format the device(s). For example:

```
fio-format /dev/fct0 /dev/fct1
```

Formatting will erase all user data, be sure to back up your data. You can reverse the split by merging the controllers (without losing data) up until you format the virtual devices.

Merging Controllers

If your IBM High IOPS Adapter (including the two virtual devices) is suitable for merging, then you will be able to use the `fio-update-iodrive` utility to merge the virtual devices back into one physical device.

1. Back up all of your data. Because a low-level format is needed to complete the merge, all of the user data on your device will be erased.
2. Use the `fio-update-iodrive` command-line utility to configure the device for merging:
   a. Use the `--merge` option to merge the virtual devices.
   b. Use the `-d` option to specify a device.

Attention!

The `fio-update-iodrive` utility only successfully works against one of the two virtual devices for each physical IBM High IOPS Adapter. Out of the two virtual devices, only the first virtual device (in terms of device numbering) is linked to the physical device (and the firmware). The second virtual device is not linked, and any firmware operation against that second virtual device will fail with this message:

```
Error: Device '/dev/fctx' had an error while updating.
This device does not support firmware update.
```

This is expected, and the error will not affect the update/merge of the first (linked) virtual device. The update operation will complete on all devices that can merge and otherwise accept firmware changes.

---

   c. Specify the firmware path, and check the *IBM ioMemory VSL Release Notes* to make sure the

firmware supports Virtual Controller technology.

Example:

```
fio-update-iodrive --merge -d /dev/fct0 <firmware-path>
```

3. Reboot.
4. Load the ioMemory VSL driver.
5. Run `fio-status` to determine which devices need to be formatted.
6. Low-level format the device(s). For example:

```
fio-format /dev/fct0
```

Attention!
Formatting will erase all user data, be sure to back up your data. You can reverse the merge by splitting the controllers (without losing data) up until you format the merged device.

Device Naming

The IBM High IOPS Adapter receives a name and number as part of the install process for identification. The syntax is `fctx` where *x* indicates the device number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter installed on the system. Use the IBM Flash Management Console or the `fio-status` utility to view this device number.

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Adding a Filesystem

With IBM High IOPS Adapter(s) and ioMemory VSL software installed, you can now use the Windows Disk Management utility to make your device available to applications. Typically, Windows detects the new device, initializes it, and displays it in Disk Management. You can then add partitions, format a volume, or create a RAID configuration on your IBM High IOPS Adapter using the standard Windows procedures (see the *Windows Disk Management Utility* documentation for more details).

If Windows does not initialize the device, you can do so manually. To initialize an IBM High IOPS Adapter,

1. Select **Start** > **Control Panel**.
2. Click **Administrative Tools**.
3. Click **Computer Management**.
4. Click **Disk Management** in the Storage section of the console tree.
5. Locate and right-click the IBM High IOPS Adapter in the list of storage devices on the right. (If the

IBM High IOPS Adapter does not appear in the list, choose **Rescan Disks** from the Action menu. You may also need to restart your computer to display the IBM High IOPS Adapter in the list.)

6. Click **Initialize Disk**.

You can now use the Disk Management Utility to add a file system to your IBM High IOPS Adapter.

Creating a RAID Configuration

You can use your IBM High IOPS Adapter as part of a RAID configuration with one or more additional IBM High IOPS Adapters. To do so, you must format your IBM High IOPS Adapters as dynamic volumes. In turn, you can then use these dynamic volumes to create multi-disk RAID configurations (spanned, striped, mirrored, or RAID 5).

For specific steps to perform a RAID configuration, see the *Windows Disk Management Utility* documentation for details.

NOTE-

If you are using RAID1/Mirroring and one device fails, be sure to run a fio-format on the replacement device (not the remaining good device) before rebuilding the RAID.

Using the Device as a Page Files Store

To safely use the IBM High IOPS Adapter with page files (also known as Virtual Memory) requires passing the `preallocate_memory` kernel module parameter. To set this parameter, use either the optional IBM Flash Management Console (see IBM Flash Management Console documentation), or use the fio-config command-line utility (see See fio-config on page 41 for the full utility instructions):

```
fio-config -p FIO_PREALLOCATE_MEMORY 1149D2717-1121,1149D2717-1111,10345
```

- Where `1149D2717-1111,1149D2717-1111,10345` are serial numbers obtained from `fio-status`, see See fio-format on page 45.

Once you have set this parameter, you can go into the system settings and use the IBM High IOPS Adapter (s) to store the paging files. For more information see See Using the Windows Page Files on page 64.

NOTE-

Be sure to provide the serial numbers for the IBM High IOPS Adapter, not an adapter, when applicable.

Attention!

You must have enough RAM available to enable the IBM High IOPS Adapter with pre-allocation enabled for use as swap. Attaching an IBM High IOPS Adapter, with pre-allocation enabled, without sufficient RAM may result in the loss of user processes and system instability.

Consult the *IBM ioMemory VSL Release Notes* for RAM requirements with this version of the

ioMemory VSL software.

NOTE-

The `preallocate_memory` parameter is recognized by the ioMemory VSL software at load time, but the requested memory is not actually allocated until the specified device is attached.

Setting the Amount of Preallocated Memory

If you enable devices for preallocation (as described above), the ioMemory VSL software will automatically preallocate the amount of memory based on your formatted sector size. If you have a sector size that is less than 4KiB (for example, 512B sectors), then the ioMemory VSL software will preallocate a very large amount of memory (calculated for worst-case scenarios based on 512B sectors).

See the *IBM ioMemory VSL Release Notes* for worst-case RAM requirements based on formatted sizes. The ioMemory VSL software preallocates enough memory for worst-case scenarios in order to avoid an out-of-memory situation where the IBM High IOPS Adapter would no longer function due to insufficient memory (resulting in a system crash).

Operating systems normally use at least 4KiB blocks of data for virtual memory, so it would be safe in most cases for the ioMemory VSL software to preallocate enough memory for a worst-case scenario based on 4KiB sectors. There are two ways to force the ioMemory VSL software to preallocate based on 4KiB block sizes:

- **Format the device to 4KiB sectors**. With preallocation enabled, the ioMemory VSL software will automatically preallocate memory based on 4KiB blocks of data. Use `fio-format` to format the IBM High IOPS Adapter with 4KiB sector sizes.
- **Use the `PREALLOCATE_MB` parameter**. This parameter sets the amount of memory that the ioMemory VSL software will preallocate for every IBM High IOPS Adapter in the system that is enabled for preallocation (as described in the previous section).

Attention!

Ensure that you are preallocating enough system memory. If you do not allocate enough memory and you attempt to use the device for paging files (due to a miscalculation or entry error), the system may crash as memory resources are depleted.

1. Determine the amount of system memory needed for every device in a worst-case scenario.
   a. See the *IBM ioMemory VSL Release Notes* for worst-case RAM requirements based on sector sizes.
   b. You can base this calculation on the sector size that aligns with the data block size that your operating system uses for virtual memory.
2. Set the parameter by using the fio-config command-line utility (see See fio-config on page 41 for the full utility instructions):

```
fio-config -p PREALLOCATE_MB=<value>
```

Where `<value>` is the amount of system memory in MB that the ioMemory VSL software should preallocate for **every** IBM High IOPS Adapter that is enabled for preallocation. For example, if you entered a value of `3500`, then the ioMemory VSL software will preallocate about 3.5GB of RAM for every IBM High IOPS Adapter that is enabled for preallocation in that system.

Attention!

In order for the preallocation of memory to be effective, this value should be larger than the default memory usage of the device (as reported by runing `fio-status -a`).

Discard (TRIM) Support

With this version of the ioMemory VSL software, Discard (also known as TRIM) is enabled by default.

Discard addresses an issue unique to solid-state storage. When a user deletes a file, the device does not recognize that it can reclaim the space. Instead the device assumes the data is valid.

Discard is a feature on newer filesystem releases. It informs the device of logical sectors that no longer contain valid user data. This allows the wear-leveling software to reclaim that space (as reserve) to handle future write operations.

Attention!

Windows does not support TRIM with a RAID 5 configuration.

TRIM on Windows Server 2008 R2 and Newer

Windows Server 2008 R2 and newer have built-in TRIM support. With these operating systems, ioMemory devices work with Windows TRIM commands by default.

Performance and Tuning

IBM High IOPS Adapters provide high bandwidth, high Input/Output per Second (IOPS), and are specifically designed to achieve low latency.

As IBM High IOPS Adapters improve IOPS and low latency, the device performance may be limited by operating system settings and BIOS configuration. These settings may need to be tuned to take advantage of the revolutionary performance of IBM High IOPS Adapters.

While IBM High IOPS Adapters generally perform well out of the box, this section describes some of the common areas where tuning may help achieve optimal performance.

Disable CPU Frequency Scaling

Dynamic Voltage and Frequency Scaling (DVFS) are power management techniques that adjust the CPU voltage and/or frequency to reduce power consumption by the CPU. These techniques help conserve power and reduce the heat generated by the CPU, but they adversely affect performance while the CPU transitions between low-power and high-performance states.

These power-savings techniques are known to have a negative impact on I/O latency and IOPS. When tuning for performance, you may benefit from reducing or disabling DVFS completely, even though this may increase power consumption.

DVFS, if available, is often configurable as part of your operating systems power management features as well as within your system's BIOS interface. Within the operating system and BIOS, DVFS features are often found under the Advanced Configuration and Power Interface (ACPI) sections; consult your computer documentation for details.

Limiting ACPI C-States

Newer processors have the ability to go into lower power modes when they are not fully utilized. These idle states are known as ACPI C-states. The `C0` state is the normal, full power, operating state. Higher C-states (`C1`, `C2`, `C3`, etc.) are lower power states.

While ACPI C-states save on power, they can have a negative impact on I/O latency and maximum IOPS. With each higher C-state, typically more processor functions are limited to save power, and it takes time to restore the processor to the `C0` state.

When tuning for maximum performance you may benefit from limiting the C-states or turning them off completely, even though this may increase power consumption.

Setting ACPI C-State Options

If your processor has ACPI C-states available, you can typically limit or disable them in the BIOS interface (sometimes referred to as a Setup Utility). APCI C-states may be part of of the Advanced Configuration and Power Interface (ACPI) menu. Consult your computer documentation for details.

Setting NUMA Affinity

Servers with a NUMA (Non-Uniform Memory Access) architecture may require special installation instructions in order to maximize IBM High IOPS Adapter performance. This includes most multi-socket servers.

On some servers with NUMA architecture, during system boot, the BIOS will not associate PCIe slots with the correct NUMA node. Incorrect mappings result in inefficient I/O handling that can significantly degrade performance. To prevent this, you must manually assign ioMemory devices optimally among the available NUMA nodes.

See See NUMA Configuration on page 71 for more information on setting this affinity.

Setting the Interrupt Handler Affinity

Device latency can be affected by placement of interrupts on NUMA systems. We recommend placing interrupts for a given device on the same NUMA node that the application is issuing I/O from. If the CPUs on this node are overwhelmed with user application tasks, in some cases it may benefit performance to move the the interrupts to a remote node to help load-balance the system.

Many operating systems will attempt to dynamically place interrupts across the nodes, and generally make good decisions.

Windows IRQ Policy

By default, Windows uses a policy of `IrqPolicyAllCloseProcessors` and a priority of IrqPriorityNormal, which should work best for most applications.

If manual tuning is needed, Windows provides the Interrupt Affinity Policy Tool. Information on this tool can be found at: http://msdn.microsoft.com/en-us/windows/hardware/gg463378. The settings that the application changes are listed at: http://msdn.microsoft.com/en-us/library/ff547969(v=vs.85).aspx.

With Windows Sever 2008 or newer on a machine with more than 64 processors, there's an additional GroupPolicy parameter that can be set through the registry in order to set the affinity to a different processor group. This is documented at: http://msdn.microsoft.com/en-us/windows/hardware/gg463349.

Monitoring and Managing Devices

IBM provides many tools for managing your IBM High IOPS Adapters. These tools will allow you to monitor the devices for errors, warnings, and potential problems. They will also allow you to manage the devices including performing the following functions:

- Firmware upgrades
- Low-level formatting
- Attach and detach actions
- Device status and performance information
- Configuring Swap and Paging
- Generating bug reports

Management Tools

IBM has provided several tools for monitoring and managing IBM High IOPS Adapters. These include stand-alone tools that require no additional software and data-source tools that can be integrated with other applications.

Consider the descriptions of each tool to decide which tool (or combination of tools) best fits your needs.

Attention!

The ioMemory VSL software does print some error messages to the system logs, and while these messages are very useful for troubleshooting purposes, the ioMemory VSL software log messages are not designed for continual monitoring purposes (as each is based on a variety of factors that could produce different log messages depending on environment and use case). For best results, use the tools described in this section to regularly monitor your devices.

Stand-alone Tools

These stand-alone tools do not require any additional software.

- **Command-line Utilities**: These utilities are installed with the ioMemory VSL software and are run manually in a terminal. The `fio-status` utility provides status for all devices within a host. The other utilities allow you to perform other management functions. See Command-line Utilities Reference on page 38 for full details.
- **IBM Flash Management Console**: The GUI browser-based IBM Flash Management Console allows you to monitor and manage every IBM High IOPS Adapter installed in multiple hosts across your network. It collects all of the alerts for all IBM High IOPS Adapters and displays them in the Alert Tab. You may also set up the IBM Flash Management Console to send email or SMS messages for specific types of alerts or all alerts. The IBM Flash Management Console packages and documentation are available as separate downloads.

Data-source Tools

These data-source tools provide comprehensive data, just like the stand-alone tools, but they do require integration with additional software. At a minimum, some tools can interface with a browser. ***However, the benefit of these tools is that they can be integrated into existing management software that is customized for your organization.***

These tool packages and documentation are also available as separate downloads (separate from the ioMemory VSL software packages).

- **SNMP Subagent**: The IBM SNMP AgentX subagent allows you to monitor and manage your IBM High IOPS Adapters using the Simple Network Management Protocol. You can use a normal SNMP browser, or customize your existing application to interface with the subagent.
- **SMI-S CIM Provider**: The CIM provider allows you to monitor and manage your devices using the Common Information Model. You can use a normal CIM browser, or customize your existing application to interface with the CIM provider.
- **ioMemory VSL Management SDK**: This C programing API allows you to write customize applications for monitoring and managing IBM High IOPS Adapters.

Example Conditions to Monitor

This section gives examples of conditions you can monitor. It is intended as an introduction and not as a comprehensive reference. These conditions will have slightly different names, states, and values, depending on the tool you choose. For example, an SNMP MIB may have a different name than a SMI-S object or an API function.

In order to properly monitor these conditions, you should become familiar with the tool you choose to implement and read the documentation for that tool. You may also discover additional conditions that you wish to frequently monitor.

For quick reference, the possible states/values of these conditions are described as Normal (**GREEN**), Caution/Alert (**YELLOW**), or Error/Warning (**RED**). You may implement your own ranges of acceptable states/values, especially if you use a data-source tool.

Device Status

All of the monitoring tools return information on the status of the IBM High IOPS Adapters, including the following states:

GREEN	Attached
YELLOW	Detached, Busy (including: Detaching, Attaching, Scanning, Formatting, and Updating)
RED	Minimal Mode, Powerloss Protect Disabled

If the device is in Minimal Mode, the monitoring tool can display the reason for the Minimal Mode status.

Required Actions

If the device is in Minimal Mode, the action will depend on the reason. For example, if the reason is outdated firmware, then you will need to update the firmware.

Temperature

IBM High IOPS Adapters require adequate cooling. In order to prevent thermal damage, the ioMemory VSL software will start throttling write performance once the on-board controller reaches a specified temperature. If the controller temperature continues to rise, the software will shut down the device once the controller temperature reaches the maximum operating temperature.

These temperatures depend on the device. Newer IBM High IOPS Adapters have higher thermal tolerances. Consult the *IBM High IOPS Adapter Hardware Installation Guide* to determine the thermal tolerances of all devices you will monitor. **This table uses the controller thermal tolerances for newer devices** (93°C throttling, 100°C shutdown).

GREEN	<93°C
YELLOW	93-99°C
RED	100°C

You may wish to shift the conditions by a few degrees so the **YELLOW** condition exists before throttling occurs. For example:

GREEN	<90°C
YELLOW	90-96°C
RED	97°C

Attention!

NAND Board Temperature

Newer IBM High IOPS Adapters also report the temperature of the NAND Boards. This is also a critical temperature to monitor. Consult the *IBM High IOPS Adapter Hardware Installation Guide* to see if your device reports this temperature and to see the temperature thresholds.

Required Actions

If the temperature is at or approaching the **YELLOW** condition, thermal mitigation steps may be necessary. Evaluate the server environment and system requirements necessary to operate the High IOPS adapters. Server operating conditions are documented in the user guides for the server and the requirement to operate High IOPS adapter is at the following website, which may include updates to uEFI and IMM code levels:

http://www.ibm.com/support/entry/portal/docdisplay?lndocid=SERV-IOPS

Health Reserves Percentage

IBM High IOPS Adapters are highly fault-tolerant storage subsystem with many levels of protection against component failure and the loss nature of solid-state storage. As in all storage subsystems, component failures may occur.

By pro-actively monitoring device age and health, you can ensure reliable performance over the intended product life. The following table describes the Health Reserve conditions.

GREEN	>10%
YELLOW	0-10%
RED	0%

At the 10% healthy threshold, a one-time warning is issued. At 0%, the device is considered unhealthy. It enters *write-reduced* mode. After the 0% threshold, the device will soon enter *read-only* mode.

For complete information on Health Reserve conditions and their impact on performance, see See Monitoring the Health of Devices on page 62.

Required Actions

The device needs close monitoring as it approaches 0% reserves and goes into write-reduced mode, which will result in reduced write performance. Prepare to replace the device soon.

Write (Health Reserves) Status

In correlation with the Health Reserves Percentage, the management tools will return write states similar to these:

GREEN	Device is healthy
YELLOW	Device is getting close to entering reduced write mode.
RED	Device has entered reduced-write or read-only mode to preserve the flash from further wearout.

Required Actions

The device needs close monitoring as it approaches 0% reserves and goes into write-reduced mode, which will result in reduced write performance. Prepare to replace the device soon.

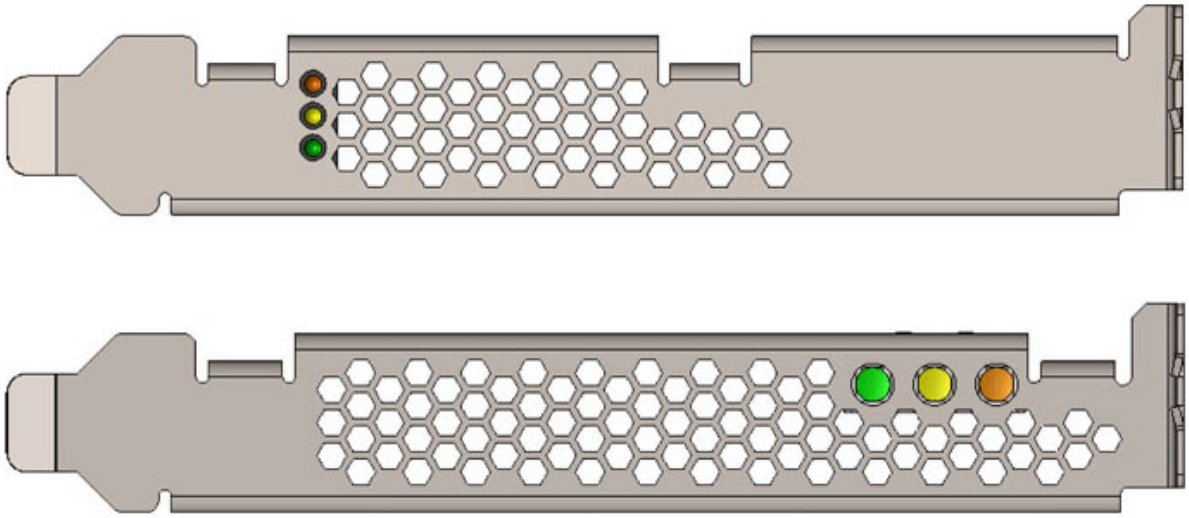
Device LED Indicators

If you have physical access to the devices and depending on your device configuration, you can use the LED indicator(s) on the bracket to monitor their status.

Attention!

IBM High IOPS Adapters may have an additional LEDs (that are not on the bracket, as shown below. You can ignore those other LEDs, as they are not meant for monitoring device and software functionality.

The LEDs on your device should be similar to one of these configurations:



This table explains the information that these LEDs convey:

Green	Yellow	Amber	Indication	Notes
OFF	**OFF**	**OFF**	Power is off.	
OFF	**OFF**	**LIT**	Power is on. Problem with device, or driver not loaded (and device unattached).	Use `fio-status` to view problem, or load driver (and attach device).
LIT	**OFF**	**OFF**	Power is on. Driver loaded (device may or may not be attached).	You may need to attach the device.
LIT	**FLASHING**	**OFF**	Writing (Rate indicates volume of writes).	Can appear in combination with the Read LED indication.
FLASHING	**OFF**	**OFF**	Read (rate indicated volume of reads).	Can appear in combination with the Write LED indication.
LIT	**LIT**	**LIT**	Location Beacon.	Use the `fio-beacon` utility to initiate this behavior.

Maintenance

This section explains additional software maintenance functions not covered in the sections See Configuration on page 17 and See Monitoring and Managing Devices on page 26.

Uninstalling the Software

To uninstall the ioMemory VSL software,

1. Go to **Start** > **Control Panel**.
2. Click **Programs & Features**.
3. Select the **ioMemory VSL** entry.
4. Click **Uninstall**.

Windows uninstalls the ioMemory VSL software folder along with all files and folders.

Upgrading the Software with a RAID Configuration

Attention!

Be sure to read the *IBM ioMemory VSL Release Notes* document that comes with each new release as well as these installation instructions to ensure no loss of data when performing upgrades.

To upgrade the ioMemory VSL software with a RAID configuration in place:

1. Shut down any applications that are accessing the IBM High IOPS Adapters.
2. Open the ioMemory VSL utilities folder. (The default location for this release is `C:\Program Files\Common Files\VSL Utils`.)
3. Use the `fio-config` utility to disable auto attach. For example:

   ```
   fio-config -p AUTO_ATTACH 0
   ```

   Your IBM High IOPS Adapter will no longer automatically attach the next time you restart the computer.
4. Uninstall the ioMemory VSL software in **Windows Add/Remove Programs**.
5. Restart the computer.
6. Download the latest ioMemory VSL software package from http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**).
7. Unzip and install the ioMemory VSL software. While finishing installation, click the "No" button to

select a manual restart.

8. Open the ioMemory VSL utilities folder. (The default location is `C:\Program Files\Common Files\VSL Utils`)
9. Use the `fio-config` utility to re-enable auto attach. For example:

```
fio-config -p AUTO_ATTACH 1
```

   Your IBM High IOPS Adapter will now automatically attach the next time you restart the computer.

10. Update the firmware of the devices. Follow the steps in See Upgrading the Firmware on page 15.

NOTE-

Restart the computer after the firmware upgrade is complete. The ioMemory VSL Check Utility will run at next boot.

Windows now detects your devices in the RAID configuration with the upgraded software.

Defragmentation

The IBM High IOPS Adapter does not need to be defragmented. Some versions of Windows, however, run defragmentation as a scheduled task automatically. If necessary, you should turn off automatic defragmentation.

Disabling Auto-Attach

When the ioMemory VSL software is installed, it is configured to automatically attach any devices when the ioMemory VSL software is loaded. Sometimes you may want to disable the auto-attach feature (to assist in troubleshooting or diagnostics). To do so:

NOTE-

You can also use the IBM Flash Management Console to enable or disable auto-attach. See the IBM Flash Management Console documentation for more information.

1. Open the command-line interface with Administrator permissions.
2. Run the following command:

```
fio-config -p AUTO_ATTACH 0
```

   a. See See fio-config on page 41 for more information on setting parameters.

Once you restart your system, your IBM High IOPS Adapter will no longer automatically attach until you re-enable auto attach (see See Enabling Auto-Attach on page 33)

When you finish troubleshooting the ioMemory VSL software issue, use the `fio-attach` utility or the IBM Flash Management Console to attach the IBM High IOPS Adapter(s) and make them available to Windows.

Enabling Auto-Attach

To re-enable auto-attach after disabling it using the method described in [Disabling Auto-Attach]:

1. Open the command-line interface with Administrator permissions.
2. a. Run the following command:

```
fio-config -p AUTO_ATTACH 1
```

i. See See fio-config on page 41 for more information on setting parameters.

The next time you restart your Windows system, your IBM High IOPS Adapter will automatically attach.

Unmanaged Shutdown Issues

Unmanaged shutdown due to power loss or other circumstances can force the IBM High IOPS Adapter to perform a consistency check during restart. This may take several minutes or more to complete and is shown by a progress percentage during Windows startup.

You can cancel this consistency check by pressing Esc during the first 15 seconds after the "Fusion-io Consistency Check" message appears at the prompt. If you choose to cancel the check, however, the IBM High IOPS Adapter(s) will remain unavailable to users until the check is done. (You can perform this check later on using IBM Flash Management Console's Attach function).

Although data written to the IBM High IOPS Adapter will not be lost due to unmanaged shutdowns, important data structures may not have been properly committed to the device. This consistency check (also called a rescan) repairs these data structures.

Improving Rescan Times

The rescan of the device (also called a consistency check) the VSL performs after an unmanaged shutdown may take an extended period of time depending on the total capacity of the device(s) that the ioMemory VSL software needs to scan.

Default Fast Rescan

By default, all IBM High IOPS Adapters formatted with the fio-format utility or ioSphere are formatted to have improved rescan times. You can disable this default fast rescan by reformatting the device and using the `-R` option. Disabling this feature will reclaim some reserve capacity that is normally set aside to help improve rescan times.

If you leave the default fast rescan feature in place you can also take further steps to improve rescan times by implementing one of the following module parameters.

Faster Rescans Using Module Parameters

These two module parameters require the default fast rescan formatting structure, and they also use system memory (RAM) to help improve rescan times. The extra memory enables the rescan process to complete faster, which reduces downtime after a hard shutdown. This memory allocation is only temporary and is freed up after the rescan process is complete.

If you decide to use one of these parameters, you will need to set the upper limit of RAM used by that parameter. To do this, you will need to determine how much RAM each parameter may use in your scenario, how much system RAM is available, and (therefore) which parameter is more suited for your use case.

For more information on setting module parameters, see See fio-config on page 41.

Here is a quick comparison of the two parameters:

- **RMAP Parameter**
    - **Fastest**: This improvement results in the fastest rescan times.
    - **Less Scalable**: (All or nothing.) This parameter requires enough RAM to function. If the RAM limit is set too low, then the ioMemory VSL software will not use RMAP at all, and it will revert back to the default fast rescan process.
    - **Target Scenario**: This parameter will improve any use case if there is enough RAM available for the parameter. It is more suited for smaller capacity IBM High IOPS Adapters and/or systems with fewer IBM High IOPS Adapters installed. We also recommend it for devices that have been used for many small random writes.
- **RSORT Parameter**
    - **Faster**: This improves rescan times over the default fast rescan process.
    - **Scalable**: With this parameter, the ioMemory VSL softwareworks with the system RAM to improve rescan times until it reaches the RAM limit set in the parameter. At that point, the software reverts back to the default fast rescan process.
    - **Target Scenario**: This parameter will improve rescan times in any use scenario. It is especially useful in systems with multiple IBM High IOPS Adapters and/or larger-capacity IBM High IOPS Adapters. We also recommend it when IBM High IOPS Adapters are used to store databases.

RMAP Parameter

The RMAP_MEMORY_LIMIT_MiB parameter sets the upper memory (RAM) limit (in mebibytes) used by the ioMemory VSL software to perform the RMAP rescan process. You should only use this option if you have enough memory for all of your IBM High IOPS Adapters in the system. If you do not have enough memory to use this option, use the RSORT parameter instead.

Because this parameter requires a set amount of memory, it often works best with fewer IBM High IOPS Adapters and/or smaller-capacity IBM High IOPS Adapters in a system, but the determining factor is how much memory is in the system and whether there is enough to set the appropriate memory limit.

This parameter requires `4.008` bytes of RAM per block of IBM High IOPS Adapter capacity.

1. First determine the number of blocks that are formatted for each device.

    a. This information is visible when you format the device using the `fio-format` utility.

    b. Or you can estimate the number of block using the device capacity and the formatted sector size.

    This example shows a quick estimation of the number of blocks on a `400GB` device with `512B` size sectors (`2` sectors per KB):

    ```
    400GB * 1000MB/GB * 1000KB/MB * 2 Blocks/kB = 800,000,000 Blocks
    ```

2. Multiply the number of blocks by `4.008` bytes of RAM per block (and translate that into MiB) to determine the memory limit that is required for this parameter to function.

    a. In the example above there were `800 million` blocks:

    ```
    800,000,000 Blocks * 4.008B/Block * 1KiB/1024B * 1MiB/1024KiB =
    ~3058MiB of RAM
    ```

    b. In this example, you would need about 3100 MiB of RAM available in your system for a 400GB IBM High IOPS Adapter formatted for 512B sectors, and you would need to set the RMAP parameter to `3100`.

    NOTE-

    Default Value

    The RMAP parameter is, by default, set to `3100`. It is set to this low default value so the rescan process does not use all of the RAM in systems that have less available memory.

    - If the RMAP value is too low for the number of IBM High IOPS Adapter blocks in the system, then the ioMemory VSL software will not use the RMAP process to improve rescan times, it will just use the default fast rescan process. (RMAP is an all-or-nothing setting.)

    - If you don't have enough system memory to use the RMAP parameter, consider using the RSORT parameter. The RSORT parameter will use its RAM limit to improve the rescan process, and then the ioMemory VSL softwarerevert to the default fast rescan process to finish the consistency check.

3. Set the module parameter to the value you have determined. See See fio-config on page 41 for more information on setting parameters.

RSORT Parameter

The RSORT_MEMORY_LIMIT_MiB parameter sets the memory (RAM) limit used by the ioMemory VSL software to perform the RSORT rescan process. The RSORT rescan process is faster than the default rescan process and we recommend using it to rescan devices that are used datastores for databases.

If this parameter is given any memory limit, the ioMemory VSL software will use the RSORT process until either the rescan is done or it consumes the memory limit. If the process runs out of memory, it will revert to the default fast rescan process. However, in order to optimize the use of this process, you can calculate the target RAM usage and set the limit based on that target. There is no penalty for setting a high limit, the RSORT process will only use the RAM it needs (up to the limit that is set).

This target is based on 32 bytes per write extent. For example, if your database writes 16kB at a time, there is one write extent per 16kB of IBM High IOPS Adapter capacity.

NOTE-

Blocks per Write Extent

One measure of the the benefits of the RSORT process is to see how many blocks are written per write extent. The RSORT process improves rescan times over the default fast rescan process on when a device has 8 or more blocks written per extent. For example, if your IBM High IOPS Adapter is formatted to 512B sector sizes (2 sectors per KB), and your database writes in 8KB chunks, then your database writes 16 blocks per write extent and RSORT would improve the rescan times.

---

1. First determine the number of blocks that are formatted for each device.

    a. This information is visible when you format the device using the `fio-format` utility.

    b. Or you can estimate the number of block using the total device capacities and their formatted sector sizes.

    This example shows a quick estimation of the number of blocks on 1200GB of IBM High IOPS Adapter capacity with 512B size sectors (2 sectors per KB):

```
1200GB * 1000MB/GB * 1000KB/MB * 2 Blocks/kB = 2,400,000,000
Blocks
```

2. Divide the number of blocks by the write extents per block to determine the total possible number of write extents on the device(s).

    a. In the example above there were 2.4 billion blocks. We will assume 16KB write extents (32 blocks per write on 512B sectors):

```
2,400,000,000 Blocks * 1 Write Extent/32 Blocks = 150,000,000
Writes
```

3. Multiply the number of writes by 32 bytes of RAM per write (and translate that into MiB) to determine the memory target for this parameter.

    a. In the example above there were 150 million write extents:

```
150,000,000 Writes * 32B/Write * 1KiB/1024B * 1MiB/1024KiB =
~4578MiB of RAM
```

    b. In this example, you would want to set the RSORT limit to about 4600 MiB of RAM

available in your system for 1200GB of IBM High IOPS Adapter capacity formatted for 512B sectors.

NOTE-

Default Value

The RMAP parameter is, by default, set to `0`m and it has a maximim of 100000 (100GB).

---

4. Set the module parameter to the value you have determined. See See fio-config on page 41 for more information on setting parameters.

Appendix A - Command-line Utilities Reference

The ioMemory VSL software installation packages include various command-line utilities, installed by default in `C:\Program Files\Common Files\VSL Utils`. These provide a number of useful ways to access, test, and manipulate your device.

Attention!

There are some additional utilities installed in the `C:\Program Files\Common Files\VSL Utils` directory that are not listed below. Those additional utilities are dependencies (used by the main ioMemory VSL utilities), and you should not use them directly unless Customer Support advises you to do so.

NOTE-

Administrator Rights: The command-line utilities require administrator rights in order to run under Windows (right-click the **Command Prompt** menu item and select **Run as administrator**.)

To run these utilities from a command line, you must either change to the directory which contains them (by default, `C:\Program Files\Common Files\VSL Utils`) or add that directory to your system path. As a convenience, if you used the Windows installer then the utilities directory has been added to the system path for you. Otherwise, see the documentation for your version of Windows for information about adding a directory to the system path.

Utility	Purpose
`fio-attach`	Makes an IBM High IOPS Adapter available to the OS.
`fio-beacon`	Lights the IBM High IOPS Adapter's external LEDs.
`fio-bugreport`	Prepares a detailed report for use in troubleshooting problems.
`fio-config`	Enables configuration parameters for device operation.
`fio-detach`	Temporarily removes an IBM High IOPS Adapter from OS access.
`fio-format`	Used to perform a low-level format of an IBM High IOPS Adapter.
`fio-pci-check`	Checks for errors on the PCI bus tree, specifically for IBM High IOPS Adapters.
`fio-status`	Displays information about the device.
`fio-sure-erase`	Clears or purges data from the device.
`fio-update-iodrive`	Updates the IBM High IOPS Adapter's firmware.

NOTE-

There are `-h` (Help) and `-v` (Version) options for all of the utilities. Also, `-h` and `-v` cause the utility to exit after displaying the information.

fio-attach

Description

Attaches the IBM High IOPS Adapter and makes it available to the operating system. This creates a block device in `/dev` named `fiox` (where `x` is `a`, `b`, `c`, etc.). You can then partition or format the IBM High IOPS Adapter, or set it up as part of a RAID array. The command displays a progress bar and percentage as it operates.

NOTE-

In most cases, the ioMemory VSL software automatically attaches the device on load and does a scan. You only need to run fio-attach if you ran fio-detach or if you set the ioMemory VSL software's auto_attach parameter to 0.

NOTE-

If the IBM High IOPS Adapter is in minimal mode, then auto-attach is disabled until the cause of the device being in minimal mode is fixed.

Syntax

```
fio-attach <device> [options]
```

where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the device number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system.

You can specify multiple IBM High IOPS Adapters. For example, `/dev/fct1 /dev/fct2` indicates the second and third IBM High IOPS Adapters installed on the system.

Option	Description
`-r`	Force a metadata rescan. This may take an extended period of time, and is not normally required. **Attention!** Only use this option when directed by Customer Support.
`-c`	Attach only if clean.
`-q`	Quiet: disables the display of the progress bar and percentage.

fio-beacon

Description

Lights the IBM High IOPS Adapter's LED(s) to locate the device. You should first detach the IBM High IOPS Adapter and then run `fio-beacon`.

Syntax

```
fio-beacon <device> [options]
```

where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system. The device numbers are visible using `fio-status`.

Option	Description
`-0`	Off: (Zero) Turns off the LED beacon.
`-1`	On: Lights the LED beacon.
`-p`	Prints the PCI bus ID of the device at `<device>` to standard output. Usage and error information may be written to standard output rather than to standard error.

fio-bugreport

Description

Prepares a detailed report of the device for use in troubleshooting problems.

Syntax

```
fio-bugreport
```

Notes

This utility captures the current state of the device. When a performance or stability problem occurs with the device, run the `fio-bugreport` utility and contact Customer Support at http://www.ibm.com/systems/support for assistance in troubleshooting.

`fio-bugreport` runs several information-gathering utilities and combines the resulting data into a text file. The results are saved in the `utils` directory (default installation path is `C:\Program Files\Common Files\VSL Utils`) in a `.cab` file that indicates the date and time the utility was run.

Sample Output

```
C:\Program Files\Common Files\VSL Utils\fio-bugreport.exe
Generating bug report. Please wait, this may take a while...
-----------------------------------------
Gathering all Windows Event Logs...DONE
Gathering Fusion-io Windows Event Logs...DONE
```

```
Gathering System Information...DONE
Running fio utilities...DONE
Compressing to CAB file...DONE
Bug report has successfully been created:
fio-bugreport-20090921_173256.cab.
  Please attach this file to your support case.
  If you do not have an open support case for this issue, please open a
support
  case with a problem description and then attach this file to your new
case.
```

For example, the filename for a bug report file named `fio-bugreport-20090921_173256.cab` indicates the following:

- Date (20090921)
- Time (173256, or 17:32:56)

fio-config

Description

Sets and gets ioMemory VSL software configuration parameters for device operation. For a list of parameters, see **Parameters Reference** below.

In order for the parameter value(s) to be enforced, you must either reboot the system or first disable and then re-enable all IBM High IOPS Adapters in the **Device Manager**. This will reload the ioMemory VSL software with the values(s) enabled. Be sure to use the `-p` option if you plan to reboot.

Syntax

```
fio-config [options] [<parameter>] [<value>]
```

where `<parameter>` is the ioMemory VSL software parameter you wish to set, and `<value>` is the value you wish to set for the parameter.

Options	Description
`-e`	Enumerate configuration parameter names and values.
`-g <name>`	Get the configuration parameter.
`-p <name>`	Set and make the configuration parameter persistent. **Use this option if you want the parameter setting to remain after a reboot**.
`-s <name>`	Set the configuration parameter in memory only.
`-V`	Print verbose information.
`-v`	Print version information.

Parameters Reference

The following table describes the ioMemory VSL software parameters you can set with the `fio-config` utility.

> **Attention!**
> `fio-config` options must be entered in uppercase to function properly.

MSI (Message Signaled Interrupts) is enabled by default for this platform, and it cannot be disabled using `fio-config`.

Other than `FIO_PREALLOCATE_MEMORY` all `fio-config` options are global{mdash}they apply to all Fusion-io devices in the computer.

> **Attention!**
> By setting the `FIO_PREALLOCATE_MEMORY` parameter, you **overwrite previous values**. If you wish to add additional serial numbers to the list, you must list the new serial numbers as well as the previously entered numbers. To clear the list, set the parameter without any values.

Option	Default (min/max)	Description
`AUTO_ATTACH`	`1` (`0`, `1`)	Always attach the device on driver load (`1`).
`IODRIVE_TINTR_HW_WAIT`	`0` (`0`, `255`)	Interval (microseconds) to wait between hardware interrupts.
`FIO_EXTERNAL_POWER_OVERRIDE`	No devices selected	Allows selected devices to draw full power from the PCIe slot. Where the `<value>` for this parameter is a comma-separated list of adapter serial numbers. **Attention!** Use with care, see [Enabling PCIe Power Override] for more information.
`FORCE_MINIMAL_MODE`	`0` (`0`, `1`)	Force minimal mode on the device (`1`), this parameter is set to false (`0`) by default.
`PARALLEL_ATTACH`	`0` (`0`, `1`)	Enable parallel attach of multiple devices (`1`), this parameter is set to false (`0`) by default.

Option	Default (min/max)	Description
FIO_PREALLOCATE_MEMORY	0	For the selected device(s), pre-allocate all memory necessary to have the device usable as swap space. For example: `fio-config /dev/fct0 -p FIO_PREALLOCATE_MEMORY "1234,54321"` where "1234" and "54321" are serial numbers obtained from fio-status.
WIN_LOG_VERBOSE	1 (0, 1)	If enabled (1), the ioMemory VSL software will write additional messages to the event log. This will assist Customer Support in troubleshooting any device issues or failures.
WIN_DISABLE_ALL_AFFINITY	0 (0, 1)	When WIN_DISABLE_ALL_AFFINITY is set to 0, the driver will enable interrupt and worker thread affinity in the driver. When WIN_DISABLE_ALL_AFFINITY is set to 1, the driver will disable all affinity settings. This is an override of any other affinity settings. The driver must be reloaded for this parameter to take effect.

Option	Default (min/max)	Description
WIN_DISABLE_DEFAULT_NUMA_AFFINITY	0 (0, 1)	When WIN_DISABLE_DEFAULT_NUMA_AFFINITY is set to 0, during initialization, the driver will query Windows for the affinity settings assigned to the adapter by the OS. This is what is known as the "default NUMA affinity". Once the affinity is queried correctly, the driver sets the affinity of the adapter's interrupt and associated worker threads to the default OS setting. This generally has the effect of setting the affinity of the interrupt and worker threads to all processors on a single NUMA node in the system. When WIN_DISABLE_DEFAULT_NUMA_AFFINITY is set to 1, the driver will ignore the affinity settings assigned to the adapter by the OS. The driver must be reloaded for this parameter to take effect.
FIO_AFFINITY	N/A	FIO_AFFINITY is a list of <affinity specification> triplets to specify the affinity settings of all adapters in the system. Each item in the triplet is separated by a comma, and each triplet set is separated by a semicolon. **Attention!** For syntax information and examples showing the use of this parameter, see See NUMA Configuration on page 71.

fio-detach

Description

Detaches the IBM High IOPS Adapter and removes the corresponding fctxIBM High IOPS Adapter block device from the OS. The fio-detach utility waits until the device completes all read/write activity before

executing the detach operation. By default, the command also displays a progress bar and percentage as it completes the detach.

Attention!

Before using this utility, ensure that the device you want to detach is **NOT** currently mounted and in use.

Syntax

```
fio-detach <device> [options]
```

where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system.

You can specify multiple IBM High IOPS Adapters. For example, `/dev/fct1 /dev/fct2` indicates the second and third IBM High IOPS Adapters installed on the system. You can also use a wildcard to indicate all IBM High IOPS Adapters on the system. For example, `/dev/fct*`

Option	Description
`-f`	Force: Causes an immediate detach (does not save metadata). **Attention!** Although the `-f` (force) option causes the IBM High IOPS Adapter to detach, even in a RAID setup, it is strongly recommended to take the drives/volume offline using the Windows Disk Management plug-in, then perform the detach. Forcing the detach may result in loss of data.
`-q`	Quiet: Disables the display of the progress bar and percentage.

Notes

Attempting to detach an IBM High IOPS Adapter may fail with an error indicating that the device is busy. This typically may occur if the IBM High IOPS Adapter is part of a software RAID (0,1,5) volume, is mounted, or some process has the device open.

Windows refuses the request to detach the drive associated with the IBM High IOPS Adapter because it is part of a RAID volume and may cause the volume to fail. This does not occur with simple volumes (such as a single IBM High IOPS Adapter). To detach in this case, take the volume offline using the Disk Management MMC plug-in application.

fio-format

Description

NOTE-

IBM High IOPS Adapters ship pre-formatted, so `fio-format` is generally not required except to

change the logical size or block size of a device, or to erase user data on a device. To ensure the user data is truly erased, use `fio-sure-erase`, see See fio-sure-erase on page 51 for more information.

Performs a low-level format of the IBM High IOPS Adapter. By default, `fio-format` displays a progress-percentage indicator as it runs.

Attention!

Use this utility with care, as it deletes all user information on the device. You will be prompted as to whether you want to proceed with the format.

NOTE-

Using a larger block (sector) size, such as 4096 bytes, can significantly reduce worst-case ioMemory VSL host memory consumption. However, some applications are not compatible with non-512-byte sector sizes.

NOTE-

If you do not include the `-s` or `-o` options, the device size defaults to the advertised capacity. If used, the `-s` and `-o` options must include the size or percentage indicators.

Attention!

Do not interrupt the formatting! We recommend adding power backup to your system to prevent power failures during formatting. If formatting is interrupted, please contact Customer Support.

Syntax

```
fio-format [options] <device>
```

where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the device number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system. Use `fio-status` to view this number.

Options	Description
`-b <size B|K>`	Set the block (sector) size, in bytes or kibibytes (base 2). The default is 512 bytes. For example: `-b 512B` or `-b 4K` (`B` in `512B` is optional).
`-f`	Force the format size, bypassing normal checks and warnings. This option may be needed in rare situations when `fio-format` does not proceed properly. (The "Are you sure?" prompt still appears unless you use the `-y` option.)
`-q`	Quiet mode: Disable the display of the progress-percentage indicator.

`-s <size M|G|T|%>`	Set the device capacity as a specific size (in TB, GB, or MB) or as a percentage of the advertised capacity: • `T` Number of terabytes (TB) to format • `G` Number of gigabytes (GB) to format • `M` Number of megabytes (MB) to format • `%` Percentage, such as 70% (the percent sign must be included)
`-o <size B|K|M|G|T|%>`	Over-format the device size (to greater than the advertised capacity), where the maximum size equals the maximum physical capacity. If a percentage is used, it corresponds to the maximum physical capacity of the device. (Size is required for the `-o` option; see the `-s` option above for size indicator descriptions.) **Attention!** Before you use this option, please discuss your use case with Customer Support.
`-R`	Disable fast rescan on unclean shutdown to reclaim some reserve capacity.
`-y`	Auto-answer "yes" to all queries from the application (bypass prompts).

You must re-attach the device in order to use the IBM High IOPS Adapter. See fio-attach on page 39 for details.

fio-pci-check

Description

Checks for errors on the PCI bus tree, specifically for IBM High IOPS Adapters. This utility displays the current status of each IBM High IOPS Adapter. It also prints the standard PCI Express error information and resets the state.

NOTE-

It is perfectly normal to see a few correctable errors when `fio-pci-check` is initially run. Subsequent runs should reveal only one or two errors during several hours of operation.

Attention!

The ioMemory VSL software must be loaded to run this utility. Some PCI errors cannot be reset in Windows.

Syntax

```
fio-pci-check [options]
```

Option	Description
`-d <value>`	`1` = Disable the link; `0` = bring the link up (Not recommended).
`-e`	Enable PCI-e error reporting.
`-f`	Scan every device in the system.
`-n`	Do not perform any writes to config space. Will prevent errors from being cleared.
`-o`	Optimize the IBM High IOPS Adapter PCIe link settings by increasing the maximum read request size if it is too low.
`-r`	Force the link to retrain.
`-v`	Verbose: Print extra data about the hardware.

fio-status

Description

Provides detailed information about the installed devices. This utility operates on either `fctx` or `fiox` devices. The utility depends on running as root and having the ioMemory VSL driver loaded. If no driver is loaded, a smaller set of status information is returned.

`fio-status` provides alerts for certain error modes, such as a minimal-mode, read-only mode, and write-reduced mode, describing what is causing the condition.

Syntax

```
fio-status [<device>] [<options>]
```

where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system.

If `<device>` is not specified, `fio-status` displays information for all cards in the system. If the ioMemory VSL driver is not loaded, this parameter is ignored.

Option	Description
`-a`	Report all available information for each device.
`-e`	Show all errors and warnings for each device. This option is for diagnosing issues, and it hides other information such as format sizes.
`-c`	Count: Report only the number of IBM High IOPS Adapters installed.
`-d`	Show basic information set plus the total amount of data read and written (lifetime data volumes). This option is not necessary when the `-a` option is used.

`-fj`	Format JSON: creates the output in JSON format, which can be used for scripted management applications.
`-fx`	Format XML: creates the output in XML format.
`-u`	Show unavailable fields. Only valid with `-fj` or `-fx`.
`-U`	Show unavailable fields and details why. Only valid with `-fj` or `-fx`. **NOTE-** Some `fio-status` fields are unavailable depending on the operating system or device. For example, some legacy fields are unavailable on newer IBM High IOPS Adapters.
`-F<field>`	Print the value for a single field (see the next option for field names). Requires that a device be specified. Multiple `-F` options may be specified.
`-l`	List the fields that can be individually accessed with `-F`.

Attention!

Output Change

The standard formatting of `fio-status` ouput has changed compared to the output from ioMemory VSL software version 2.x. This will affect any custom management tools that used the output of this utility.

Basic Information: If no options are used, `fio-status` reports the following basic information:

- Number and type of devices installed in the system
- ioMemory VSL software version

Adapter information:

- Adapter type
- Product number
- External power status
- PCIe power limit threshold (if available)
- Connected IBM High IOPS Adapters

Block device information:

- Attach status
- Product name
- Product number
- Serial number
- PCIe address and slot

- Firmware version
- Size of the device, out of total capacity
- Internal temperature (average and maximum, since ioMemory VSL software load) in degrees Centigrade
- Health status: healthy, nearing wearout, write-reduced or read-only
- Reserve capacity (percentage)
- Warning capacity threshold (percentage)

Data Volume Information: If the `-d` option is used, the following data volume information is reported *in addition* to the basic information:

- Physical bytes written
- Physical bytes read

All Information: If the `-a` option is used, all information is printed, which includes the following information *in addition* to basic and data volume information:

Adapter information:

- Manufacturer number
- Part number
- Date of manufacture
- Power loss protection status
- PCIe bus voltage (avg, min, max)
- PCIe bus current (avg, max)
- PCIe bus power (avg, max)
- PCIe power limit threshold (watts)
- PCIe slot available power (watts)
- PCIe negotiated link information (lanes and throughput)

Block device information:

- Manufacturer's code
- Manufacturing date
- Vendor and sub-vendor information
- Format status and sector information (if device is attached)
- FPGA ID and Low-level format GUID
- PCIe slot available power
- PCIe negotiated link information
- Card temperature, in degrees Centigrade
- Internal voltage (avg and max)
- Auxiliary voltage (avg and max)
- Percentage of good blocks, data and metadata

- Lifetime data volume statistics
- RAM usage

Error Mode Information: If the ioMemory VSL software is in minimal mode, read-only mode, or write-reduced mode when `fio-status` is run, the following differences occur in the output:

- Attach status is "Status unknown: Driver is in MINIMAL MODE:"
- The reason for the minimal mode state is displayed (such as "Firmware is out of date. Update firmware.")
- "Geometry and capacity information not available." is displayed.
- No media health information is displayed.

fio-sure-erase

Attention!

As a best practice, do not use this utility if there are any IBM High IOPS Adapters installed in the system that you do not want to clear or purge. First remove any devices that you do not want to accidentally erase. Once the data is removed with this utility it is gone forever. **It is not recoverable**.

Attention!

Before you use this utility, be sure to back up any data that you wish to preserve.

NOTE-

After using `fio-sure-erase`, format the device using `fio-format` before using the device again, see See fio-format on page 45.

Attention!

If the device is in Read-only mode, perform a format using `fio-format` before running `fio-sure-erase`. If the device is in Minimal mode, then `fio-sure-erase` cannot erase the device. Updating the firmware may take the device out of Minimal Mode. If the device remains in Minimal mode, contact Customer Support at http://www.ibm.com/systems/support for further assistance.

In order to run `fio-sure-erase`, the block device **must be detached**. See See fio-detach on page 44 section for more information.

Description

The `fio-sure-erase` is a command-line utility that securely removes data from IBM High IOPS Adapters. It complies with the "Clear" and "Purge" level of destruction from the following standards:

1. DOD 5220.22-M - Comply with instructions for Flash EPROM
2. NIST SP800-88- Comply with instructions for Flash EPROM

See below for more information on Clear and Purge support.

Registry Requirement

On Windows, a registry key must be created to configure the driver for ECC-bypass mode:

1. Locate the following key:

```
HKEY_LOCAL_
MACHINE\SYSTEM\CurrentControlSet\Services\fiodrive\Parameters
```

2. Create a DWORD key underneath it called "BypassECC" and set the value to "1".

3. Restart the computer before running the utility.

Syntax

```
fio-sure-erase [options] <device>
```

Where `<device>` is the name of the device node (`/dev/fctx`), where *x* indicates the card number: 0, 1, 2, etc. For example, `/dev/fct0` indicates the first IBM High IOPS Adapter detected on the system. Use `fio-status` to view this device node, see See fio-status on page 48.

NOTE-

Products with Multiple Devices

`fio-sure-erase` works on individual IBM High IOPS Adapters. For example, if you are planning to purge an IBM High IOPS Duo Adapter, you will need to perform this operation on each of the product's two IBM High IOPS Adapters.

Option	Description
`-p`	Purge instead of Clear: performs a write followed by an erase. For more information on Purge, see below. **Attention!** Purging the device may take hours to accomplish, depending on the size of the device that needs to be purged.
`-y`	No confirmation: do not require a yes/no response to execute the utility.
`-t`	Do not preserve current format parameters, including device and sector size (reset to default).
`-q`	Quiet: do not display the status bar.

NOTE-

If you run `fio-sure-erase` with no options, a Clear is performed. For more information, see below.

When the utility completes, each block of memory consists of uniform 1 bits or 0 bits.

Clear Support

A "Clear" is the default state of running `fio-sure-erase` (with no options), and refers to the act of performing a full low-level erase (every cell pushed to "1") of the entire NAND media, including retired erase blocks.

Metadata that is required for operation will not be destroyed (media event log, erase counts, physical bytes read/written, performance and thermal history), but any user-specific metadata will be destroyed.

The following describes the steps taken in the Clear operation:

1. Creates a unity map of every addressable block (this allows `fio-sure-erase` to address every block, including previously unmapped bad blocks).
2. For each block, performs an erase cycle (every cell is pushed to "1").
3. Restores the bad block map.
4. Formats the device (the purpose of this is to make the device usable again, the utility erases all of the headers during the clear).

Purge Support

A "Purge" is implemented by using the `-p` option with `fio-sure-erase`. Purge refers to the act of first overwriting the entire NAND media (including retired erase blocks) with a single character (every cell written to logical "0"), and then performing a full chip erase (every cell pushed to "1") across all media (including retired erase blocks).

Metadata that is required for operation will **not** be destroyed (media event log, erase counts, physical bytes read/written, performance and thermal history), but any user-specific metadata will be destroyed.

The following describes the steps taken in the Purge operation:

1. Creates a unity map of every addressable block (this allows `fio-sure-erase` to address every block, including previously unmapped bad blocks).
2. For each block, performs a write cycle (every cell written to "0").
3. For each block, performs an erase cycle (every cell pushed to "1").
4. Restores the bad block map.
5. Formats the drive (the purpose of this is to make the drive usable again, the utility erases all of the headers during the clear).

fio-update-iodrive

Attention!

You should back up the data on the IBM High IOPS Adapter prior to any upgrade as a precaution.

Description

Updates the IBM High IOPS Adapter's firmware. This utility scans the PCIe bus for all IBM High IOPS Adapters and updates them. A progress bar and percentage are shown for each device as the update completes.

Attention!

It is extremely important that the power not be turned off during a firmware upgrade, as this could cause device failure. If a UPS is not already in place, consider adding one to the system prior to performing a firmware upgrade.

Attention!

Note that when running multiple firmware upgrades in sequence, it is critical to load the ioMemory VSL driver after each firmware upgrade step. Otherwise the on-device format will not be changed, and there will be data loss.

Attention!

Do not use this utility to downgrade the IBM High IOPS Adapter to an earlier version of the firmware. Doing so may result in data loss and void your warranty. Contact Customer Support at at http://www.ibm.com/systems/support if you have issues with your upgrade.

NOTE-

The default action (without using the `-d` option) is to upgrade all IBM High IOPS Adapters with the firmware contained in the `fio-firmware-highiops-<version>.<date>.fff` firmware archive file. Confirm that all devices need the upgrade prior to running the update. If in doubt, use the `-p` (Pretend) option to view the possible results of the update.

Attention!

You must detach all IBM High IOPS Adapters before updating the firmware.

Attention!

Upgrade Path

There is a specific upgrade path that you must take when upgrading IBM High IOPS Adapter. Consult the *IBM ioMemory VSL Release Notes* for this ioMemory VSL software release before upgrading IBM High IOPS Adapters.

NOTE-

If you receive an error message when updating the firmware that instructs you to update the midprom information, contact Customer Support.

To update one or more specific devices:

- If the ioMemory VSL driver is loaded, use the `-d` option with the device number.

Syntax

```
fio-update-iodrive [options] <firmware-path>
```

where `<firmware-path>` is the full path to the firmware archive file `fio-firmware-highiops-<version>.<date>.fff` available at http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**). If you downloaded the `.fff` firmware archive file, then the firmware is most likely with the other downloaded packages.

Option	Description
`-d`	Updates the specified devices (by `fctx`, where *x* is the number of the device shown in `fio-status`). If this option is not specified, all devices are updated. **Attention!** Use the `-d` option with care, as updating the wrong IBM High IOPS Adapter could damage your device.
`-f`	Force upgrade (used when directed by Customer Support). **Attention!** Use the `-f` option with care, as it could damage your card.
`-l`	List the firmware available in the archive.
`-p`	Pretend: Shows what updates would be done. However, the actual firmware is not modified.
`-c`	Clears locks placed on a device.
`-q`	Runs the update process without displaying the progress bar or percentage.
`-y`	Confirm all warning messages.
`--split`	Split the IBM High IOPS Adapter into virtual devices.
`--merge`	Merge the virtual devices of an IBM High IOPS Adapter.

If you arrived at this section from See Upgrading the Firmware on page 15, you should return to that section.

Appendix B - Troubleshooting Event Log Messages

The Windows System Event Log displays the following messages concerning the IBM High IOPS Adapter: Informational, Warnings, and Errors.

NOTE-

Each IBM High IOPS Adapter is numbered from `0` upwards. Use the `fio-status` utility or IBM Flash Management Console to view this number for your device.

Attention!

While these messages are very useful for troubleshooting purposes, the ioMemory VSL log messages are not designed for continual monitoring purposes (as each is based on a variety of factors that could produce different log messages depending on environment and use case). For best results, use the tools described in See Monitoring and Managing Devices on page 26 to regularly monitor your devices.

Verbose Event Log Parameter

If you begin experiencing issues with your IBM High IOPS Adapters, you should enable the `WIN_LOG_VERBOSE` ioMemory VSL parameter. This will expand the extent of the ioMemory VSL error log messages in the event log and provide additional crucial information for troubleshooting any issues.

Sample Command:

```
fio-config.exe -p WIN_LOG_VERBOSE 1
```

For more information on enabling parameters, see See fio-config on page 41.

Viewing Logs

To open the Windows Event Viewer,

1. Click **Start**.
2. Click **Computer** and right-click **Manage**.
3. Expand **Diagnostics**.
4. Expand **Event Viewer**.

5. Expand **Windows Logs**.
6. Select **System**.

Error Messages

The following are common Event Log error messages, along with suggested solutions:

Message	Suggested Solution
Error: ioDrive(x) firmware is too old. The firmware must be updated.	Follow the instructions in See Upgrading the Firmware on page 15 to update the firmware.
Error: ioDrive initialization failed with error code `0xerrorcode`*	1. Reinstall the Windows ioMemory VSL. 2. Remove and reseat the IBM High IOPS Adapter. 3. Remove and insert the IBM High IOPS Adapter in a different PCIe slot.
Error: ioDrive was not attached. Use the `fio-attach` utility to rebuild the drive.	This error may appear after an unmanaged shutdown. You can use either the `[fio-attach]` command-line utility or IBM Flash Management Console to re-attach the device. This attach process may take up to ten minutes as the utility performs a consistency check on the device(s).
Warning: ioDrive was not loaded because auto-attach is disabled.	The IBM High IOPS Adapter must attach to the Windows operating system to be available to users and applications. (This attach normally occurs at boot time.) As part of this attach process, the ioMemory VSL checks to see if there is an AutoAttach parameter in the Windows registry. If you create this Registry parameter to disable auto-attach, the attach operation does not complete. To attach an unattached device, 1. Run the IBM Flash Management Console. 2. Select your unattached IBM High IOPS Adapter from the Device Tree. 3. Click **Attach**. 4. Confirm the Attach operation. Your device now attaches to the Windows operating system. To re-enable Auto-Attach at boot time, refer to See Enabling Auto-Attach on page 33.

* Where `0xerrorcode` is one of the following:

Error Code	Description

0xFFFFFC00	Uncorrectable ECC Error
0xFFFFFBFF	Uncorrectable ECC Error
0xFFFFFBFE	Invalid Media Format
0xFFFFFBFD	Unknown Error

Or one of the 43 standard Windows errno definitions found at http://msdn.microsoft.com/en-us/library/t3ayayh1%28v=vs.110%29.aspx

Attention!

The error code is converted to a negative number, and then reported in hexadecimal format. For example, `errno=1` is converted to `-1` and is represented as `0xFFFFFFFF`, and `errno=1024` is converted to `-1024` and is represented as `0xFFFFFC00`.

Informational Messages

The following is a common Event Log informational message:

Message	Additional Information
Affinity not set for ioMemory VSL device fct119 because either WIN_DISABLE_ALL_AFFINITY is set to true or "SetWorkerAffinity119" does not exist in the registry and WIN_DISABLE_DEFAULT_NUMA_AFFINITY is set to true.	When `WIN_DISABLE_ALL_AFFINITY` is set to `0`, the driver will enable interrupt and worker thread affinity in the driver. When `WIN_DISABLE_ALL_AFFINITY` is set to `1`. the driver will disable all affinity settings. This is an override of any other affinity settings. Refer to See fio-config on page 41 for more information about affinity settings.

Appendix C - Manual Installation

The Windows Setup program will install ioMemory VSL software on your Windows operating system. However, there are some instances where you may need to manually install the software for a particular IBM High IOPS Adapter, including:

- After a software installation (including upgrade), IBM High IOPS Adapters don't show up in `fio-status`.
- You install new IBM High IOPS Adapters on a system that has previously installed IBM High IOPS Adapters and ioMemory VSL software.

Follow the steps below forWindows Server 2008. This will ensure that the ioMemory VSL software is installed for a particular device. Repeat the steps for each device, if needed.

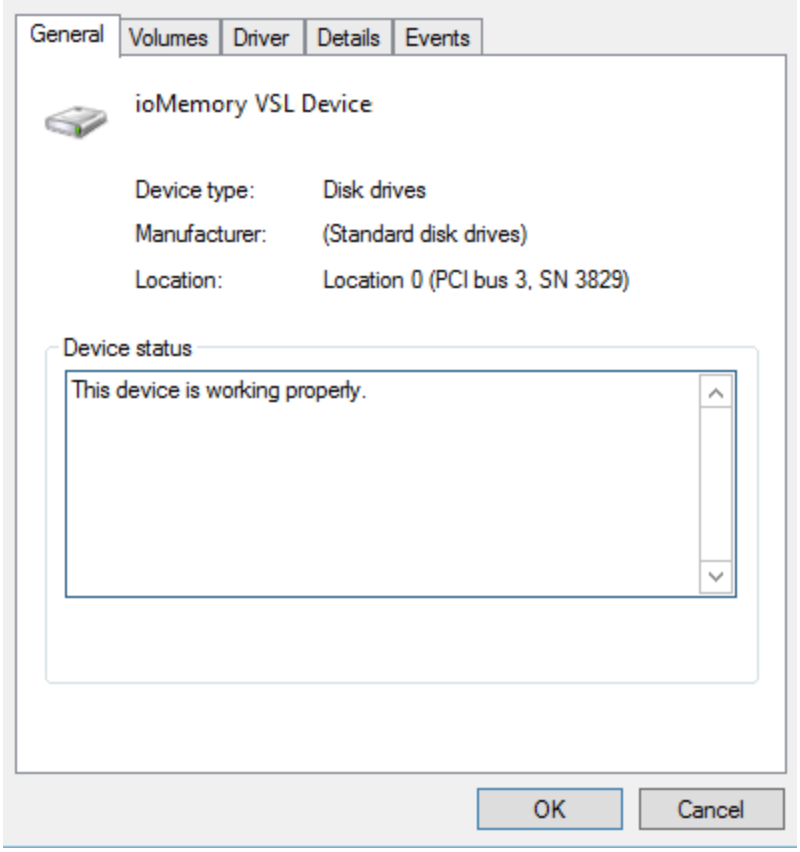
Manual Install on Windows Server 2008 and 2012

Before you manually install the ioMemory VSL software, make sure you have downloaded and run the ioMemory VSL Windows Setup program from http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**). This will install the ioMemory VSL software on the system, and you will now be able to install the ioMemory VSL software for each IBM High IOPS Adapter.

The Windows Driver Wizard may automatically detect the new IBM High IOPS Adapter and starts to locate its ioMemory VSL software after you restart the system. If this happens, you may skip to the Installation Wizard procedure below.

1. Launch the Device Manager.
   - In Windows Server 2008, choose **Start** > **Control Panel** > **Device Manager**.
   - In Windows Server 2012, from the **Server Manager** select **Tools** (in the upper right) > **Computer Management** > **Device Manager**.
2. Select **Fusion ioMemory VSL devices**.
3. Click on your IBM High IOPS Adapter(s) in the list. The Properties dialog box appears.

> **Attention!**
> The device may be titled `Mass Storage Controller`.



a. If the **Device Status** reads `This device is working properly`, then the ioMemory VSL software has been installed.

b. If the device is not working correctly, you will need to manually install the software for that device. Continue with the manual installation.

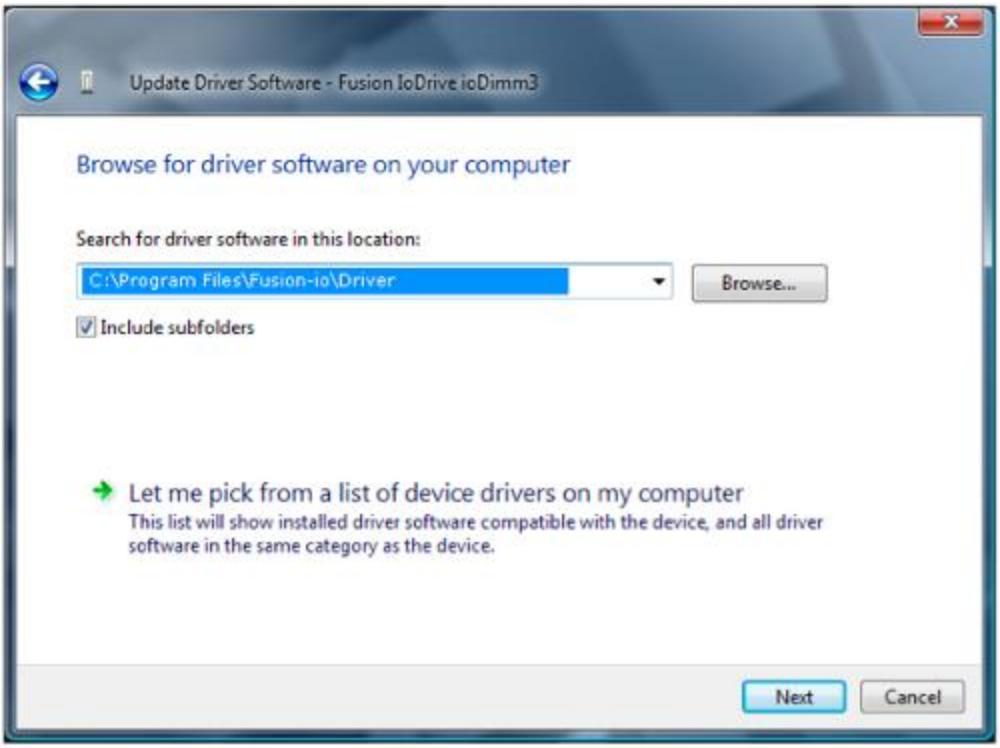
4. Close the Properties dialog box.

5. Right-click on the device and choose **Update Driver**.

6. Follow the instructions below.

Installation Wizard

1. Windows will ask you to locate the software driver.



2. Click **Browse** next to the path field. Windows displays a file dialog.
3. Select the folder with the ioMemory VSL software (the default is `C:\Program Files\IBM HIGH IOPS\<VSL-Version>\Driver`).
4. Click **OK**.
5. Click **Next**.
   Windows finds the correct software and installs the device software. When the driver installation completes,
6. Restart the computer.
7. Proceed to See Upgrading the Firmware on page 15 to continue.

Appendix D - Monitoring the Health of Devices

This section describes how the health of IBM High IOPS Adapters can be measured and monitored in order to safeguard data and prolong device lifetime.

Health Metrics

The ioMemory VSL software manages block retirement using pre-determined retirement thresholds. The IBM Flash Management Console and the `fio-status` utilities show a health indicator that starts at 100 and counts down to 0. As certain thresholds are crossed, various actions are taken.

At the 10% healthy threshold, a one-time warning is issued. See See Health Monitoring Techniques on page 62 for methods for capturing this alarm event.

At 0%, the device is considered unhealthy. It enters *write-reduced* mode, which somewhat prolongs its lifespan so data can be safely migrated off. In this state the IBM High IOPS Adapter behaves normally, except for the reduced write performance.

After the 0% threshold, the device will soon enter *read-only* mode -- any attempt to write to the IBM High IOPS Adapter causes an error. Some filesystems may require special mount options in order to mount a read-only block device in addition to specifying that the mount should be read-only.

Read-only mode should be considered a final opportunity to migrate data off the device, as device failure is more likely with continued use.

The IBM High IOPS Adapter may enter failure mode. In this case, the device is offline and inaccessible. This can be caused by an internal catastrophic failure, improper firmware upgrade procedures, or device wearout.

NOTE-

For service or warranty-related questions, contact the company form which you purchased the device.

NOTE-

For products with multiple IBM High IOPS Adapters, these modes are maintained independently for each device.

Health Monitoring Techniques

`fio-status -a`: Output from the `fio-status` utility (using the `-a` option) shows the health percentage and device state. These items are referenced as "`Media status`" in the sample output below.

```
Found 3 ioMemory devices in this system
Fusion-io driver version: 3.x.x build xxxx

Adapter: Single Adapter
        Fusion-io ioDrive 1.30TB, Product Number:F00-001-1T30-CS-0001,
SN:1133D0248, FIO SN:1134D9565
...
Media status: Healthy; Reserves: 100.00%, warn at 10.00%; Data: 99.12%
Lifetime data volumes:
   Physical bytes written: 6,423,563,326,064
   Physical bytes read   : 5,509,006,756,312
```

The following Health Status messages are produced by the `fio-status` utility:

- Healthy
- Read-only
- Reduced-write
- Unknown

IBM Flash Management Console: In the Device Report tab, look for the Reserve Space percentage in the right column. The higher the percentage, the healthier the drive is likely to be.

Software RAID and Health Monitoring

Software RAID stacks are typically designed to detect and mitigate the failure modes of traditional storage media. The IBM High IOPS Adapter attempts to fail as gracefully as possible, and these new failure mechanisms are compatible with existing software RAID stacks. An IBM High IOPS Adapter in a RAID group will fail to receive data at a sufficient rate if: a) the device is in a write-reduced state, and b) it is participating in a write-heavy workload. In this case, the device will be evicted from the RAID group. A device in read-only mode will be evicted when write I/Os are returned from the device as failed. Catastrophic failures are detected and handled just as though they are on traditional storage devices.

Appendix E - Using the Windows Page Files

Introduction

This appendix describes how to effectively use paging (also called swap or Virtual Memory) files on IBM High IOPS Adapters with Windows.

Using a page file with a traditional disk drive places practical limits on the usable size of the page file and virtual memory, due to the poor performance of disk drives in relation to RAM. Placing the OS paging file on one or more IBM High IOPS Adapters allows much larger page files and usable virtual memory. This is due to the much faster response times and bandwidth on IBM High IOPS Adapters versus hard disks.

Configuring Device Paging Support

The ioMemory VSL software can be configured to support paging files on one or more IBM High IOPS Adapters. This requires that each IBM High IOPS Adapter used with a paging file pre-allocates the worst-case amount of memory it may need in any possible I/O scenario. This is done on a device instance.

Because of the extra host RAM memory use, paging should be enabled only on IBM High IOPS Adapters that will actually hold a paging file. It is possible to place a single paging file on more than one IBM High IOPS Adapter. In this case Windows will stripe paging I/O across all available paging files, possibly providing additional performance to the Virtual Memory (VM) subsystem.

ioMemory VSL RAM Consumption

The amount of RAM pre-allocated per IBM High IOPS Adapter depends on the device's total size and the sector (block) size selected when formatting the drive (with `fio-format`).

NOTE-

Consult the Release Notes for this version of the software for RAM usage per GB of IBM High IOPS Adapter.

Using a larger sector size significantly reduces the amount of host memory consumption needed for paging support. It is recommended that a 4K sector size be used because a) that is generally the natural size of a host memory page, and b) it minimizes overall host memory consumption. In Windows, NTFS will generally use a cluster size of 4K, so formatting to 512 is not useful except for applications that compatible only with 512-byte sector sizes.

The indicated amount is needed per IBM High IOPS Adapter that supports paging. You must carefully plan which IBM High IOPS Adapter(s) will be used to hold a paging file.

Non-paged Memory Pool

Pre-allocated memory for the IBM High IOPS Adapter comes from the Windows kernel non-paged memory pool. This pool dynamically grows as system components consume additional kernel memory. The maximum size of this pool is restricted to 75% of RAM up to a maximum of 128GB.

The amount of in-use, non-paged pool memory should be noted when planning page file usage. This is because the IBM High IOPS Adapter pre-allocates RAM, and that reduces the available physical non-paged memory. The ioMemory VSL software will fail to load if the total pre-allocated memory plus the in-use, non-paged memory exceeds the maximum non-paged memory pool.

To determine the total non-paged memory pool use for two IBM High IOPS Adapters, let's use the following example:

- One IBM High IOPS Adapter that requires 850 MB of RAM, and the other requires 1700 MB or RAM.

  NOTE-
  Consult the *IBM ioMemory VSL Release Notes* for this version of the ioMemory VSL software for RAM requirements.

- Both are formatted with a 4K sector size
- Both will support paging files

The current allocated non-paged pool is obtained from Task Manager and, in this example, has a value of 576 MiB. (Values shown in Task Manager are in MiB \[1024x1024 = 1 MiB\]). The total RAM on the system is 8000 MB and the OS is Server 2008 R2.

First, covert the 576 MiB into MB: `576 MiB * (1 MB/1.048576 MiB) = ~549 MB`

To calculate the total available non-paged pool, use the following formula:

```
(8000 MB x 0.75) - 549 - 850 - 1700
```

which still leaves 2901 MB available for the non-paged pool.

Enabling/Disabling Paging Support

Memory pre-allocation occurs during ioMemory VSL software initialization. To enable paging support, you must enable the `FIO_PREALLOCATE_MEMORY` configuration item. This can be done using the `fio-config` command-line utility. This parameter is assigned a string with a list of decimal serial numbers of the IBM High IOPS Adapters that will support a paging file. The ioMemory VSL software performs memory pre-allocation for those instances.

Below is an example of using the `fio-config` utility to enable paging and pre-allocation on two IBM High IOPS Adapters with serial numbers 1234 and 17834. Serial number information can be obtained using the `fio-status` utility.

```
fio-config -p FIO_PREALLOCATE_MEMORY "1234,17834"
```

To disable paging support on all devices, use a value of `0` for `FIO_PREALLOCATE_MEMORY`:

```
fio-config -p FIO_PREALLOCATE_MEMORY "0"
```

To query the current value, run this command:

```
fio-config -g FIO_PREALLOCATE_MEMORY
```

An alternate method to manage (enable or disable) paging support is to use the IBM Flash Management Console.

NOTE-

You must reload the ioMemory VSL software for the new pre-allocation setting to take effect. Typically this can be done by restarting the machine or using disable/enable within Device Manager for each IBM High IOPS Adapter instance.

Also, using the Windows System Properties to change paging file configuration requires a system restart before the properties are applied. Therefore, you can change both `FIO_PREALLOCATE_MEMORY` and the system page file configuration and then apply both with a single restart.

Windows Page File Management

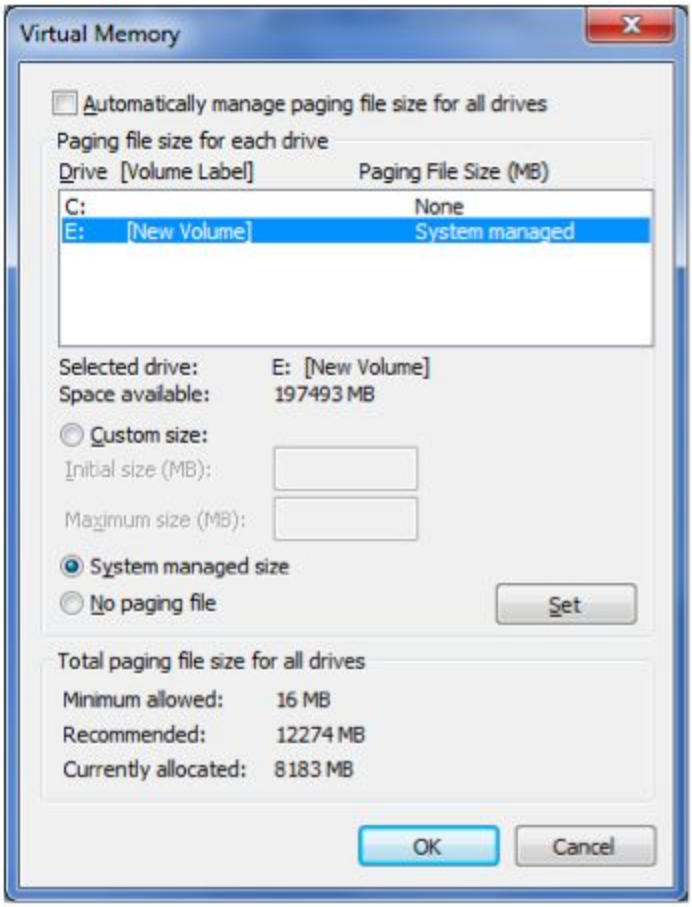
By default, the ioMemory VSL software disables support for page files. The previous section described how to enable support for page files on one or more IBM High IOPS Adapters. The following describes how to work with the built-in Windows control panels to configure and set up paging files on IBM High IOPS Adapters.

Setting Up Paging File(s)

To set up page files in Windows,

1. Go to **Control Panel** and double-click System.
2. Click **Advanced system settings** from the Task pane.
3. On the Advanced tab, click **Settings**. The Performance Options dialog opens.

4. On the Advanced tab, click **Change**. The Virtual Memory dialog opens.



Using this dialog, you can configure a page file for each available drive in the system. Selecting the "Automatically manage paging file size for all drives" checkbox causes Windows to create a single page file on the system drive, which is the drive the OS is started from. This checkbox should be cleared when using an IBM High IOPS Adapter with a paging file.

Windows supports up to 16 distinct paging files. To enable a page file on an IBM High IOPS Adapter,

1. Choose the IBM High IOPS Adapter from the device list.
2. Select the **Custom size** radio button.
3. Provide values in the **Initial size** and **Maximum size** fields.
4. When prompted to restart, click **Yes**. This is necessary for the new page file settings to take effect.
5. Click **Set** to save the setting. Do not omit this step, or your changes will be lost.
6. Click **OK**.

To remove a paging file on the drive, follow the steps earlier but select **No paging file**. For performance reasons, typically you will remove all paging files on any system hard disk.

NOTE-

The Virtual Memory dialog allows page files to be configured on available IBM High IOPS Adapters, even if the IBM High IOPS Adapter has not been configured to support a page file. Even though the dialog allows enabling of the page file, following the required restart you'll notice that no page file was created on the device. Follow the directions earlier in this document to properly enable page file support on one or more IBM High IOPS Adapters.

System Drive Paging File Configuration

By default Windows creates and manages a page file on the system boot drive (typically a hard disk), which is typically where Windows is installed. Keeping a regular page file on the system hard disk is generally not optimal, because the hard disk's I/O performance is many orders of magnitude slower than an IBM High IOPS Adapter. To remedy this, you can eliminate or minimize the size of the system boot drive page file, as explained later. Enabling page files on IBM High IOPS Adapters (but not the system drive) improves Virtual Memory (VM) subsystem performance, as the VM manager stripes I/O across all available page files. Additionally, the IBM High IOPS Adapters act as a very large memory store, which can greatly improve memory usage for large applications.

The Windows kernel uses the system disk page file to store crash dumps. Crash dumps may be small (mini-dumps) or large (full-kernel memory dumps). Typically, running without dump file support or with a small dump file is adequate. There are several possible system drive page file configurations:

1. Eliminate all page files on any hard disks, including the system boot drive. Although this maximizes paging I/O on IBM High IOPS Adapters, no post-mortem crash dump file will be available if a system crash occurs. However, it may be possible to re-enable a page file on the system drive and then reproduce the crash scenario.

2. Create a minimal-size page file on the system boot drive. The recommended minimum size is 16MB, although Windows may warn that a minimum 400MB page file is needed.

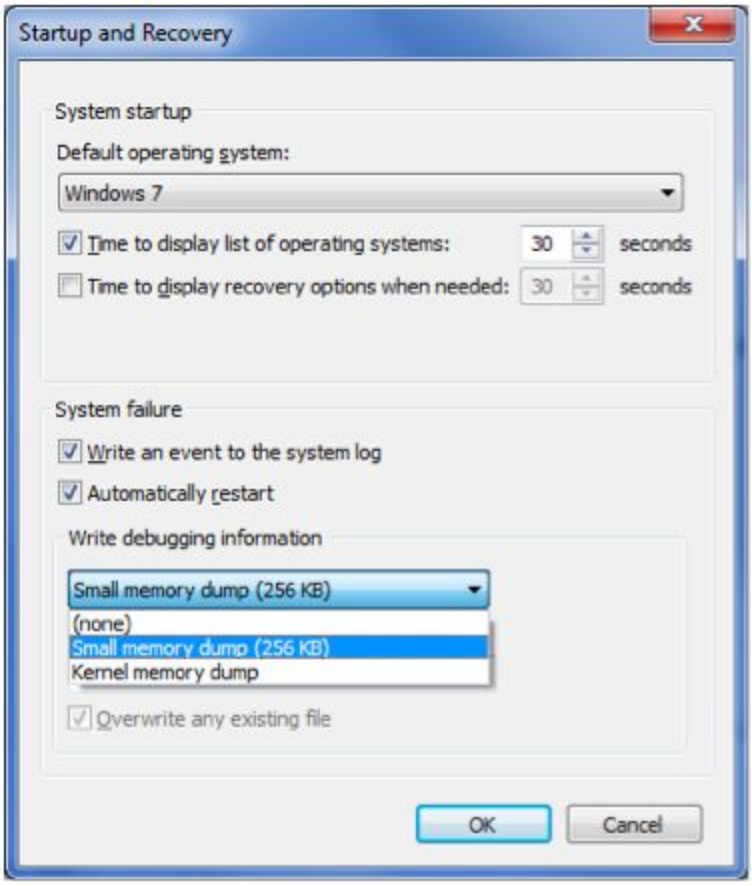
3. Create a page file large enough for a full-kernel memory dump. This typically requires a page file at least the size of installed RAM, with some recommending the size equal to RAM x 1.5.

To view or change the crash dump configuration,

1. Go to the **System Properties** dialog.

2. Click the Advanced tab.

3. In the Startup and Recovery section, click **Settings**. The Startup and Recovery dialog opens.



In the System Failure section you can change settings to handle the system log, restart, and debugging information.

Guaranteeing Minimum Committable Memory

If you enable "System managed size" or set a "Custom size" in the Virtual Memory dialog, you should do so with care. If the initial size is less than the desired amount of committable virtual memory, this can cause an application to have memory allocation failures if the amount of committed memory exceeds the currently allocated page file size or the initial size value. When committed memory exceeds the current page file size, a request to allocate additional memory will fail. The Windows Virtual Memory manager will slowly increase the size of the paging file up to the available size of its drive or to the "Maximum size" custom setting, whichever is smaller.

If you want to use a large amount of committed virtual memory (more than 1.5 times the amount of RAM) and avoid application memory allocation errors, the initial and maximum committed memory should be explicitly set for the expected application committed memory usage. These values should generally be the same.

How Large Should You Make the Paging File?

The following articles explain in great detail how to size the page file appropriately.

- Main Article Link: Pushing the Limits of Windows
- Specific section that documents virtual memory: Pushing the Limits of Windows: Virtual Memory

Verifying Page File Operation

To verify that a page file is actively placed on an IBM High IOPS Adapter, you can browse for hidden files at the drive's root. For example, run the following command at a prompt:

```
dir c: /ah
```

In the output listing there should be a file called `pagefile.sys`. If no page file is present, then recheck the page file configuration in the Virtual Memory dialog and verify that page file support has been enabled on the queried IBM High IOPS Adapter.

Page File Performance

Using an IBM High IOPS Adapter} as the paging store can improve overall Virtual Memory system performance. Actual benefits will vary widely with an application's virtual memory usage and with hardware platform/performance.

Appendix F - NUMA Configuration

About NUMA Architecture

Servers with a NUMA (Non-Uniform Memory Access) architecture may require special installation instructions in order to maximize IBM High IOPS Adapter performance. This includes most multi-socket servers.

On some servers with NUMA architecture, during system boot the BIOS will not associate PCIe slots with the correct NUMA node. Incorrect mappings result in inefficient I/O handling that can significantly degrade performance.

Using the `FIO_AFFINITY` Parameter

Use this parameter to map devices with specific NUMA nodes.

Attention!

The example below shows the final implementation of custom affinity settings. This implementation required an analysis of the specific system, including the system architecture, type and number of IBM High IOPS Adapters installed, and the particular PCIe slots that were used. Your particular circumstances will require a custom analysis of your set-up. This analysis requires understanding of your system's NUMA architecture compared to your particular installation.

Your actual settings may be different than the example below, depending on your server configuration. In order to create the correct settings for your specific system, use `fio-status` to list all of the devices and determine the `<device-id>` (see below). Then use the example below of setting the `FIO_AFFINITY` parameter as a template and modify it for your particular system.

Determining the Bus Number

In order to create the correct settings for your specific system, use `fio-status` to list all of the devices' bus numbers. For example:

```
fio-status
Found 2 ioMemory devices in this system
...
       PCI:04:00.0
...
       PCI:0F:00.0
```

Attention!

In Windows, the bus number is displayed in hex, but you need to enter the number in decimal. In this example, `04` is `4` and `0F` is `15`.

Attention!

Note that the PCI device ID, including the bus number, may change if you change any of the PCI devices in the system. For example, if you add a network card or another IBM High IOPS Adapter. If the device ID changes, you will have to update the configuration.

FIO_AFFINITY Parameter

Configuring your IBM High IOPS Adapters for servers with NUMA architecture requires the use of the `FIO_AFFINTIY` parameter with the fio-config utility.

The `FIO_AFFINITY` parameter is a list of `<affinity specification>` triplets that specify the affinity settings of all devices in the system. Each item in the triplet is separated by a comma, and each triplet set is separated by a semicolon.

Syntax:

```
fio-config -p FIO_AFFINITY <affinity specification>[;<affinity
specification>...]
```

Where each `<affinity specification>` has the following syntax:

```
<[domain number:]bus number>,[g|n]<group or node number>[,<hex mask>]
```

If domain number is not specified, it will be set to `0` (most common).

If there is no g or n character before the group/node number, then the number is assumed to be a group number.

The hex mask is optional. If it is not present, the mask is assumed to be `0xffffffffffffffff`. Also, the `0x` prefix is optional.

If the hex mask is a node mask, then the mask is relative to the node, not the group to which the node belongs.

Simple Example:

```
fio-config -p FIO_AFFINITY 1:7,n0,0xf;20,n1;80,7;2:132,4,0xff0
```

Has the effect of creating :

PCI Address (domain:bus)	Node/Group	Processor Affinity

1:7	node 0	processors 0 to 3 in the node (mask 0xf)
0:20	node 1	all processors in the node (no hex mask)
0:80	group 7	all processors in the group (no hex mask)
2:132	group 4	processors 4 to 11 in the group (mask 0xff0)

Advanced Configuration

If your server has multiple NUMA nodes and multiple IBM High IOPS Adapters installed, you will need to make sure that the IBM High IOPS Adapters are spread out among the various nodes.

While it may be optimal to pair devices to nodes that are electronically closer each device's PCIe slot (which would require an advanced understanding of your server's NUMA architechure and an analysis of the device installation), just simply spreading out all of the devices' node affinity among the available nodes should result in improved performance.

Checking the Log for Errors

If you enter a configuration that is not valid, then the settings will be disabled and an error will be available in the system logs.

For example:

```
fio-config -p FIO_AFFINITY 5,g0,0xf;6,0xf
```

In this example, the affinity for device `fct6` is set incorrectly, because there is no group/node number before the mask. The following errors appear in the system log:

```
2011-09-09T12:22:15.176086800Z - ERROR - FusionEventDriver - FIO_AFFINITY:
Invalid group or node number
2011-09-09T12:22:15.176086800Z - ERROR - FusionEventDriver - Invalid FIO_
AFFINITY parameter syntax at character 13: "5,g0,0xf;6,0x". Manual
affinity settings are disabled!
```

```
# fio-status
Found 2 ioMemory devices in this system
...
       PCI:04:00.0
...
       PCI:0F:00.0
```

Attention!

In Windows, the bus number is displayed in hex, but you need to enter the number in decimal. In this example, `04` is `04` and `0F` is `15`.

In the example above the device IDs would be `0000:04:00.0` and `0000:15:00.0` on a system that had a domain of `0000`.

Attention!

Note that the PCI device ID may change if you change any of the PCI devices in the system. For example, if you add a network card or another IBM High IOPS Adapter. If the device ID changes, you will have to update the configuration.

<device-id>	Node/Group	Processor Affinity
0000:04:00.0	node 1	all processors in node 1
0000:1d:00.0	node 0	all processors in node 0
0000:05:00.0	node 2	all processors in node 2
0000:1e:00.0	node 3	all processors in node 3

Appendix G - Upgrading Devices from VSL 2.x to 3.x

This version of the ioMemory VSL software supports new features, including the latest generation of High IOPS architecture and improved Flashback protection. These features require the latest version of the IBM High IOPS Adapter firmware. Every IBM High IOPS Adapter in a system running 3.1.x or later must be upgraded to the latest version of the firmware.

For example, if you have a system running 2.x ioMemory VSL software with Legacy IBM High IOPS Adapters previously installed, and you want to install new Second Generation IBM High IOPS Adapters (that require the latest version of the firmware), then you will need to upgrade all of the existing devices to the latest firmware version.

Attention!

You cannot revert a device's firmware to an earlier version once you have upgraded the device (without voiding your warranty). If you experience problems with your upgrade, please contact Customer Support at http://www.ibm.com/systems/support.

Attention!

Upgrading devices (previously configured for VSL 2.x.x) to work with VSL 3.x.x will require a low-level media format of the device. No user data will be maintained during the process. Be sure to backup all data as instructed.

Attention!

Upgrade Path

Depending on the current firmware version of your devices, you may need to upgrade your device's firmware multiple times in order to preserve internal structures. Consult the ioMemory VSL software for the upgrade path. Visit http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**) for all of the required software and firmware versions.

For more information on upgrading from one version to the next, see the *IBM ioMemory VSL Release Notes* (available at http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**)) for the version you will upgrade the device to. Then follow the upgrade instructions in that version's user guide for your operating system (including the firmware update instructions).

Upgrade Procedure

Be sure to follow the upgrade path in the *IBM ioMemory VSL Release Notes*. Make sure that all previously installed Legacy IBM High IOPS Adapters are updated with the appropriate firmware.

Attention!

If you plan to use Legacy IBM High IOPS Adapters and Second Generation IBM High IOPS Adapters in the same host, perform this upgrade on all existing Legacy IBM High IOPS Adapters **before** installing the new Second Generation IBM High IOPS Adapters.

1. Prepare each existing Legacy IBM High IOPS Adapter for upgrade.

    a. Backup user data on each device.

    Attention!

    The upgrade process will require a low-level media format of the device. No user data will be maintained during the process; be sure to make a complete backup.

    Use a backup method of your choice. For best results, use software and backup devices that have proven effective in the past. Do not backup the data onto another IBM High IOPS Adapter on the same system. The back up must be to a local disk or to an externally attached volume.

    b. Run the `fio-bugreport` utility and save the output. This will capture the device information for each device in the system. This device information will be useful in troubleshooting any upgrade issues. Sample command:

    ```
    fio-bugreport
    ```

    c. Detach Legacy IBM High IOPS Adapters, for example:

    ```
    fio-detach /dev/fct*
    ```

    For more information, see See fio-detach on page 44.

2. Uninstall the 2.x ioMemory VSL software.

    a. Go to **Start** > **Control Panel**.

    b. Click **Programs & Features**.

    c. Select the ioMemory VSL entry.

    d. Click **Uninstall**.

    e. Restart the computer.

3. Install the new ioMemory VSL software.

a. Download the ioMemory VSL installation program for Windows at http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**)

b. Run the ioMemory VSL installation program. The installation program presents a custom setup tree-view with options for installation.

NOTE-

Mouse over a component in the tree view to see its description.

---

c. Click **Next**.

d. To select a different folder for the installation, browse to the folder and click **OK**. The default folder is `C:\Program Files\IBM HIGH IOPS`.

NOTE-

The uninstaller file is placed in the root of the default install folder (`C:\Program Files\IBM HIGH IOPS`).

---

e. Follow the onscreen prompts to complete the install.

f. Choose **Reboot Now** on the finish screen of the installer.

Attention!

For full installation instructions, see [Existing ioMemory VSL Installation].

---

4. Update the firmware on each device to the latest version using `fio-update-iodrive`.

Attention!

Prevent Power Loss

Take measures to prevent power loss during the update, such as a UPS. Power loss during an update may result in device failure. For all warnings, alerts, and options pertaining to this utility, see See fio-update-iodrive on page 53.

Sample syntax:

```
fio-update-iodrive <firmware-path>
```

Where `<firmare-path>` is the full path to the firmware archive file (`fio-firmware-highiops-<version>.<date>.fff`) available at http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**). This command will update all of the devices to the selected firmware. If you wish to update specific devices, consult See fio-update-iodrive on page 53 for more options.

5. Reboot the system

6. **Destructive Step**

   Attention!

   Running `fio-format` in the next step will erase the entire device, including user data. Once this format is started, the device cannot be downgraded to the 2.x driver without voiding your warranty. If you experience problems with your upgrade, please contact Customer Support at http://www.ibm.com/systems/support.

7. Format each device using `fio-format`, for example:

   ```
   fio-format <device>
   ```

   You will be prompted to confirm you wish to erase all data on the device.

   Attention!

   The format may take an extended period of time, depending on the wear on the device.

8. Attach all Legacy IBM High IOPS Adapters, for example:

   ```
   fio-attach /dev/fct*
   ```

9. Check the status of all devices using fio-status, for example:

   ```
   fio-status -a
   ```

Your Legacy IBM High IOPS Adapters have now been successfully upgraded for this version of the ioMemory VSL software. You may now install any Second Generation IBM High IOPS Adapters.

IBM Support

IBM High IOPS Adapter software and documentation are available on the web at the following address:

http://www.ibm.com/support/entry/portal/docdisplay?lndocid=MIGR-65723 (follow that link and then select **IBM High IOPS software matrix**).