



hIOmonTM
Disk I/O Ranger
User Guide

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Making Data PerformSM

hIOmon Disk I/O Ranger User Guide

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1. hIOmon Disk I/O Ranger Display

This document provides information about the hIOmon "Disk I/O Ranger Display" application that is included within the standalone "hIOmon Disk I/O Ranger" software product and that is also included as a "hIOmon Add-On" within the "hIOmon I/O Performance Monitor" software product, both of which are Licensed Software Packages available from hyperI/O LLC (and its authorized distributors, resellers, and other licensees).

This document includes a brief overview of the "Disk I/O Ranger Display" application along with detailed descriptions including instructions for its use.

NOTE

Please refer to the hyperI/O web site (URL provided on the cover of this document) for the latest information about the hIOmon software products, including datasheet, user guide documents, white papers, and screenshot examples.

1.1 Overview

hIOmon is an innovative, unique performance analysis software tool that lets you both measure and monitor disk I/O operations and their performance up at the **application** level upon an individual, specific **file** (as well as disk and process) basis. It can examine and efficiently record the activity and performance of the file (and device) I/O operations associated with user-selected files and devices.

The hIOmon "Disk I/O Ranger" software and the hIOmon "I/O Performance Monitor" software both enable you to collect "Performance Threshold Range Metrics" during the normal, everyday use of your computer system. The hIOmon "Disk I/O Ranger Display" application can be used to display and export these metrics in real-time, as briefly described below.

The hIOmon "Disk I/O Ranger Display" application is run as a Microsoft® Windows® HTML Application (HTA). The metrics displayed are those **currently** collected by the hIOmon I/O Monitor, which must be properly configured to collect the particular types of metrics displayed by the hIOmon "Disk I/O Ranger Display" application. See the section below for the configuration requirements.

Also note that the hIOmon Disk I/O Ranger Display includes a "Help" button, which you can click to display detailed instructions and other information on how to use the hIOmon Disk I/O Ranger Display application.

NOTE

Please note that the hIOmon "Disk I/O Ranger Display" relies upon the "I/O Summary" operation performance metrics that can be collected and exported by the hIOmon software. Consequently, the hIOmon "Summarized Data Licensing Option" must be available (licensed for use) in order to make use of this Add-On.

1.1.1 Performance Threshold Range Metrics

The hIOmon "Performance Threshold Range Metrics" are a selected set of summarized I/O operation performance metrics that are specifically focused upon the ranges of I/O operations per second (IOPS), megabytes-per-second (MB/s) data transfer rates, response time (RT), and I/O operation queue depths/lengths **actually observed** by the hIOmon I/O Monitor for individual files, devices, and processes.

These metrics are automatically included within the summarized I/O operation performance information that can be collected by the hIOmon I/O Monitor. They can be displayed by the hIOmon Presentation Client, the hIOmon CLI, and the hIOmon WMI Browser, all of which are included within the "hIOmon I/O Performance Monitor" software package. These metrics are also accessible via the hIOmon WMI Support for the Microsoft "Windows Management Instrumentation (WMI)".

The hIOmon "Performance Threshold Range Metrics" can also be directly exported to a CSV-formatted "hIOmon Manager Export File", which is another feature that is included within the "hIOmon I/O Performance Monitor" software package.

Please note that the hIOmon "Performance Threshold Range Metrics" reflect the **actual** I/O operation activity observed by the hIOmon I/O Monitor. For instance, the "IOPS < 100" Range Count for read I/O operations reflects the number of one-second intervals during which the hIOmon I/O Monitor actually observed a total number of monitored read I/O operations that was less than 100 read I/O operations.

Similarly, the "MBS 100 < 200" Range Count for write I/O operations reflects the number of one-second intervals during which the hIOmon I/O Monitor actually observed a total amount of data transferred by write I/O operations that was 100 000 000 bytes (i.e., 100 megabytes) or more, but less than 200 000 000 bytes (i.e., 200 megabytes).

Also note that the hIOmon "Disk I/O Ranger Display" application displays the selected Performance Threshold Range Metrics in **real-time**. That is, the current summarized values of these metrics (as maintained by the hIOmon I/O Monitor) are retrieved by the hIOmon "Disk I/O Ranger Display" application from the hIOmon I/O Monitor and then displayed. This display is repeatedly refreshed (i.e., the latest values are retrieved from the hIOmon I/O Monitor and then displayed) upon a user-selected periodic basis (e.g., every five seconds).

Please see the various screenshots shown within the “**Error! Reference source not found.**” section below (q.v., “Figure 1”) that illustrate the display of actual "Performance Threshold Range Metrics" by the hIOmon Disk I/O Ranger Display application for specific monitored items (including a logical device/drive, a physical device, a file, and a process).

The hIOmon "Performance Threshold Range Metrics" provide a quick and easy way to assess the actual "speeds and feeds" I/O performance of your particular files, devices, and applications in everyday, normal usage – and without requiring the collection and post-processing of I/O operation trace information!

1.1.2 Configuration for Collecting the Metrics

The hIOmon Disk I/O Ranger software or the hIOmon I/O Performance Monitor software must be properly configured in order to successfully capture/collect the “Performance Threshold Range Metrics” for display by the hIOmon "Disk I/O Ranger Display" application. This **proper configuration** includes an active/loaded hIOmon “Filter Selection”. The hIOmon "**Filter Selection**" specifies the particular files/devices that are to be monitored by the hIOmon software as well as the specific types of I/O operations to be monitored and the types of I/O operation performance metrics to be collected. Moreover, the collection of I/O operation performance metrics generally begins when the Filter Selection is loaded/activated (these metrics are also reset to zeros when a Filter Selection is re-loaded/activated).

More specifically, the active Filter Selection must be configured to request the monitoring of read I/O operations (if "Read Range Counts" are to be displayed) and/or write I/O operations (if "Write Range Counts" as to be displayed) along with the collection of "summary" metrics (including "Device Summary" metrics) for the particular files and logical devices, physical volume(s), and/or physical device(s) of interest.

Please note that the "I/O Summary" metrics collected by hIOmon are **summarized** I/O operation performance metrics that are **automatically** aggregated by the hIOmon I/O Monitor at the time that it observes the individual I/O operations. Moreover, the collection of these "summary" metrics does **not** require the collection of "I/O operation trace" data (which is a separate option also provided by the hIOmon “I/O Performance Monitor” software product). The “summary” metrics are a unique feature of the hIOmon software that enable you to easily obtain a concise, higher-level view of the selected I/O operation activity upon an individual, specific file, device, and/or process basis.

The hIOmon "Disk I/O Ranger Display" application provides a simple and quick way to display a selected subset (specifically the "Performance Threshold Range Metrics") within the large, comprehensive set of summary metrics that can be captured, displayed, and exported by the hIOmon I/O Monitor.

Please note that this application also provides a limited means to configure the hIOmon software so as to collect the summary metrics required for display. Additional information is provided within the "Getting Started" section below.

In addition, a hIOmon client (e.g., the hIOmon Presentation Client, the hIOmon WMI Browser, etc.) can be used to more specifically configure the hIOmon software in accordance with particular monitoring requirements; please note that these clients are included with the "hIOmon I/O Performance Monitor" software package. The "hIOmon User Guide" document provides detailed instructions on how you can use the hIOmon Presentation Client (as well as the other hIOmon clients such as the hIOmon WMI Browser) to configure the hIOmon software so as to collect and export a variety of I/O operation performance metrics.

Various hIOmon "Add-Ons" that are included within the hIOmon "I/O Performance Monitor" software package can also be used to quickly and easily configure the hIOmon software so as to meet particular configuration requirements. The hIOmon "Device and File I/O Performance Analysis Add-On" and "Solid State Disk (SSD) I/O Performance Analysis Add-On", as examples, use a series of interactive input prompts that allow you to simply specify the particular devices/files for which the hIOmon software is to collect summary metrics for read and write I/O operations, including the "Performance Threshold Range Metrics". Based upon your selected input parameters, the hIOmon Add-Ons will then automatically configure the hIOmon software; please note that a **restart/reboot** of the computer system might be required in order to activate the required hIOmon configuration changes.

1.1.3 Requirements

The hIOmon "Disk I/O Ranger Display" application supports the Microsoft Windows 7, Windows Vista, Windows XP, Windows Server 2003, Windows Server 2008, and Windows Server 2008 R2 operating system platforms. This hIOmon application also requires the use of Internet Explorer version 5.5 or higher to operate properly.

In addition, the hIOmon "Disk I/O Ranger Display" application requires:

1. That the hIOmon "Disk I/O Ranger" software or the hIOmon "I/O Performance Monitor" software be properly installed and active (i.e., that the hIOmon Manager and hIOmon I/O Monitor components are currently running; note that these components are normally configured upon the installation of the hIOmon software to automatically be started when the computer system is started).
2. That the hIOmon "I/O Summary Data" option is licensed. Note that the trial/demonstration version of the hIOmon "Disk I/O Ranger" and the hIOmon "I/O Performance Monitor" software includes full-support for this licensing option. The hIOmon WMI Support, which is also required, is also included within the standard (including trial/demo version) hIOmon software installation package for both of these hIOmon software products.

3. That the hIOmon “Raw Device Extended Feature” option is licensed if physical volumes and/or physical devices are to be monitored by the hIOmon software. This optional feature gives you the ability to measure and monitor disk I/O operation activity below the file system level (so that you can actually see, for example, how much a particular physical volume or device contributes to (specific) file I/O operation performance).

The I/O operation performance metrics collected by hIOmon through the use of the “Raw Device Extended Feature” are called “Physical Device Extended Metrics”. These I/O operation performance metrics are collected by the hIOmon I/O Monitor at the “physical device” level within the operating system for those physical disks that are partitioned/formatted (i.e., the hIOmon monitoring of physical disks at the “physical device” level is akin to the “PhysicalDisk” performance counter support provided by the Windows “Performance Monitor” and “System Monitor” facilities).

Note that the trial/demonstration version of the hIOmon “Disk I/O Ranger” and the hIOmon “I/O Performance Monitor” software includes full-support for this licensing option.

4. The “Disk I/O Ranger Display” application is interactive; as such it requires limited user input (e.g., optionally specifying the particular devices to be monitored) as shown in “Figure 6 - hIOmon Disk I/O Ranger Display Configuration Settings”.

1.1.4 Where to Find the hIOmon Disk I/O Ranger Display Application

The hIOmon “Disk I/O Ranger Display” application can be found in the “hIOmonDiskIORanger” folder within the “..\hyperIO\hIOmon\Support\AddOns\” directory where the hIOmon software was installed; this applies to both the “hIOmon Disk I/O Ranger” and the “hIOmon I/O Performance Monitor” software products.

1.2 Getting Started

A “hIOmon Disk I/O Ranger” **icon** is placed upon the desktop along with the “Start -> Programs -> hIOmon -> hIOmon Disk I/O Ranger” **shortcut** (both of which are added by the Windows Installer as part of the hIOmon software installation process).

You can also run the hIOmon “Disk I/O Ranger Display” application by simply double-clicking upon the “hIOmonDiskIORanger.hta” file located within the “hIOmonDiskIORanger” folder as noted above in section “Where to Find the hIOmon Disk I/O Ranger Display Application”.

When first run after the installation of the hIOmon software package, the hIOmon Disk I/O Ranger Display application will by default determine whether there is an existing

Filter Selection that is currently active, which should **not** be the case if you have not yet used any of the hIOMon clients (e.g., the hIOMon Presentation Client, the hIOMon WMI Brower, etc.), or a hIOMon Add-On to configure the hIOMon software.

If no active Filter Selection is found, then the hIOMon Disk I/O Ranger Display application will automatically perform the following steps:

1. Create a Filter Selection (named "IORangerFS" by default) that will include a single filter specifying that **both** read and write I/O operations for all files upon the "C:" logical drive are to be monitored by the hIOMon I/O Monitor and that "summary" I/O operation performance metrics are to be collected for the monitored files.
2. In addition, "Device Summary" metrics will also be collected for the "C:" logical drive; these "Device Summary" metrics reflect the combined totals for all of the monitored files that reside upon the C: logical disk and for which the hIOMon I/O Monitor observed read and/or write I/O operations.
3. Will display an input prompt asking whether you also want both read and write I/O operations to be monitored by the hIOMon I/O Monitor for the **physical disk** associated with the "C:" logical drive. If you enter a response indicating "Yes", then an additional filter for this physical disk will be included within the created Filter Selection; this filter will specify that "summary" I/O operation performance metrics are to be collected by the hIOMon I/O Monitor for both read and write I/O operations to the physical disk.
4. After successfully creating this "IORangerFS" Filter Selection, the hIOMon Disk I/O Ranger Display application will then load/activate this Filter Selection. The hIOMon I/O Monitor will immediately begin monitoring I/O operations for files residing upon the C: drive and collecting summary metrics

Please note that no reboot of the system will be required unless you requested (in step 3 above) that I/O operation performance metrics are also to be collected for the physical disk associated with the C: drive. If you did request that physical device metrics also be collected, then you will need to restart the system in order to complete the configuration of the hIOMon software; the hIOMon I/O Monitor will be able to monitor I/O operations at the physical device level within the Windows OS I/O stack after the system has been restarted. If you do not restart the system in this case, then an error message will be shown when you try to display I/O operation performance metrics for the physical device.

5. The hIOMon Disk I/O Ranger Display application will then make the "IORangerFS" Filter Selection the "default" Filter Selection. The hIOMon Manager software component loads the "default" Filter Selection (if any) automatically each time the system is started.

The hIOmon Disk I/O Ranger Display application is initially configured so that **only** the combined "Read/Write" IOPS, MBS, QD (Queue Depth), and Response Time (RT) metrics are displayed, with the display refreshed with the current metric values upon a five-second periodic basis.

Please note that all of the above configuration settings for the hIOmon Disk I/O Ranger Display application can be changed by using the "Settings" button/option at the bottom of the "Main Display" (q.v., "Figure 1").

1.3 Main Display

The following screenshots illustrate the use of the hIOmon Disk I/O Ranger Display to display selected "Performance Threshold Range Metrics" for an individual physical device, a logical device, a file, and a process/application.

For example, the screenshot shown in "Figure 1" illustrates the display of the **combined** read and write I/O operation IOPS, MBs, QD (Queue Depth), and Response Time (RT) Range metrics for a physical device (DR0). The metrics can be displayed separately for the read I/O operations, the write I/O operations, and upon a combined read and write I/O operation basis.

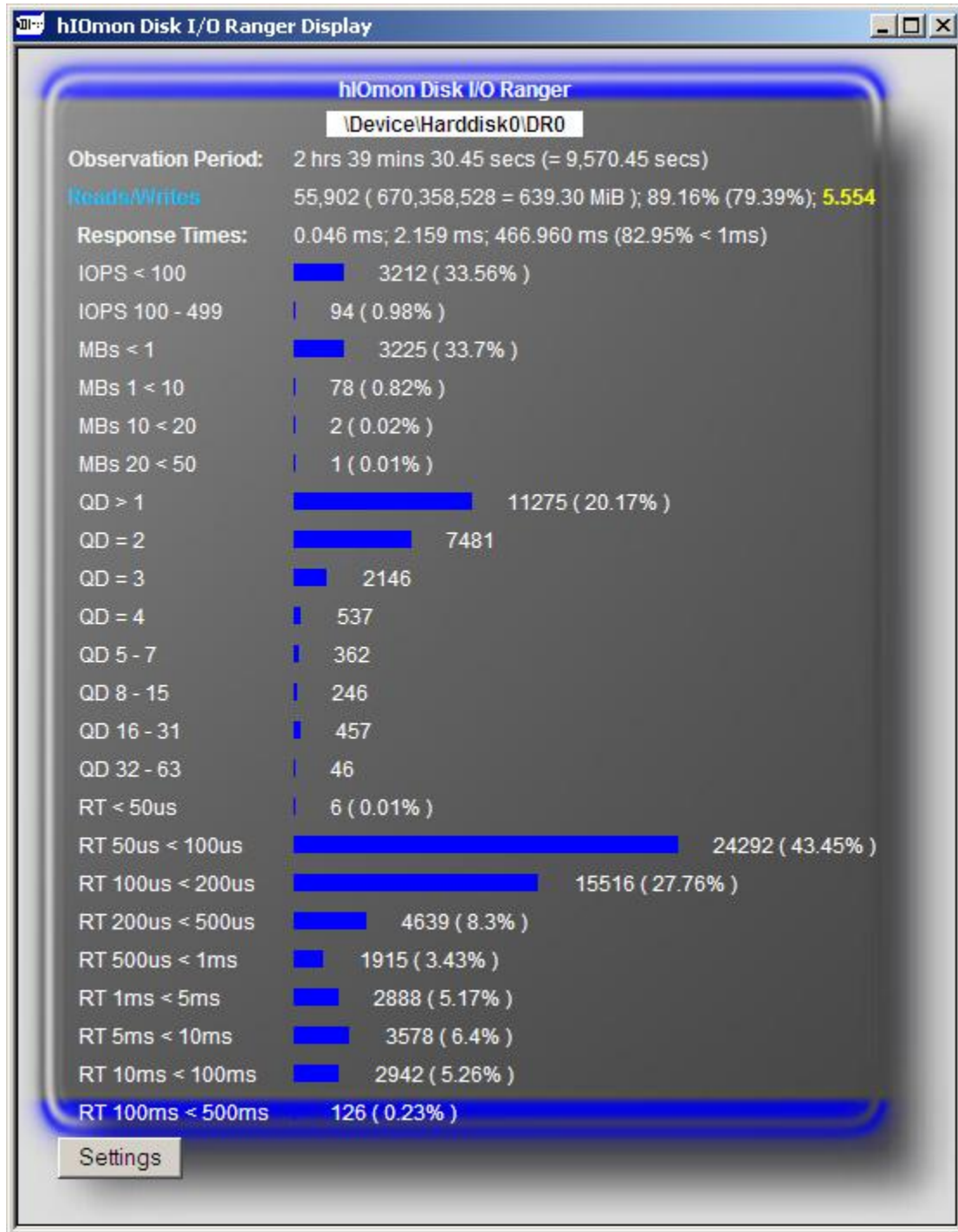
Please note that the first "one-second interval" begins with the first monitored read (in the case of the read and the combined read/write metrics) or write (in the case of the write and the combined read/write metrics) I/O operation observed by the hIOmon I/O Monitor for the respective file, device, or process.

The Range Counts are provided upon an "overall" basis (i.e., since the start of the Observation Period). The time duration of the Observation Period is shown near the top of the display under the name of the file, device, or process for which the metrics pertain. For each Range Count, a bar is shown that includes the value for the respective Range Count that has been accumulated by the hIOmon I/O Monitor during the Observation Period.

These "overall" values for each individual Range Count reflect the respective metrics for the file, device, or process collected by the hIOmon I/O Monitor since it first began monitoring the file, device, or process at the start of the Observation Period.

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Figure 1 - hIOmon Disk I/O Ranger Display for a Physical Device



In addition, the following overall total numbers are also shown separately for read I/O operations, write I/O operations, and combined read and write I/O operations; note again that these overall totals reflect the cumulative totals since the hIOmon I/O Monitor began monitoring the file, device, or process:

- Number of I/O operations performed

- Amount of data transferred in both bytes and mebibytes (MiB)
- The percentage of I/O operations that performed a random access. An I/O operation is considered to be sequential if its starting data transfer address is contiguous to the ending data transfer address of the prior I/O operation. Please note that the first I/O operation to a file is considered to be neither a random nor a sequential I/O operation; this also applies to the first monitored I/O operation to a physical volume or physical device.
- The corresponding percentage of the data transferred by the random I/O operations
- The hIOMon “DataTransferred/Time Index“ value (described below)
- The minimum, average, and maximum response times observed
- The percentage of I/O operations whose response time was less than one millisecond

Please note that for both the IOPS and MBs Range Count types, a percentage is also always shown following the value for each individual Range Count. This percentage is the Range Count value divided by the total number of seconds that comprise the Observation Period. As such, it basically indicates the percentage of time within the Observation Period that the respective IOPS or MBs Range Count value (e.g., "IOPS < 100") was observed by the hIOMon I/O Monitor.

In addition, a percentage is shown for the Response Time (RT) Range Count types; this percentage is the respective Range Count value divided by the combined sum of the Range Count values. As such, it basically indicates the percentage of applicable I/O operations that experienced the respective Response Time range.

A percentage is also shown for the first Queue Depth (QD) Range Count; this number represents the percentage of the total I/O operations that experienced a queue depth that was greater than one as observed by the hIOMon I/O Monitor.

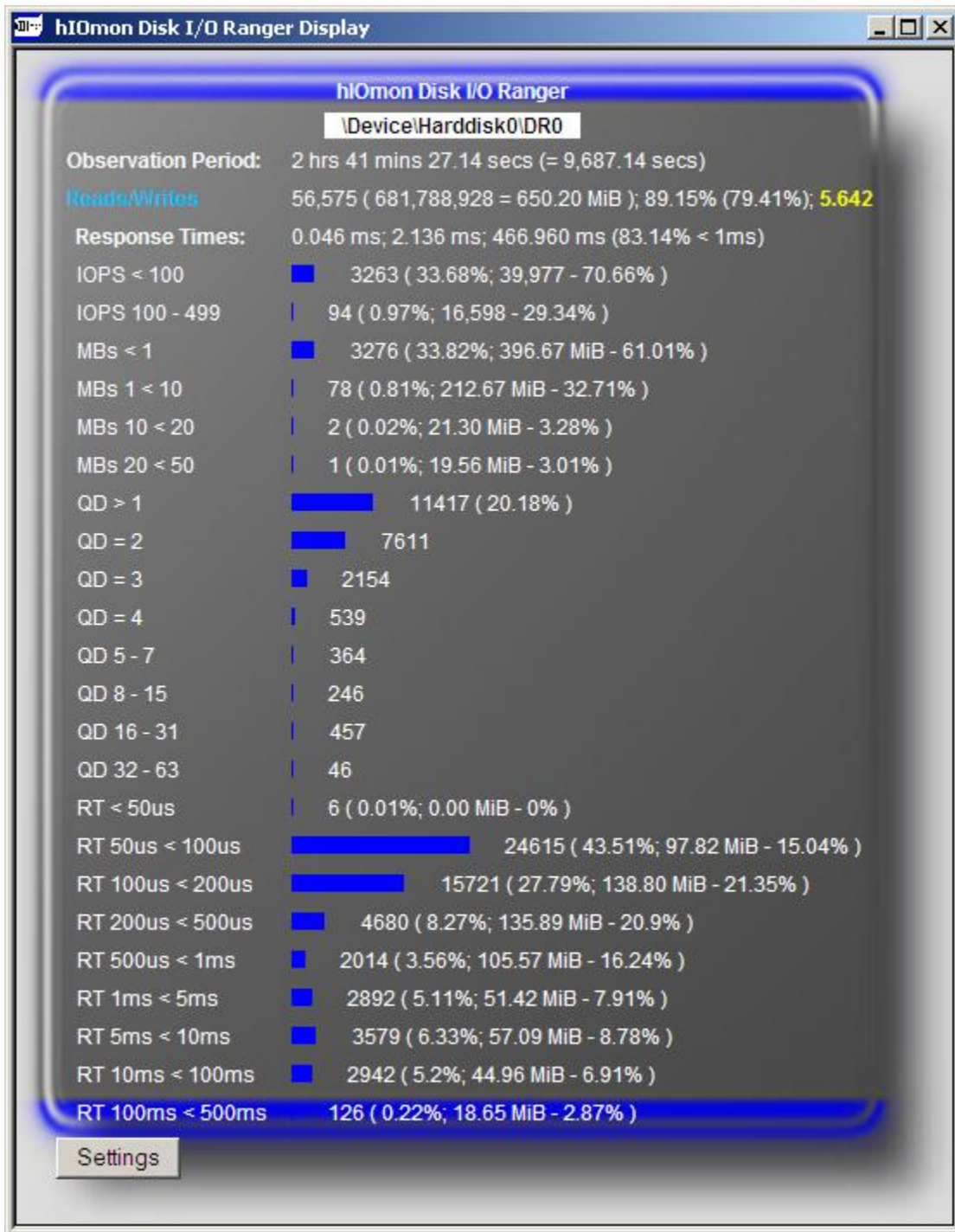
A **second** percentage (and associated value) can optionally be shown (see the "IOPS oper count" option within the "Settings" display panel shown in “Figure 6”) that shows for each individual IOPS Range Count, the total number of I/O operations associated with the respective Range Count value and its respective percentage of the total number of I/O operations (i.e., the sum of the Range Count values).

For MBs and RT Range Counts, this second percentage/value displays the total amount of data transferred associated with the respective Range Count value and its respective percentage of the total amount of data transferred by the sum of the Range Count values. The display of this second percentage and associated value can be requested by enabling the "MBs data transferred" option or “RT data transferred” option respectively as shown within the "Settings" panel.

The screenshot in “Figure 2” illustrates the display of this second percentage and associated value for both the IOPS and MBs Range Counts.

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Figure 2 - hIOmon Disk I/O Ranger Extended Display for a Physical Device

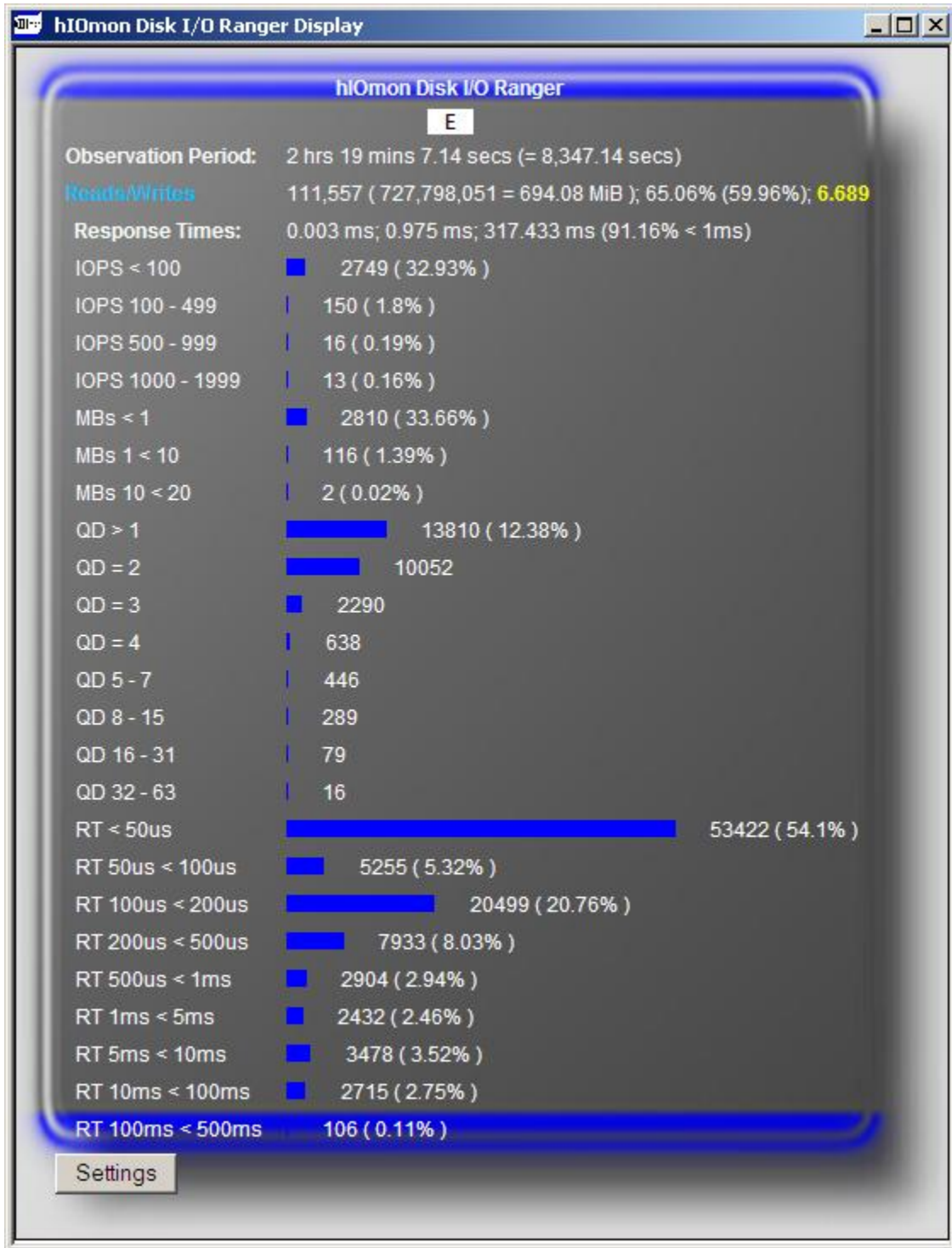


hIOmon can collect the summarized "Performance Threshold Range Metrics" upon an individual, specific logical device basis (e.g., "E:").

"Figure 3" illustrates a hIOmon Disk I/O Ranger Display for a Logical Device/Drive.

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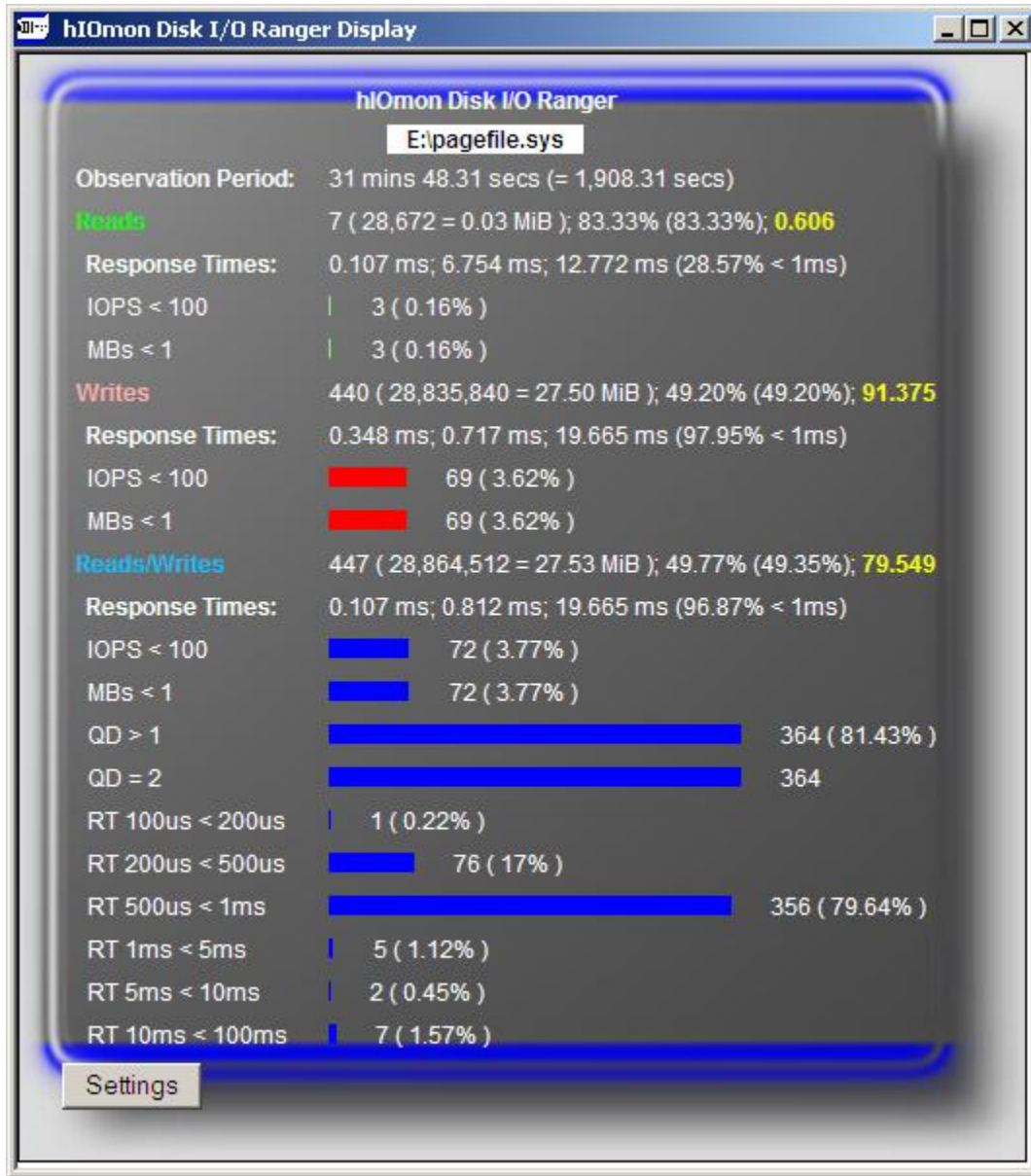
Figure 3 - hIOmon Disk I/O Ranger Display for a Logical Device



The summarized metrics collected upon a logical device basis reflect the combined totals for all of the monitored files that reside upon the associated logical device (i.e., only those files upon the device that were specified by the Filter Selection to be monitored by the hIOmon I/O Monitor).

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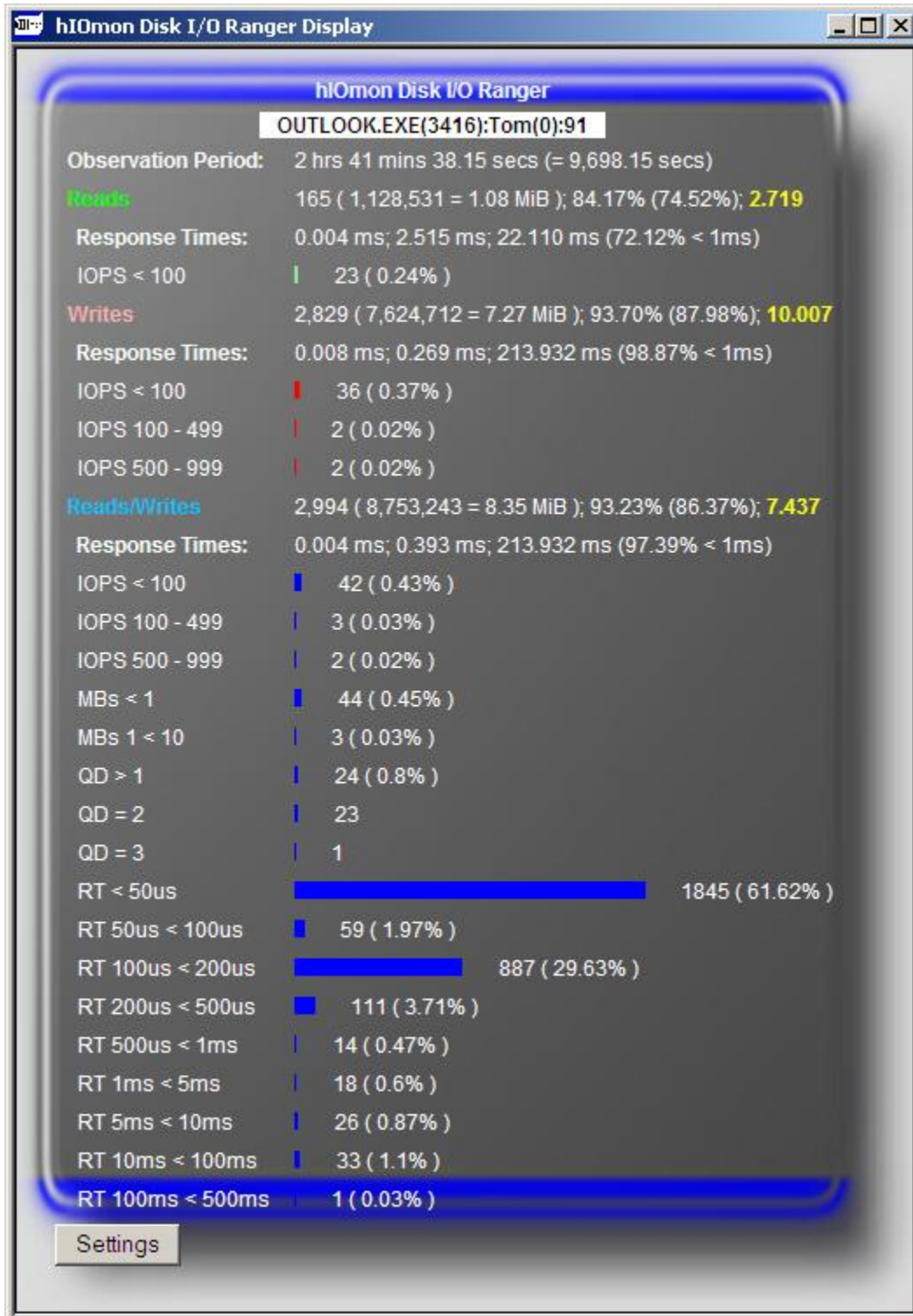
Figure 4 - hIOmon Disk I/O Ranger Display for a File



In addition to individual logical devices, physical volumes, and physical devices, the hIOmon Disk I/O Ranger Display can display the selected "Performance Threshold Range Metrics" for a specific, monitored file. "Figure 4" illustrates a hIOmon Disk I/O Ranger Display for a individual, specific file.

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Figure 5 - hIOmon Disk I/O Ranger Display for a Process/Application



hIOmon can also collect the summarized "Performance Threshold Range Metrics" upon an individual, specific process basis, as shown by "Figure 5".

The summarized metrics collected upon an individual process basis reflect the combined totals for all of the monitored files to which the process directed an I/O operation (i.e., only those files that were specified by the Filter Selection to be monitored by the hIOmon I/O Monitor).

NOTE

Please note that hIOmon can be used to collect **empirical** metrics that can reflect the actual I/O operations performed through the normal, everyday use of your very own applications and associated files! Moreover, no file, application, or operating system changes are required!

1.3.1 Items Shown within the Main Display

As shown within the screenshots in the prior section, the Main Display of the hIOmon "Disk I/O Ranger Display" application can include the display of the following items/metrics:

- Monitored Item Name, which is the name of the device, file, or process for which the selected "Performance Threshold Range Metrics" are being displayed in real-time. The name is shown at the top of the Main Display in black text within a white background. The name will be truncated with an appended "..." if the length of the name exceeds the width of the Main Display window (this can occur with some long file names).

The "Settings" button at the bottom of the Main Display can be used to select a different monitored item to be displayed.

- Observation Period, which is the overall length of time during which the hIOmon I/O Monitor captured the displayed Performance Threshold Range and associated metrics. Please note that the respective time duration converted into seconds is also displayed. Also note that this Observation Period generally begins when the hIOmon I/O Monitor started monitoring the corresponding monitored item (i.e., the displayed file, device, or process); that is, when the first monitored I/O operation was observed by the hIOmon I/O Monitor for the respective file or process after the Filter Selection was loaded (or reloaded). In the case of devices, the Observation Period begins when the Filter Selection is loaded (or reloaded).
- Reads, which provides the overall total number of Read I/O operations observed during the Observation Period for the respective file, device, or process. The total amount of data transferred (both in bytes and converted to mebibytes) by these read I/O operations is also shown, followed by the read "random I/O operation percentage", the read "random data transferred percentage", and the

hIOmon read "DataTransferred/Time Index" metric (which is highlighted in yellow text).

The read "Random I/O operation percentage" is calculated by dividing the number of random read I/O operations by the combined sum of random read and sequential read I/O operations. An I/O operation is considered to be sequential if its starting data transfer address is contiguous to the ending data transfer address of the prior I/O operation; in the case of the "**Read** random I/O operation percentage", the prior **read** I/O operation applies. Please also note that the first I/O operation to a file is considered to be neither a random nor a sequential I/O operation; this also applies to the first monitored I/O operation to a physical volume or physical device.

The read "Random data transferred percentage" reflects the percentage of the data that was transferred by the random read I/O operations. This percentage is calculated by dividing the amount of data transferred by the random read I/O operations by the combined sum of the data transferred by the random read and by the sequential read I/O operations.

The hIOmon read "**DataTransferred/Time Index**" metric is calculated by taking the observed overall total amount of data transferred by the read I/O operations (converted to megabytes for scaling), and then dividing this combined total amount by the corresponding combined sum of the observed time durations (i.e., response times) of the read I/O operations that were performed to transfer this data. The resulting value is considered to be an index.

The basic concept behind the hIOmon "DataTransferred/Time Index" metric is straightforward and simple: "Better" storage I/O operation performance is fundamentally about transferring (more) data faster. So for a given amount of data, transferring this data more quickly (i.e., in less time). And similarly, transferring more data within the same amount of time. More specifically, the relationship is basically between the amount of data transferred and the corresponding amount of time that it took to perform the I/O operations required for the data transfer.

Overall, this Index metric provides a "high-level" means for relative comparison, where basically "higher is better" (i.e., the "higher" the Index number, the better the performance). It resembles the "fuel economy" index for an automotive vehicle (i.e., "miles-per-gallon" or "kilometres/litre") as an overall measure of "performance efficiency".

Lastly, please note that you can select (within the "Settings/Options Display" option window) whether the IOPS, MBs, QD, and/or RT Range Counts (as described below) are to be shown within the "Main Display".

Note that at least one of the "Read Range Counts" display options must be selected for the Read metrics to appear; also if no read I/O operations have been

observed by the hIOMon I/O Monitor, then nothing will be displayed for the "Read Range Counts".

- Response Time, which provides the minimum, average, and maximum Read I/O operation response time observed by the hIOMon I/O Monitor during the Observation Period for the respective file, device, or process.

Also shown is the percentage of the total number of Read I/O operations whose response time was less than one millisecond.

- IOPS Range Counts. Each IOP Range Count reflects the total number of times that the hIOMon I/O Monitor observed an I/O operations-per-second (IOPS) within the corresponding range. Only those IOP Range Counts that have a non-zero value are displayed.

The individual Read IOP Range Counts include:

- IOPS < 100. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the first "IOPS Range". By default, the first IOPS Range is an IOPS of less than 100 I/O operations. Also note that all I/O operations included within the IOPS Range Counts reflect I/O operations that successfully transferred one or more bytes.
- IOPS 100 – 499. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the second "IOPS Range". By default, the second IOPS Range is an IOPS of between 100 and 499 I/O operations inclusive.
- IOPS 500 – 999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the third "IOPS Range". By default, the third "IOPS Range" is an IOPS of between 500 and 999 I/O operations inclusive.
- IOPS 1000 – 1999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the fourth "IOPS Range". By default, the fourth "IOPS Range" is an IOPS of between 1000 and 1999 I/O operations inclusive.
- IOPS 2000 – 4999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the fifth "IOPS Range". By default, the fifth "IOPS Range" is an IOPS of between 2000 and 4999 I/O operations inclusive.

- IOPS 5000 – 9999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the sixth "IOPS Range". By default, the sixth "IOPS Range" is an IOPS of between 5000 and 9999 I/O operations inclusive.
- IOPS 10000 – 19999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the seventh "IOPS Range". By default, the seventh "IOPS Range" is an IOPS of between 10000 and 19999 I/O operations inclusive.
- IOPS 20000 – 39999. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the eighth "IOPS Range". By default, the eighth "IOPS Range" is an IOPS of between 20000 and 39999 I/O operations inclusive.
- IOPS 40000 and >. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of completed Read I/O operations within the ninth "IOPS Range". By default, the ninth "IOPS Range" is an IOPS of 40000 or more I/O operations inclusive.

Please note that for each IOPS Range Count value displayed, a **percentage** is also always shown following the overall value. This percentage is the IOPS Range Count value divided by the total number of seconds that comprise the Observation Period. As such, it basically indicates the percentage of time within the Observation Period that the respective IOPS Range Count value (e.g., "IOPS < 100") was observed by the hIOMon I/O Monitor.

- MBS Range Counts. Each MBs Range Count reflects the total number of times that the hIOMon I/O Monitor observed an actual megabytes-per-second (MBS) transfer amount within the corresponding range. Only those MBs Range Counts that have a non-zero value are displayed.

The individual Read MBs Range Counts include:

- MBs < 1. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the first "Megabytes Per Second (MBs) Range". By default, the first "MBs Range" is a MB/s of less than one MB/s. Also note that all I/O operations included within the MBs Range Counts reflect I/O operations that successfully transferred one or more bytes.

- MBs 1 < 10. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the second "MBs Range". By default, the second "MBs Range" is a MB/s of between 1 and above but less than 10 MB/s.
- MBs 10 < 20. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the third "MBs Range". By default, the third "MBs Range" is a MB/s of between 10 and above but less than 20 MB/s.
- MBs 20 < 50. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the fourth "MBs Range". By default, the fourth "MBs Range" is a MB/s of between 20 and above but less than 50 MB/s.
- MBs 50 < 100. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the fifth "MBs Range". By default, the fifth "MBs Range" is a MB/s of between 50 and above but less than 100 MB/s.
- MBs 100 < 200. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the sixth "MBs Range". By default, the sixth "MBs Range" is a MB/s of between 100 and above but less than 200 MB/s.
- MBs 200 < 500. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the seventh "MBs Range". By default, the seventh "MBs Range" is a MB/s of between 200 and above but less than 500 MB/s.
- MBs 500 < 1000. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the eighth "MBs Range". By default, the eighth "MBs Range" is a MB/s of between 500 and above but less than 1000 MB/s.
- MBs 1000 and >. The accumulated count of one-second time intervals during which the hIOMon I/O Monitor observed an actual total number of data bytes transferred by Read I/O operations within the ninth "MBs Range". By default, the ninth "MBs Range" is a MB/s of 1000 or more.

Please note that for each MBs Range Count value displayed, a **percentage** is also always shown following the overall value. This percentage is the MBs Range Count value divided by the total number of seconds that comprise the Observation Period. As such, it basically indicates the percentage of time within the Observation Period that the respective MBs Range Count value (e.g., "MBs < 1") was observed by the hIOmon I/O Monitor.

- Queue Depth (QD) Range Counts. Each QD Range Count reflects the total number of times that the hIOmon I/O Monitor observed an actual Queue Depth/Length within the corresponding range. Only those QD Range Counts that have a non-zero value are displayed.

The individual Read QD Range Counts include:

- QD > 1. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operations Queue Depth/Length greater than one; that is, where two or more Read I/O operations were concurrently outstanding (had not yet completed and includes requests in service).
- QD = 2. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the first "QD Range". By default, the first QD Range Count is a queue depth of two (2).
- QD = 3. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the second "QD Range". By default, the second QD Range Count is a queue depth of three (3).
- QD = 4. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the third "QD Range". By default, the third QD Range Count is a queue depth of four (4).
- QD 5 – 7. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the fourth "QD Range". By default, the fourth QD Range Count is a queue depth of between 5 and 7 inclusive.
- QD 8 – 15. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the fifth "QD Range". By default, the fifth QD Range Count is a queue depth of between 8 and 15 inclusive.
- QD 16 – 31. The accumulated number of times that the hIOmon I/O Monitor observed a Read I/O operation queue depth within the sixth "QD Range". By default, the sixth QD Count Range is a queue depth of between 16 and 31 inclusive.

- QD 32 – 63. The accumulated number of times that the hIOMon I/O Monitor observed a Read I/O operation queue depth within the seventh "QD Range". By default, the seventh QD Count Range is a queue depth of between 32 and 63 inclusive.
- QD 64 and >. The accumulated number of times that the hIOMon I/O Monitor observed a Read I/O operation queue depth within the eighth "QD Range". By default, the eighth QD Count Range is a queue depth of 64 or more.

Please note that for first QD Range Count only (i.e., "QD > 1"), a **percentage** is also shown following the overall value. This percentage is the QD Range Count value divided by the overall total number of Read I/O operations observed during the Observation Period. As such, it basically indicates the percentage of Read I/O operations that experienced a Queue Depth of more than one Read I/O operation as observed by the hIOMon I/O Monitor.

- Response Time (RT) Range Counts. Each RT Range Count reflects the total number of times that the hIOMon I/O Monitor observed a Read I/O operation whose response time (i.e., the time duration between the start of an I/O operation and the completion of the I/O operation, which includes both service time and queue time) was within the corresponding range. Only those RT Range Counts that have a non-zero value are displayed.

The individual Read MBs Range Counts include:

- RT < 50us. The accumulated count of Read I/O operations whose time duration (response time) as observed by the hIOMon I/O Monitor was within the first "Response Time (RT) Range". By default, the first "RT Range" is a response time of less than 50 microseconds. Also note that all I/O operations included within the RT Range Counts reflect I/O operations that successfully transferred one or more bytes.
- RT 50us < 100us. The accumulated count of Read I/O operations whose response time as observed by the hIOMon I/O Monitor observed was within the second "RT Range". By default, the second "RT Range" is a response time of 50 microseconds or more but less than 100 microseconds.
- RT 100us < 200us. The accumulated count of Read I/O operations whose response time as observed by the hIOMon I/O Monitor observed was within the third "RT Range". By default, the third "RT Range" is a response time of 100 microseconds or more but less than 200 microseconds.
- RT 200us < 500us. The accumulated count of Read I/O operations whose response time as observed by the hIOMon I/O Monitor observed

was within the fourth “RT Range”. By default, the fourth “RT Range” is a response time of 200 microseconds or more but less than 500 microseconds.

- RT 500us < 1ms. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the fifth “RT Range”. By default, the fifth “RT Range” is a response time of 500 microseconds or more but less than 1 millisecond.
- RT 1ms < 5ms. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the sixth “RT Range”. By default, the sixth “RT Range” is a response time of 1 millisecond or more or more but less than 5 milliseconds.
- RT 5ms < 10ms. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the seventh “RT Range”. By default, the seventh “RT Range” is a response time of 5 milliseconds or more or more but less than 10 milliseconds.
- RT 10ms < 100ms. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the eighth “RT Range”. By default, the eighth “RT Range” is a response time of 10 milliseconds or more or more but less than 100 milliseconds.
- RT 100ms < 500ms. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the ninth “RT Range”. By default, the ninth “RT Range” is a response time of 100 milliseconds or more or more but less than 500 milliseconds.
- RT 500ms and >. The accumulated count of Read I/O operations whose response time as observed by the hIOmon I/O Monitor observed was within the tenth “RT Range”. By default, the tenth “RT Range” is a response time of 500 milliseconds or more.

Please note that for each RT Range Count value displayed, a **percentage** is also always shown following the overall value. This percentage is the respective RT Range Count value divided by the combined sum of the RT Range Count values. As such, it basically indicates the percentage of applicable Read I/O operations that experienced the respective Response Time range as observed by the hIOmon I/O Monitor.

- Writes, which provides the overall total number of Write I/O operations observed during the Observation Period for the respective file, device, or process. The

total amount of data transferred (both in bytes and converted to mebibytes) by these write I/O operations is also shown, followed by the write "random I/O operation percentage", the write "random data transferred percentage", and the hIOmon write "DataTransferred/Time Index" metric (which is highlighted in yellow text).

Also shown is the minimum, average, and maximum Write I/O operation response time observed by the hIOmon I/O Monitor during the Observation Period for the respective file, device, or process along with the percentage of the total number of Write I/O operations whose response time was less than one millisecond.

Please note that at least one of the "Write Range Counts" display options must be selected for the Write metrics to appear; also if no write I/O operations have been observed by the hIOmon I/O Monitor, then nothing will be displayed for the "Write Range Counts".

As with the Read I/O operations, you can select (within the "Settings/Options Display" window) whether the IOPS, MBs, QD, and/or RT Range Counts (as described above, but for write I/O operations only) are to be displayed.

- Reads/Writes, which provides the overall total number of combined Read and Write I/O operations observed during the Observation Period for the respective file, device, or process. The total amount of data transferred (both in bytes and converted to mebibytes) by these combined read and write I/O operations is also shown, followed by the read/write "random I/O operation percentage", the read/write "random data transferred percentage", and the hIOmon read/write "DataTransferred/Time Index" metric (which is highlighted in yellow text).

In the case of the read/write "random" percentages, the prior I/O operation can be either a read or a write I/O operation. The hIOmon read/write "DataTransferred/Time Index" metric is calculated by taking the observed overall total amount of data transferred by the read and write I/O operations combined (converted to megabytes for scaling), and then dividing this combined total amount by the corresponding combined sum of the observed time durations (i.e., response times) of the read and write I/O operations that were performed to transfer this data.

Also shown is the minimum, average, and maximum I/O operation response time (whether Read or Write I/O operation, with the average based upon the total number of Read and Write I/O operations combined) observed by the hIOmon I/O Monitor during the Observation Period for the respective file, device, or process along with the percentage of the total number of Read and Write I/O operations combined whose response time was less than one millisecond.

Please note that at least one of the "Read/Write Range Counts" display options must be selected for the combined Read/Write metrics to appear; also if no read

nor write I/O operations have been observed by the hIOmon I/O Monitor, then nothing will be displayed for the "Read/Write Range Counts".

As with the Read I/O operations, you can select (within the "Settings/Options Display" window) whether the IOPS, MBs, QD, and/or RT Range Counts (as described above, but for combined read and write I/O operations) are to be displayed.

Also please note the following:

1. All of the above metrics reflect the **total, cumulative values** that have been automatically accumulated by the hIOmon I/O Monitor during the indicated Observation Period.
2. Note that the first "one-second interval" begins with the first monitored read (in the case of the read and the combined read/write metrics) or write (in the case of the write and the combined read/write metrics) I/O operation observed by the hIOmon I/O Monitor for the respective file, device, or process.
3. The metrics are displayed upon a individual monitored item basis (i.e., for a **single** file, process, logical disk, physical volume, or physical device). The "Settings/Options Display" button/option can be used to select a different monitored item for which the metrics are to be displayed.
4. The display of the metric values is periodically **refreshed/updated** automatically to the current values. You can view the refresh time interval by clicking on the "Settings" button/option; the "Settings" options can also be used to select a different refresh time interval.
5. An **error** indication will be displayed near the bottom of the Main Display in the event that the hIOmon Disk I/O Ranger Display application encounters an error. Click on the "Settings" option/button to view additional details about the error.
6. If a Filter Selection change is made while the hIOmon Disk I/O Ranger Display application is active (i.e., is running), then the hIOmon Disk I/O Ranger Display application will subsequently display the selected metrics for the new Observation Period.
7. You can invoke/run more than one instance of the hIOmon Disk I/O Ranger Display application. Each instance can be configured to display the current metrics for a different monitored item (i.e., file, process, logical disk, physical volume, or physical device).

Please see the "help.htm" file (click on the "Help" button shown within the "Settings" display) that is included with the "hIOmon Disk I/O Ranger Display" application for additional details.

1.4 Settings/Options Display

As shown in “Figure 6”, the Settings/Options Display of the “hIOmon Disk I/O Ranger Display” application includes the following displayed information and configuration options:

- Metrics for monitored:, which provides the option to select from either monitored devices, files, or processes for which the “Performance Threshold Range Metrics” are to be displayed.

When you select one of these three options, the drop-down list box immediately below will be populated with the respective items for which there are “Performance Threshold Range Metrics” available for display.

For example, if you click on the "Devices" button, the label of the drop-down list box will change to "Device names:" and the drop-down box will list the names of all devices for which Performance Threshold Range Metrics are available for display within the “**Error! Reference source not found.**”. Similarly, if you click on the "Files" button, a list of file names (for files for which metrics are available for display) will be shown within the drop-down list box; a list of process names (for which metrics are available for display) will be shown within the drop-down box if the "Processes" button is selected.

To refresh the list of names within the drop-down list box, simply close and then re-open the "Settings" window. The "Settings" windows also refreshes the list of names within the drop-down list box each time that you select a different monitored item type option (so to force a refresh of the names within the drop-down list box, select a different monitored item type option and then reselect the monitored item type of interest).

- Device Names (or File Names or Process Names), which is a drop-down list box that displays the full names of the monitored items for which there are Performance Threshold Range Metrics available for display. This list of names can be either device, file, or process names depending upon which one of the three “Metrics for monitored:” buttons is currently selected.

To display metrics for a particular monitored item (i.e., a specific device, file, or process), simply select the specific monitored item of interest and then click on the "OK" button. Please note that the selection will immediately take effect upon clicking the "OK" button. Please see the “OK” button below for additional details.

The particular monitored item for which metrics are currently being displayed in the Main Display is highlighted with a green background within the drop-down list box. Also please note that alongside each physical volume/device name are the

drive letters of the particular Logical Disks that are associated with the respective physical volume/device.

Lastly please note that the specified physical volume (or physical device) represents a physical volume (or physical device) at the respective level within the Windows operating system. The “physical device”, for instance, is akin to the Windows Performance Monitor “PhysicalDisk” performance object (with “\Device\Harddisk0\DR0”, as an example, representing physical device 0.

- Seconds between refreshes, which is an input text field that enables you to specify the time interval between refreshes/updates of the metrics displayed within the Main Display. This time interval is specified in terms of seconds and must be a number greater than zero.

The new refresh interval will immediately take effect upon clicking the "OK" button. Please see the “OK” button for additional details.

You can also temporarily stop the refresh update of the Main Display by clicking upon the “Stop” button located to the right of the input text field where the refresh time interval value is specified. The "Stop" button is automatically changed to a “Start” button when the refresh update of the Main Display has been stopped. Click on the "Start" button to resume the refresh update of the Main Display; note that an immediate refresh of the Main Display is performed when the "Start" button is clicked (and the subsequent refresh updates are performed in accordance with the specified refresh time interval).

- Read Range Counts, which provides a separate checkbox for each of the four basic types of "Performance Threshold Range Metrics": IOPS, MBs, QD (Queue Depth) and Response Time (RT). To enable the display of **Read** I/O operation metrics for a particular type, simply enable/select the respective checkbox.

For example, select/enable the "IOPS" checkbox to display the "IOPS Range Counts" for read I/O operations within the Main Display. Please note that the “OK” button must subsequently be clicked for any changes to these checkboxes to take effect within the Main Display.

- Write Range Counts, which provides a separate checkbox for each of the four basic types of "Performance Threshold Range Metrics": IOPS, MBs, QD (Queue Depth) and Response Time (RT). To enable the display of **Write** I/O operation metrics for a particular type, simply enable/select the respective checkbox.

For example, select/enable the "MBs" checkbox to display the "MBs Range Counts" for write I/O operations within the Main Display. Please note that the “OK” button must subsequently be clicked for any changes to these checkboxes to take effect within the Main Display.

- Read/Write Range Counts, which provides a separate checkbox for each of the four basic types of "Performance Threshold Range Metrics": IOPS, MBs, QD (Queue Depth) and Response Time (RT). To enable the display of combined **Read/Write** I/O operation metrics for a particular type, simply enable/select the respective checkbox.

For example, select/enable the "QD" checkbox to display the "QD Range Counts" for read and write I/O operations combined within the Main Display. Please note that the "OK" button must subsequently be clicked for any changes to these checkboxes to take effect within the Main Display.

- Display ops/data amounts, which provides two additional extended display options:
 - **IOPS oper count.** When this checkbox is selected/enabled, a **second** percentage (and associated value) is displayed that shows for IOPS Range Counts **only**, the total number of I/O operations associated with the respective IOPS Range Count value and its respective percentage of the total number of I/O operations reflected by the sum of the IOPS Range Count values. The first percentage that is always shown for IOPS Range Counts is described above.
 - **MBs data transferred.** When this checkbox is selected/enabled, a **second** percentage (and associated value) is displayed that shows for MBs Range Counts **only**, the total amount of data transferred associated with the respective MBs Range Count value and its respective percentage of the total amount of data transferred by the sum of the MBs Range Count values. The first percentage that is always shown for MBs Range Counts is described above.
 - **RT data transferred.** When this checkbox is selected/enabled, a **second** percentage (and associated value) is displayed that shows for RT Range Counts **only**, the total amount of data transferred associated with the respective RT Range Count value and its respective percentage of the total amount of data transferred by the sum of the RT Range Count values. The first percentage that is always shown for RT Range Counts is described above.

Please note that the "OK" button must subsequently be clicked for any changes to these checkboxes to take effect within the Main Display.

- Monitored device/file. Either a drop-down list box (that lists all of the "filters" included within the currently selected "Filter Selection" and from which you can select a specific filter to be **removed**) or a text input box (that enables you to enter a new filter which is to be either **added** to the currently selected Filter Selection or to a new Filter Selection) is displayed.

Click on the “**Add**” button to add a new filter to an existing Filter Selection or to add the first filter to a Filter Selection that is being newly created.

When specifying the filter, you can enter, for example, the following to monitor all files upon Logical Drive "C:": C:* (or simply enter the letter C, in which case the hIOmon Disk I/O Ranger Display application will automatically append the "*" wildcard indicator to the drive letter).

To monitor a specific file, enter the full file path name; for instance:
C:\pagefile.sys

To monitor all files within a particular folder/directory, enter the full path name for the folder/directory followed by the wildcard indicator; for example: C:\Program Files*

To monitor a specific physical device, enter the full device name (e.g., \Device\Harddisk0\DR0) or simply enter the letter of a Logical Drive associated with the physical device along with the physical device alias character (an exclamation mark: "!"); for example: C!

You can also simply enter the physical device number; for example, to monitor physical device \Device\Harddisk0\DR0, simply enter: DR0

To monitor a specific physical volume, you can simply the letter of a Logical Drive associated with the physical volume along with the physical volume alias character (a question mark: "?"); for example: C?

Also please note that the system may need to be rebooted as a result of adding a filter for a physical volume or a physical device. If a system reboot is required, the hIOmon Disk I/O Ranger Display application will display a message saying that a system reboot is required. Monitoring of the physical volume/device will not be successful until the **reboot** is performed.

The “**Remove**” button can be used to remove a specified filter from a Filter Selection.

The hIOmon Disk I/O Ranger Display application will then immediately update the selected Filter Selection by removing the filter that you selected. Also note that the Filter Selection will automatically be deleted if the last filter within the Filter Selection is removed.

Please note that the Add or Remove request is performed immediately upon the selected Filter Selection when you click upon the respective button.

- **Filter Selections.** This drop-down list box contains the names of all of the Filter Selections currently available. The associated buttons can be used to perform the following operation upon the selected Filter Selection:

Load. To load/activate a specific Filter Selection, first select the respective Filter Selection within the drop-down list box, then click on the "Load" button. The selected Filter Selection will then be immediately activated. Please note that all of the summary metrics will subsequently be reset to zeroes as a result of loading/activating the Filter Selection; in addition, a new Observation Period will begin.

The list of names for those monitored items for which there are Performance Threshold Range Metrics available for display will also change as a result of loading/activating the Filter Selection. That is, those monitored items whose metrics were collected for the prior activated Filter Selection will subsequently be removed from this list of names so that only those monitored items for which there are Performance Threshold Range Metrics available for display based upon the currently loaded Filter Selection will be included within the list. Please see the "Metrics for monitored" description above for how to refresh the list of names of monitored items for which there are Performance Threshold Range Metrics available for display.

Also please note that the system may need to be rebooted if the Filter Selection to be loaded/activated contains filters that specify a physical volume or a physical device to which the hIOMon I/O Monitor is not currently attached. If a system reboot is required, the hIOMon Disk I/O Ranger Display application will display a message saying that a system reboot is required. The loading/activation of the specified Filter Selection and the monitoring of the physical volume/device will not be successful until the **restart/reboot** is performed.

Delete. To explicitly delete a specific Filter Selection, first select the respective Filter Selection within the drop-down list box, then click on the "Delete" button. The selected Filter Selection will then be immediately deleted and removed from list of currently available/present Filter Selections shown within the drop-down list box. Please note that new Filter Selections can be added by using the "New" button described below.

Default. To assign a specific Filter Selection as the "default" Filter Selection, first select the respective Filter Selection within the drop-down list box, then click on the "Default" button. The selected Filter Selection will then be immediately assigned as the new "default" Filter Selection. The hIOMon Manager software component loads the "default" Filter Selection (if any) automatically each time the system is started.

- **New Filter Selection name:** This text box enables you to enter the name of the **new** Filter Selection that is to be **created**. enter the name of the new Filter

Selection within this "New Filter Selection name:" text input box, and then finally click on the "New" button.

You can subsequently add additional filters to this new Filter Selection by using the "Add" button described above.

Please **note** that a new Filter Selection must subsequently be loaded/activated in order for monitoring to be performed in accordance with this new Filter Selection. That is, until this new Filter Selection is loaded/activated, the monitoring of I/O operations by the hIOmon I/O Monitor will continue to be performed based upon the currently loaded/activated Filter Selection.

- Max Allowed File Count, which enables you to specify the maximum number of files for which the hIOmon I/O Monitor can concurrently maintain I/O operation performance metrics. This configurable parameter basically lets you control the maximum number of files that the hIOmon I/O Monitor is allowed to concurrently monitor.

Note that the hIOmon I/O Monitor will record a System Event Log entry in the event that the monitoring of an additional file (or directory) would exceed the maximum allowed by this configurable parameter. An error message will also be displayed within the Settings Display if the hIOmon Disk I/O Ranger Display application detects that the maximum allowed number has been reached.

The value entered for the new maximum allowed number of files to be monitored concurrently must be a number greater than zero. Please note that the "OK" button must subsequently be clicked for this new value to take effect.

Note that the new maximum value will be put into effect asynchronously by the hIOmon I/O Monitor such that it might take several minutes to actually take effect.

- Export metrics to file: This option enables you to export/save Performance Threshold Range Metrics to a file; the particular metrics that you select are written to the specified export file each time the "**Error! Reference source not found.**" is refreshed.

The text input box enables you to enter the name of the export file to which the metrics will be written. Simply enter the file name for the export file; the hIOmon Disk I/O Ranger Display application will automatically append a file extension of ".csv" (for the "Comma-Separated-Values" format of the export file) and the file will reside within the same folder/directory from which the hIOmon Disk I/O Ranger Display application was started.

Select metrics to include: Located to the right of the text box (that contains the file name of the export file) is a drop-down list box that shows the names of

the various Performance Threshold Range Metric types that can be included within the export file.

Select a particular Performance Threshold Range Metric to have it included within the export file; those specific Performance Threshold Range Metrics that are to be included within the export file are highlighted with a green background.

Please note the following:

- A selected Performance Threshold Range Metric will be written to the export file even when its value is zero (this is unlike the Main Display, which only displays non-zero Performance Threshold Range Metrics).
- An export file must contain at least one of the Performance Threshold Range Metrics items shown within the drop-down box that lists those Performance Threshold Range Metrics which can be included within an export file.
- All of the Performance Threshold Range Metrics to be included within the export file must be selected **before** you start/activate the export file (i.e., enable writing to the export file).
- The selection of Performance Threshold Range Metrics to be included within an export file **cannot** be changed after the export file has been started/activated.
- You must first **stop** the export file (if it is currently started/active) and then **delete** the export file before you can then select a modified set of Performance Threshold Range Metrics to be included within the same export file (i.e., an existing export with the same file name).
- The Performance Threshold Range Metrics selections are preserved (within the saved configuration settings) across subsequent runs of the hIOmon Disk I/O Ranger Display application. Moreover, if an export file is enabled/active at the time that you exit the hIOmon Disk I/O Ranger Display application, then the same export file will automatically be started (with the same selection settings) by the hIOmon Disk I/O Ranger Display application the next time you start the application.

Start. The Start button allows you to enable/activate the exporting of the selected Performance Threshold Range Metrics to the specified export file. Please note that only **one** export file can be active at the same time.

The current values of the Performance Threshold Range Metrics that were selected to be included within the active export file will be written to the activated export file with each periodic refresh of the “**Error! Reference source not found.**”.

The "Start" button will change to the "**Stop**" button immediately after the specified export file has been successfully enabled for exporting. Click on the "Stop" button to disable further exporting to the export file; the "Stop" button will change back to the "Start" button after exporting to the export file has been successfully disabled. Exporting to the export file will continue to be stopped until the "Start" button is again clicked.

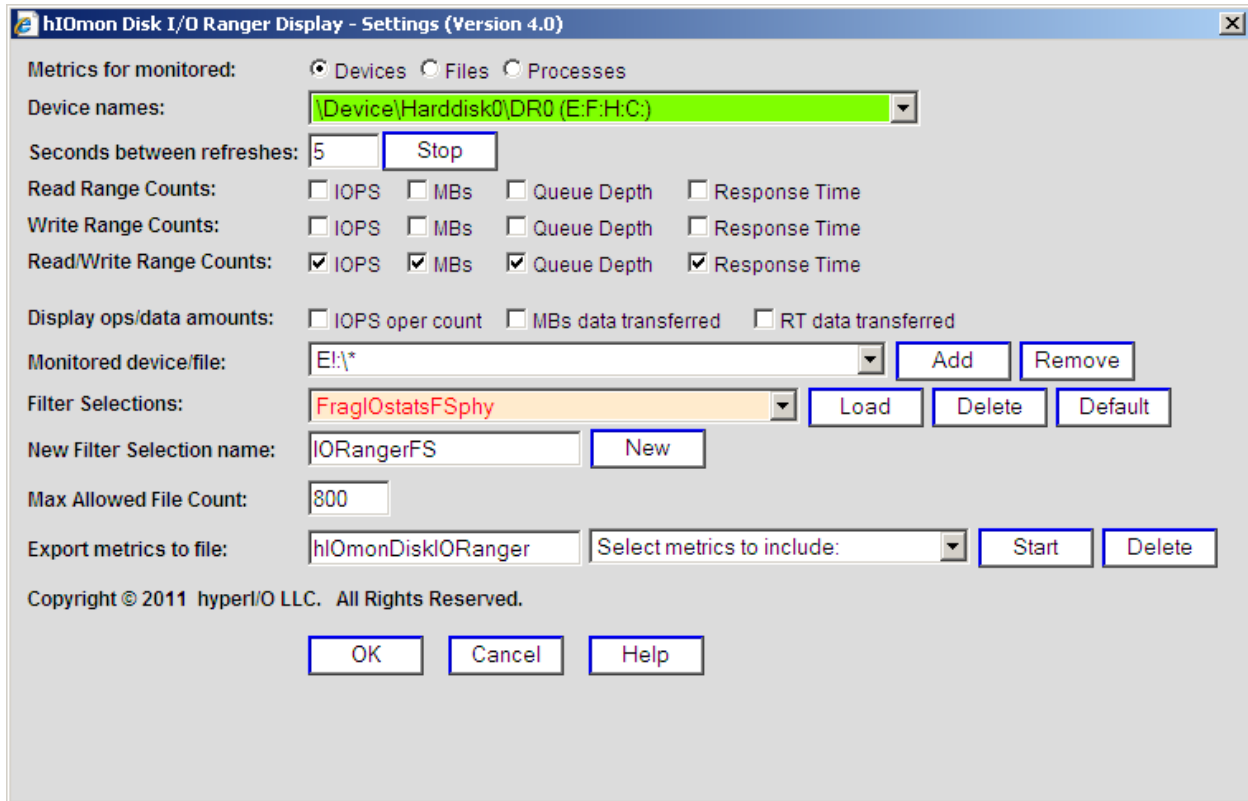
The "**Delete**" button allows you to delete the specified export file (as indicated by the file name entered into the text box that contains the file name of the export file). A currently started/activated export file must first be stopped before deleting the export file.

- OK Button. Click on the "OK" button to immediately activate the configuration changes described above (e.g., the "Seconds before refreshes" configuration option). Please note that if you click on the "OK" button without making any configuration changes, then the "Settings" display window will simply close and the operation of the hIOmon Disk I/O Ranger Display application will continue without any change.

Also please note that the configuration changes are **persistent**. That is, the configuration options will be saved so that they will **automatically** be used the next time that you start/invoke the hIOmon Disk I/O Ranger Display application.

- Cancel Button. Click on the "Cancel" button to close the "Settings" display without activating/saving any of the changes that you have made to the configuration option input fields; that is, any such entered changes that have not yet been performed will be ignored.
- Help Button. Click on the "Help" button to display the "help.htm" file that is included with the "hIOmon Disk I/O Ranger Display" application.
- Error Information. In the event of an error, the bottom portion of the "Settings" display window will provide detailed information about the error encountered by the hIOmon "Disk I/O Ranger Display" application. This error information will be displayed in red text and will be cleared when the "Settings" display window is closed.

Figure 6 - hIOmon Disk I/O Ranger Display Configuration Settings



Please see the “help.htm” file (click on the “Help” button shown within the “Settings” display) that is included with the “hIOmon Disk I/O Ranger Display” application for additional details.

1.5 Error Messages

Please see the hIOmon “Disk I/O Ranger Display” help html file (click on the “Help” button near the bottom of the “Settings” display as shown in “Figure 6”) for a brief explanation for each of the various error messages that might be shown at the bottom of the “Settings” display.

The error information will be displayed in red and will be cleared when the “Settings” display window is closed.

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