IBM

Redpaper

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Performance Metrics in TotalStorage Productivity Center Performance Reports

Introduction

This Redpaper contains the TotalStorage Productivity Center performance metrics that are available for the Storage Subsystem performance reports and Switch performance reports. The metrics are listed by report in the order in which they appear in the TotalStorage Productivity Center main Navigation Tree.

Performance metric collection

We begin with a high level discussion of the way that TPC collects performance metrics from storage devices and switches. The performance counters are usually kept in device firmware, then pulled out for processing by CIM agents, and forwarded to TPC for final calculations and insertion into the TPC database. For most devices, the counters kept in firmware are monotonically increasing values. Over time, these values go up and only up. Consequently, it is necessary to pull two samples of the counters, separated by a number of seconds, in order to take the difference in the counters and calculate metrics, such as I/O rates, using the known time between samples.

For example, each time that an I/O (a read or write) is issued to a volume, several counters (I/O count and Bytes transferred) increment. If the counters are pulled at times T1 and T2, the number of I/Os in the sample interval is obtained by subtracting the counters at time T1 from the counters at time T2 (T2-T1). When this count is divided by the number of seconds between T1 and T2, we obtain the I/O rate in I/Os/second for the sample interval (T1 to T2). This is the technique, and it is simple for metrics, such as I/O rate, data rate, average transfer size, and so forth. Other metrics, such as Read hit ratios or Disk Utilization, involve other calculations involving sampled counters and times T1 and T2.

The counters in the firmware are usually unsigned 32-bit or 64-bit counters. Eventually, these counters "wrap," meaning that the difference between the counters at T2 and T1 might be difficult to interpret. The TPC Performance Manager attempts to adjust for these wraps during its delta computations, but there might be unexpected wraps, which can confuse the Common Information Module (CIM) agent or the TPC Performance Manager. The TPC Performance Manager stores the deltas in the database. Certain counters are also stored in the TPC database, but the performance data is mostly comprised of rates and other calculated metrics that depend on the counter deltas and the sample interval, that is, the time between T1 and T2.

The primary and essential performance metrics are few and simple, for example, Read I/O Rate, Write I/O Rate, Read Response Time, and Write Response Time. Also important are data rates and transfer sizes. Cache behaviors in the form of Read Hit Ratio and Write Cache delays (percentages and rates) are important. There are a myriad of additional metrics in the TPC performance reports, but they need to be used as adjuncts to the primary metrics, sometimes helping you to understand why the primary metrics have the values they have.

There are very few metrics that measure other kinds of values. For example, the SVC storage subsystem also reports the maximum read and write response times that occur between times T1 and T2. Each time that a sample of the counters is pulled, this type of counter is set back to zero. But the vast majority of counters are monotonically increasing, reset to zero only by very particular circumstances, such as hardware, software, or firmware resets.

The design of the TPC Performance Manager allows several storage subsystems to be included in a report (or individual subsystems by selection or filtering). But not all the metrics apply to every subsystem or component. In these cases, a "-1" appears, indicating that no data is expected for the metric in this particular case.

In the remainder of this section, we look at the metrics that can be selected for each report. We examine the reports in the order in which they appear in the TPC Navigation Tree.

Reports under Disk Manager

Storage Subsystem Performance:

► By Storage Subsystem
► By Controller

- ► By I/O Group
- ► By Node
- ► By Array
- ► By Managed Disk Group
- ► By Volume
- ► By Managed Disk
- ► By Port

Reports under the Fabric Manager

Switch Performance:

- ► By Port

By Storage Subsystem report

Table 1 shows the By Storage Subsystem report metrics. Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 1   By Storage Subsystem report metrics

Subsystem	Component id
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (normal)	Average number of normal read operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000™, and DS6000™.
Read I/O Rate (sequential)	Average number of sequential read operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (normal)	Average number of normal write operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (sequential)	Average number of sequential write operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (normal)	Average number of normal reads and writes per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.

Total I/O Rate (sequential)	Average number of sequential reads and writes per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Cache Hit Percentage (normal)	Percentage of normal (random) reads that are cache hits during the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (sequential)	Percentage of sequential reads that are cache hits in the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (normal)	Percentage of normal (random) writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (sequential)	Percentage of sequential writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number needs to be 100% for most enterprise storage.
Total Cache Hits Percentage (normal)	Percentage of normal reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (sequential)	Percentage of sequential reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (overall)	Weighted average of read cache hits and write cache hits.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.
Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.

Record Mode Read I/O Rate	This is the rate in I/O/sec for a special kind of read activity detected by ESS, DS8000, and DS6000. Only the requested data is managed in cache rather than a full track or most of a track of data.
Record Mode Read Cache Hit Percentage	Read Hit percentage for the special class of reads mentioned above. ESS, DS8000, and DS6000 only.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache.
Cache Holding Time	The average number of seconds that a piece of data stays in cache. This value is calculated using Little's Law, only for DS8000, DS6000, and ESS.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend storage for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes and the actual number of physical I/O operations depends on whether the storage is RAID 5, RAID 10, or some other architecture.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.
Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time might include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend Read and Write Response Times during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.

Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for backend reads and writes during the sample interval.
Port Send I/O Rate	The average rate per second for operations that send data from an I/O port, typically to a server. This is typically a read from the server's perspective.
Port Receive I/O Rate	The average rate per second for operations where the storage port receives data, typically from a server. This is typically a write from the server's perspective.
Total Port I/O Rate	Average read plus write I/O rate per second at the storage port during the sample interval.
Port Send Data Rate	The average data rate in megabytes per second for operations that send data from an I/O port, typically to a server.
Port Receive Data Rate	The average data rate in megabytes per second for operations where the storage port receives data, typically from a server.
Total Port Data Rate	Average read plus write data rate in megabytes per second at the storage port during the sample interval.
Port Send Response Time	Average number of milliseconds that it took to service each port send (server read) operation, for a particular port over the sample interval.
Port Receive Response Time	Average number of milliseconds that it took to service each port receive (server write) operation, for a particular port over the sample interval.
Total Port Response Time	Weighted average port send and port receive time over the sample interval.
Port Send Transfer Size	Average size in kilobytes per Port Send operation during the sample interval.
Port Receive Transfer Size	Average size in kilobytes per Port Receive operation during the sample interval.
Total Port Transfer Size	Average size in kilobytes per port transfer during the sample interval.
Read Queue Time	For SVC, the average number of milliseconds that each read operation during the sample interval spent on the queue before being issued to the backend storage device.
Write Queue Time	For SVC, the average number of milliseconds that each write operation during the sample interval spent on the queue before being issued to the backend storage device.
Overall Queue Time	For SVC, the weighted average of Read Queue Time and Write Queue Time during the sample interval.
Readahead Percentage of Cache Hits	For SVC, an obscure measurement of cache hits involving data that has been prestaged for one reason or another.

Dirty Write Percentage of Cache Hits	For SVC, the percentage of write cache hits, which modified only data that was already marked "dirty" in the cache; rewritten data. This is an obscure measurement of how effectively writes are coalesced before destaging.
Write Cache Overflow Percentage	For SVC, the percentage of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Overflow I/O Rate	For SVC, the average rate per second of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Flush-through Percentage	For SVC, the percentage of write operations that were processed in Flush-through write mode during the sample interval.
Write Cache Flush-through I/O Rate	For SVC, the average rate per second of tracks processed in Flush-through write mode during the sample interval.
Write Cache Write-through Percentage	For SVC, the percentage of write operations that were processed in Write-through write mode during the sample interval.
Write Cache Write-through I/O Rate	For SVC, the average number of tracks per second that were processed in Write-through write mode during the sample interval.
CPU Utilization Percentage	For SVC the average utilization of the cluster node controllers during the sample interval.
Port to Host Send I/O Rate	For SVC, the rate per second of port send to host (server) during the sample interval.
Port to Host Receive I/O Rate	For SVC, the rate per second of port receive operations from host (server) during the sample interval.
Total Port to Host I/O Rate	For SVC, total of port send and receive I/O rate during the sample interval.
Port to Disk Send I/O Rate	For SVC, the rate per second of port send to backend storage during the sample interval.
Port to Disk Receive I/O Rate	For SVC, the rate per second of port receive operations from backend storage during the sample interval.
Total Port to Disk I/O Rate	For SVC, the sum of port to disk send and port to disk receive rates during the sample interval.
Port to Local Node Send I/O Rate	For SVC, the rate per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive I/O Rate	For SVC, the rate at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node I/O Rate	For SVC, the sum of port to local node send and receive rates during the sample interval.
Port to Remote Node Send I/O Rate	For SVC, the average number of exchanges (I/Os) per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.

Port to Remote Node Receive I/O Rate	For SVC, the average number of exchanges (I/Os) per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node I/O Rate	For SVC, the sum of port to remote node send and receive I/O per second during the sample interval.
Port to Host Send Data Rate	For SVC, the megabytes per second of port send to host (server) during the sample interval.
Port to Host Receive Data Rate	For SVC, the megabytes per second of port receive operations from host (server) during the sample interval.
Total Port to Host Data Rate	For SVC, total of port send and receive megabytes per second during the sample interval.
Port to Disk Send Data Rate	For SVC, the megabytes per second of port send to backend storage during the sample interval.
Port to Disk Receive Data Rate	For SVC, the megabytes per second of port receive operations from backend storage during the sample interval.
Total Port to Disk Data Rate	For SVC, the sum of port to disk send and port to disk receive megabytes per second during the sample interval.
Port to Local Node Send Data Rate	For SVC, the megabytes per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive Data Rate	For SVC, the megabytes per second at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node Data Rate	For SVC, the sum of port to local node send and receive megabytes per second during the sample interval.
Port to Remote Node Send Data Rate	For SVC, the average number of megabytes per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive Data Rate	For SVC, the average number of megabytes per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node Data Rate	For SVC, the sum of port to remote node send and receive megabytes per second during the sample interval.
Port to Local Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Receive Response Time	For SVC, the average port service time in milliseconds for this operation during the sample interval.
Overall Port to Local Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Local Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these receive operations are executed.
Overall Port to Local Node Queue Time	For SVC, the average time in milliseconds waiting before these port send or port receive operations are executed.

Port to Remote Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Remote Node Receive Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Overall Port to Remote Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Remote Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Remote Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these operations are executed.
Overall Port to Remote Node Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Global Mirror Write I/O Rate	For SVC, the rate in writes per second issued to the secondary site for Global Mirror during the sample interval.
Global Mirror Overlapping Write Percentage	For SVC, the percentage of writes during the sample interval for which the write operations at the primary site for Global Mirror have overlapping write domains.
Global Mirror Overlapping Write I/O Rate	For SVC, the average rate in writes per second during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Peak Read Response Time	For SVC, the peak read response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Peak Write Response Time	For SVC, the peak write response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Global Mirror Secondary Write Lag	For SVC, the number of additional milliseconds it took to service each secondary write operation for Global Mirror, over and above the time needed to service the primary writes during the sample interval.

By Controller report

The metrics for the By Controller report are shown in Table 2. This report is only for DS8000, DS6000, and ESS.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics*.

Table 2   By Controller report metrics

Subsystem	Component ID.
Controller	Component ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.

Read I/O Rate (normal)	Average number of normal read operations per second for the sample interval. Normal operations are not sequential, hence random.
Read I/O Rate (sequential)	Average number of sequential read operations per second for the sample interval. Sequential IO is detected by the subsystem.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval.
Write I/O Rate (normal)	Average number of normal write operations per second for the sample interval. Normal operations are not sequential, hence random.
Write I/O Rate (sequential)	Average number of sequential write operations per second for the sample interval. Sequential I/O is detected by the subsystem.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval.
Total I/O Rate (normal)	Average number of normal reads and writes per second for the sample interval. Normal operations are not sequential, hence random.
Total I/O Rate (sequential)	Average number of sequential reads and writes per second for the sample interval. Sequential I/O is detected by the subsystem.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval.
Read Cache Hits Percentage (normal)	Percentage of normal (random) reads that are cache hits during the sample interval.
Read Cache Hits Percentage (sequential)	Percentage of sequential reads that are cache hits in the sample interval.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (normal)	Percentage of normal (random) writes that are handled in cache. This number needs to be 100%.
Write Cache Hits Percentage (sequential)	Percentage of sequential writes that are handled in cache. This number needs to be 100%.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number needs to be 100% for most enterprise storage.
Total Cache Hits Percentage (normal)	Weighted average of read cache hits and write cache hits.
Total Cache Hits Percentage (sequential)	Percentage of sequential reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (overall)	Weighted average of read cache hits and write cache hits.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.

Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.
Record Mode Read I/O Rate	This is the rate in I/O/sec for a special kind of read activity detected by ESS, DS8000, and DS6000. Only the requested data is managed in cache rather than a full track or most of a track of data.
Record Mode Read Cache Hit Percentage	Read Hit percentage for the special class of reads mentioned above.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O. This is sometimes called non-volatile storage (NVS) Full.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache, sometimes called NVS Full.
Cache Holding Time	The average number of seconds a piece of data stays in cache. This value is calculated using Little's Law.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend RAID arrays for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes and the actual number of physical I/O operations depends on whether the storage is RAID 5, RAID 10, or some other architecture.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.

Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.
Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time can include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend Read and Write Response Times during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for backend reads and writes during the sample interval.

By I/O Group report

The By I/O Group report (report metrics are shown in Table 3) is an SAN Volume Controller (SVC) specific report.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics*.

Table 3   By I/O Group report metrics

Subsystem	Name of the SVC cluster.
I/O group	The I/O group ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number must be 100% for most enterprise storage.

Total Cache Hits Percentage (overall)	Percentage of normal reads and writes that are cache hits during the sample interval.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.
Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend storage for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.

Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time can include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend Read and Write Response Times during the sample interval.
Read Queue Time	The average number of milliseconds that each read operation during the sample interval spent on the queue before being issued to the backend storage device.
Write Queue Time	The average number of milliseconds that each write operation during the sample interval spent on the queue before being issued to the backend storage device.
Overall Queue Time	The weighted average of Read Queue Time and Write Queue Time during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for Backend Reads and Writes during the sample interval.
Port Send I/O Rate	The average rate per second for operations that send data from an I/O port, typically to a server. This is typically a read from the server's perspective.
Port Receive I/O Rate	The average rate per second for operations where the storage port receives data, typically from a server. This is typically a write from the server's perspective.
Total Port I/O Rate	Average read plus write I/O rate per second at the storage port during the sample interval.
Port Send Data Rate	The average data rate in megabytes per second for operations that send data from an I/O port, typically to a server.
Port Receive Data Rate	The average data rate in megabytes per second for operations where the storage port receives data, typically from a server.
Total Port Data Rate	Average read plus write data rate in megabytes per second at the storage port during the sample interval.
Readahead Percentage of Cache Hits	An obscure measurement of cache hits involving data that has been prestaged for one reason or another.
Dirty Write Percentage of Cache Hits	The percentage of write cache hits which modified only data that was already marked "dirty" in the cache; rewritten data. This is an obscure measurement of how effectively writes are coalesced before destaging.
Write Cache Overflow Percentage	For SVC, the percentage of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Overflow I/O Rate	For SVC, the average rate per second of write operations that were delayed due to lack of write-cache space during the sample interval.

Write Cache Flush-through Percentage	For SVC, the percentage of write operations that were processed in Flush-through write mode during the sample interval.
Write Cache Flush-through I/O Rate	For SVC, the average rate per second of tracks processed in Flush-through write mode during the sample interval.
Write Cache Write-through Percentage	For SVC, the percentage of write operations that were processed in Write-through write mode during the sample interval.
Write Cache Write-through I/O Rate	For SVC, the average number of tracks per second that were processed in Write-through write mode during the sample interval.
CPU Utilization Percentage	The average utilization of the node controllers in this I/O group during the sample interval.
Port to Host Send I/O Rate	For SVC, the rate per second of port send to host (server) during the sample interval.
Port to Host Receive I/O Rate	For SVC, the rate per second of port receive operations from host (server) during the sample interval.
Total Port to Host I/O Rate	For SVC, total of port send and receive I/O rate during the sample interval.
Port to Disk Send I/O Rate	For SVC, the rate per second of port send to backend storage during the sample interval.
Port to Disk Receive I/O Rate	For SVC, the rate per second of port receive operations from backend storage during the sample interval.
Total Port to Disk I/O Rate	For SVC, the sum of port to disk send and port to disk receive rates during the sample interval.
Port to Local Node Send I/O Rate	For SVC, the rate per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive I/O Rate	For SVC, the rate at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node I/O Rate	For SVC, the sum of port to local node send and receive rates during the sample interval.
Port to Remote Node Send I/O Rate	For SVC, the average number of exchanges (I/Os) per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive I/O Rate	For SVC, the average number of exchanges (I/Os) per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node I/O Rate	For SVC, the sum of port to remote node send and receive I/O per second during the sample interval.
Port to Host Send Data Rate	For SVC, the megabytes per second of port send to host (server) during the sample interval.
Port to Host Receive Data Rate	For SVC, the megabytes per second of port receive operations from host (server) during the sample interval.
Total Port to Host Data Rate	For SVC, the total of port send and receive megabytes per second during the sample interval.

Port to Disk Send Data Rate	For SVC, the megabytes per second of port send to backend storage during the sample interval.
Port to Disk Receive Data Rate	For SVC, the megabytes per second of port receive operations from backend storage during the sample interval.
Total Port to Disk Data Rate	For SVC, the sum of port to disk send and port to disk receive megabytes per second during the sample interval.
Port to Local Node Send Data Rate	For SVC, the megabytes per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive Data Rate	For SVC, the megabytes per second at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node Data Rate	For SVC, the sum of port to local node send and receive megabytes per second during the sample interval.
Port to Remote Node Send Data Rate	For SVC, the average number of megabytes per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive Data Rate	For SVC, the average number of megabytes per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node Data Rate	For SVC, the sum of port to remote node send and receive megabytes per second during the sample interval.
Port to Local Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Receive Response Time	For SVC, the average port service time in milliseconds for this operation during the sample interval.
Overall Port to Local Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Local Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these receive operations are executed.
Overall Port to Local Node Queue Time	For SVC, the average time in milliseconds waiting before these port send or receive operations are executed.
Port to Remote Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Remote Node Receive Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Overall Port to Remote Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Remote Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Remote Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Overall Port to Remote Node Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.

Global Mirror Write I/O Rate	For SVC, the rate in writes per second issued to the secondary site for Global Mirror during the sample interval.
Global Mirror Overlapping Write Percentage	For SVC, the percentage of writes during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Global Mirror Overlapping Write I/O Rate	For SVC, the average rate in writes per second during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Peak Read Response Time	For SVC, the peak read response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Peak Write Response Time	For SVC, the peak write response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Global Mirror Secondary Write Lag	For SVC, the number of additional milliseconds it took to service each secondary write operation for Global Mirror, over and above the time needed to service the primary writes during the sample interval.

By Node report

The By Node report (metrics shown in Table 4) is an SVC specific report.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 4   By Node report metrics

Subsystem	Name of the SVC cluster.
I/O group	The I/O group ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number needs to be almost 100%
Total Cache Hits Percentage (overall)	Weighted average of read cache hits and write cache hits.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.

Write Data Rate	Average write data rate in megabytes per second during the sample interval.
Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend storage for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.
Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.

Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time might include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend read and write response times during the sample interval.
Read Queue Time	The average number of milliseconds that each read operation during the sample interval spent on the queue before being issued to the backend storage device.
Write Queue Time	The average number of milliseconds that each write operation during the sample interval spent on the queue before being issued to the backend storage device.
Overall Queue Time	The weighted average of Read Queue Time and Write Queue Time during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for Backend Reads and Writes during the sample interval.
Port Send I/O Rate	The average rate per second for operations that send data from an I/O port, typically to a server. This is typically a read from the server's perspective.
Port Receive I/O Rate	The average rate per second for operations where the storage port receives data, typically from a server. This is typically a write from the server's perspective.
Total Port I/O Rate	Average read plus write I/O rate per second at the storage port during the sample interval.
Port Send Data Rate	The average data rate in megabytes per second for operations that send data from an I/O port, typically to a server.
Port Receive Data Rate	The average data rate in megabytes per second for operations where the storage port receives data, typically from a server.
Total Port Data Rate	Average read plus write data rate in megabytes per second at the storage port during the sample interval.
Readahead Percentage of Cache Hits	An obscure measurement of cache hits involving data that has been prestaged for one reason or another.
Dirty Write Percentage of Cache Hits	The percentage of write cache hits, which modified only data that was already marked "dirty" in the cache; rewritten data. This is an obscure measurement of how effectively writes are coalesced before destaging.
Write Cache Overflow Percentage	For SVC, the percentage of write operations that were delayed due to lack of write-cache space during the sample interval.

Write Cache Overflow I/O Rate	For SVC, the average rate per second of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Flush-through Percentage	For SVC, the percentage of write operations that were processed in Flush-through write mode during the sample interval.
Write Cache Flush-through I/O Rate	For SVC, the average rate per second of tracks processed in Flush-through write mode during the sample interval.
Write Cache Write-through Percentage	For SVC, the percentage of write operations that were processed in Write-through write mode during the sample interval.
Write Cache Write-through I/O Rate	For SVC, the average number of tracks per second that were processed in Write-through write mode during the sample interval.
CPU Utilization Percentage	The average utilization of the node controllers in this I/O group during the sample interval.
Port to Host Send I/O Rate	For SVC, the rate per second of port send to host (server) during the sample interval.
Port to Host Receive I/O Rate	For SVC, the rate per second of port receive operations from host (server) during the sample interval.
Total Port to Host I/O Rate	For SVC, total of port send and receive I/O rate during the sample interval.
Port to Disk Send I/O Rate	For SVC, the rate per second of port send to backend storage during the sample interval.
Port to Disk Receive I/O Rate	For SVC, the rate per second of port receive operations from backend storage during the sample interval.
Total Port to Disk I/O Rate	For SVC, the sum of port to disk send and port to disk receive rates during the sample interval.
Port to Local Node Send I/O Rate	For SVC, the rate per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive I/O Rate	For SVC, the rate at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node I/O Rate	For SVC, the sum of port to local node send and receive rates during the sample interval.
Port to Remote Node Send I/O Rate	For SVC, the average number of exchanges (I/Os) per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive I/O Rate	For SVC, the average number of exchanges (I/Os) per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node I/O Rate	For SVC, the sum of port to remote node send and receive I/O per second during the sample interval.
Port to Host Send Data Rate	For SVC, the megabytes per second of port send to host (server) during the sample interval.

Port to Host Receive Data Rate	For SVC, the megabytes per second of port receive operations from host (server) during the sample interval.
Total Port to Host Data Rate	For SVC, total of port send and receive megabytes per second during the sample interval.
Port to Disk Send Data Rate	For SVC, the megabytes per second of port send to backend storage during the sample interval.
Port to Disk Receive Data Rate	For SVC, the megabytes per second of port receive operations from backend storage during the sample interval.
Total Port to Disk Data Rate	For SVC, the sum of port to disk send and port to disk receive megabytes per second during the sample interval.
Port to Local Node Send Data Rate	For SVC, the megabytes per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive Data Rate	For SVC, the megabytes per second at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node Data Rate	For SVC, the sum of port to local node send and receive megabytes per second during the sample interval.
Port to Remote Node Send Data Rate	For SVC, the average number of megabytes per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive Data Rate	For SVC, the average number of megabytes per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node Data Rate	For SVC, the sum of port to remote node send and receive megabytes per second during the sample interval.
Port to Local Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Receive Response Time	For SVC, the average port service time in milliseconds for this operation during the sample interval.
Overall Port to Local Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Local Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Local Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these receive operations are executed.
Overall Port to Local Node Queue Time	For SVC, the average time in milliseconds waiting before these port send or receive operations are executed.
Port to Remote Node Send Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Port to Remote Node Receive Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.
Overall Port to Remote Node Response Time	For SVC, the average port service time in milliseconds for these operations during the sample interval.

Port to Remote Node Send Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Port to Remote Node Receive Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Overall Port to Remote Node Queue Time	For SVC, the average time in milliseconds waiting in queue before these send operations are executed.
Global Mirror Write I/O Rate	For SVC, the rate in writes per second issued to the secondary site for Global Mirror during the sample interval.
Global Mirror Overlapping Write Percentage	For SVC, the percentage of writes during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Global Mirror Overlapping Write I/O Rate	For SVC, the average rate in writes per second during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Peak Read Response Time	For SVC, the peak read response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Peak Write Response Time	For SVC, the peak write response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Global Mirror Secondary Write Lag	For SVC, the number of additional milliseconds it took to service each secondary write operation for Global Mirror, over and above the time needed to service the primary writes during the sample interval.

By Array report

The By Array report (report metrics are shown in Table 5) is for DS8000, DS6000, and ESS only.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 5   By Array report metrics

Subsystem	Component ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (normal)	Average number of normal read operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Read I/O Rate (sequential)	Average number of sequential read operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.

Write I/O Rate (normal)	Average number of normal write operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (sequential)	Average number of sequential write operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (normal)	Average number of normal reads and writes per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Total I/O Rate (sequential)	Average number of sequential reads and writes per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Cache Hit Percentage (normal)	Percentage of normal (random) reads that are cache hits during the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (sequential)	Percentage of sequential reads that are cache hits in the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (normal)	Percentage of normal (random) writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (sequential)	Percentage of sequential writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number needs to be 100% for most enterprise storage.
Total Cache Hits Percentage (normal)	Percentage of normal reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (sequential)	Percentage of sequential reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (overall)	Weighted average of read cache hits and write cache hits.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.
Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.

Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.
Record Mode Read I/O Rate	This is the rate in I/O/sec for a special kind of read activity detected by ESS, DS8000, and DS6000. Only the requested data is managed in cache rather than a full track or most of a track of data.
Record Mode Read Cache Hit Percentage	Read Hit percentage for the special class of reads mentioned above. ESS, DS8000, and DS6000 only.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend storage for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes and the actual number of physical I/O operations depends on whether the storage is RAID 5, RAID 10, or some other architecture.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.

Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time might include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend read and write response times during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for Backend Reads and Writes during the sample interval.
Disk Utilization Percentage	Average disk utilization during the sample interval. This is also the utilization of the RAID array, because the activity is uniform across the array.
Sequential I/O Percentage	Percentage of the I/O during the sample interval which the storage believes to be sequential. This is detected by the storage algorithms.

By Managed Disk Group report

The By Managed Disk Group report (report metrics are shown in Table 6) is an SVC specific report.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 6   By Managed Disk Group report

Subsystem	Name of the SVC cluster.
Managed Disk Group	The Managed Disk Group ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.

Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.
Backend Read I/O Rate	The average read rate in reads per second caused by read misses. This is the read rate to the backend storage for the sample interval.
Backend Write I/O Rate	The average write rate in writes per second caused by front-end write activity. This is the write rate to the backend storage for the sample interval. These are logical writes.
Total Backend I/O Rate	The sum of Backend Read I/O Rate and Backend Write I/O Rate over the sample interval.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.
Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time might include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend Read and Write Response Times during the sample interval.
Read Queue Time	The average number of milliseconds that each read operation during the sample interval spent on the queue before being issued to the backend storage device.
Write Queue Time	The average number of milliseconds that each write operation during the sample interval spent on the queue before being issued to the backend storage device.
Overall Queue Time	The weighted average of Read Queue Time and Write Queue Time during the sample interval.

Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for Backend Reads and Writes during the sample interval.

By Volume report

The By Volume report is an important report. Its metrics are shown in Table 7. This report is available for all Storage Management Initiative - Specification (SMI-S) compliant subsystems, though not all metrics are applicable to all subsystems.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 7   By Volume report metrics

Subsystem	Subsystem name.
Volume	Volume ID.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (normal)	Average number of normal read operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Read I/O Rate (sequential)	Average number of sequential read operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (normal)	Average number of normal write operations per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (sequential)	Average number of sequential write operations per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (normal)	Average number of normal reads and writes per second for the sample interval. Normal operations are not sequential, hence random. This metric is only for ESS, DS8000, and DS6000.

Total I/O Rate (sequential)	Average number of sequential reads and writes per second for the sample interval. Sequential I/O is detected by the subsystem. This metric is only for ESS, DS8000, and DS6000.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Read Cache Hit Percentage (normal)	Percentage of normal (random) reads that are cache hits during the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (sequential)	Percentage of sequential reads that are cache hits in the sample interval. Only for ESS, DS8000, and DS6000.
Read Cache Hits Percentage (overall)	Percentage of reads during the sample interval that are found in cache. This is an important metric.
Write Cache Hits Percentage (normal)	Percentage of normal (random) writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (sequential)	Percentage of sequential writes that are handled in cache. This number needs to be 100%. Only for ESS, DS8000, and DS6000.
Write Cache Hits Percentage (overall)	Percentage of writes that are handled in cache. This number needs to be 100% for most enterprise storage.
Total Cache Hits Percentage (normal)	Percentage of normal reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (sequential)	Percentage of sequential reads and writes that are cache hits during the sample interval.
Total Cache Hits Percentage (overall)	Weighted average of read cache hits and write cache hits.
Read Data Rate	Average read data rate in megabytes per second during the sample interval.
Write Data Rate	Average write data rate in megabytes per second during the sample interval.
Total Data Rate	Average total (read + write) data rate in megabytes per second during the sample interval.
Read Response Time	Average response time in milliseconds for reads during the sample interval. For this report, this is an average of read hits in cache as well as read misses.
Write Response Time	Average response time in milliseconds for writes during the sample interval.
Overall Response Time	Average response time in milliseconds for all I/O in the sample interval, including both cache hits as well as misses to backend storage if required.
Read Transfer Size	Average transfer size in kilobytes for reads during the sample interval.
Write Transfer Size	Average transfer size in kilobytes for writes during the sample interval.
Overall Transfer Size	Average transfer size in kilobytes for all I/O during the sample interval.

Record Mode Read I/O Rate	This is the rate in I/O/sec for a special kind of read activity detected by ESS, DS8000, and DS6000. Only the requested data is managed in cache rather than a full track or most of a track of data.
Record Mode Read Cache Hit Percentage	Read Hit percentage for the special class of reads mentioned above. ESS, DS8000, and DS6000 only.
Disk to Cache Transfer Rate	Average number of track transfers per second from disk to cache during the sample interval.
Cache to Disk Transfer Rate	Average number of track transfers per second from cache to disk during the sample interval.
Write-cache Delay Percentage	Percentage of all I/O operations that were delayed due to write-cache space constraints or other conditions during the sample interval. Only writes can be delayed, but the percentage is of all I/O.
Write-cache Delay I/O Rate	The rate of I/O (actually writes) that are delayed during the sample interval because of write cache.
Readahead Percentage of Cache Hits	For SVC, an obscure measurement of cache hits involving data that has been prestaged for one reason or another.
Dirty Write Percentage of Cache Hits	For SVC, the percentage of write cache hits which modified only data that was already marked "dirty" in the cache; rewritten data. This is an obscure measurement of how effectively writes are coalesced before destaging.
Write Cache Overflow Percentage	For SVC, the percentage of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Overflow I/O Rate	For SVC, the average rate per second of write operations that were delayed due to lack of write-cache space during the sample interval.
Write Cache Flush-through Percentage	For SVC, the percentage of write operations that were processed in Flush-through write mode during the sample interval.
Write Cache Flush-through I/O Rate	For SVC, the average rate per second of tracks processed in Flush-through write mode during the sample interval.
Write Cache Write-through Percentage	For SVC, the percentage of write operations that were processed in Write-through write mode during the sample interval.
Write Cache Write-through I/O Rate	For SVC, the average number of tracks per second that were processed in Write-through write mode during the sample interval.
Global Mirror Write I/O Rate	For SVC, the rate in writes per second issued to the secondary site for Global Mirror during the sample interval.
Global Mirror Overlapping Write Percentage	For SVC, the percentage of writes during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.
Global Mirror Overlapping Write I/O Rate	For SVC, the average rate in writes per second during the sample interval, for which the write operations at the primary site for Global Mirror have overlapping write domains.

Peak Read Response Time	For SVC, the peak read response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Peak Write Response Time	For SVC, the peak write response time in milliseconds observed during the sample interval. At the end of each sample interval, this value is reset to zero.
Global Mirror Secondary Write Lag	For SVC, the number of additional milliseconds it took to service each secondary write operation for Global Mirror, over and above the time needed to service the primary writes during the sample interval.

By Managed Disk report

The By Managed Disk report is an SVC specific report. The metrics are shown in Table 8.

Critical and universal metrics are in **bold**. Less important metrics are in normal font, and difficult to interpret metrics are in *italics.*

Table 8   By Managed Disk report metrics

Subsystem	Name of the SVC.
Managed Disk	Name of the Managed Disk.
Time	Start time of the sample interval.
Interval	Length of sample interval in seconds.
Read I/O Rate (overall)	Average number of read operations per second for the sample interval. Applies to most subsystems.
Write I/O Rate (overall)	Average number of write operations per second for the sample interval. Applies to most subsystems.
Total I/O Rate (overall)	Average number of reads and writes per second for the sample interval. Applies to most subsystems.
Backend Read Data Rate	Average number of megabytes per second read from backend storage during the sample interval.
Backend Write Data Rate	Average number of megabytes per second written to backend storage during the sample interval.
Total Backend Data Rate	Sum of the Backend Read and Write Data Rates for the sample interval.
Backend Read Response Time	Average response time in milliseconds for read operations to the backend storage.
Backend Write Response Time	Average response time in milliseconds for write operations to the backend storage. This time might include several physical I/O operations, depending on the type of RAID architecture.
Overall Backend Response Time	The weighted average of Backend Read and Write Response Times during the sample interval.

Read Queue Time	The average number of milliseconds that each read operation during the sample interval spent on the queue before being issued to the backend storage device.
Write Queue Time	The average number of milliseconds that each write operation during the sample interval spent on the queue before being issued to the backend storage device.
Overall Queue Time	The weighted average of Read Queue Time and Write Queue Time during the sample interval.
Backend Read Transfer Size	The average transfer size in kilobytes for reads to the backend storage during the sample interval.
Backend Write Transfer Size	The average transfer size in kilobytes for data written to the backend storage during the sample interval.
Overall Backend Transfer Size	Weighted average transfer size in kilobytes for Backend Reads and Writes during the sample interval.

By Port report for storage

The By Port report for storage metrics are shown in Table 9.

Table 9   By Port report for storage metrics

Subsystem	Storage subsystem.
Port	Port ID.
WWPN	Worldwide port name (WWPN) for the port.
Time	Interval start time.
Interval	Number of seconds in the interval.
Port Send I/O Rate	Average number of I/O operations per second for send operations, for a particular port during the sample interval.
Port Receive I/O Rate	Average number of I/O operations per second for receive operations, for a particular port during the sample interval.
Total Port I/O Rate	Average number of I/O operations per second for send and receive operations, for a particular port during the sample interval.
Port Send Data Rate	Average number of megabytes per second that were transferred for send (server read) operations, for a particular port during the sample interval.
Port Receive Data Rate	Average number of megabytes per second that were transferred for receive (server write) operations, for a particular port during the sample interval.
Total Port Data Rate	Average number of megabytes per second for send and receive operations during the sample interval.

Port Send Response Time	Average number of milliseconds that it took to service each send (server read) operation during the sample interval.
Port Receive Response Time	Average number of milliseconds that it took to service each receive (server write) operation during the sample interval.
Total Port Response Time	Average number of milliseconds that it took to service each send and receive operation during the sample interval.
Port Send Transfer Size	Average number of KB sent per I/O by a particular port.
Port Receive Transfer Size	Average number of KB received per I/O by a particular port during the sample interval.
Total Port Transfer Size	Average number of KB transferred per I/O by a particular port during the sample interval.
Port to Host Send I/O Rate	Average rate per second of port send to host (server) during the sample interval.
Port to Host Receive I/O Rate	Average rate per second of port receive operations from host (server) during the sample interval.
Total Port to Host I/O Rate	Average of port send and receive I/O rate during the sample interval.
Port to Disk Send I/O Rate	For SVC, the average rate per second of port send to backend storage during the sample interval.
Port to Disk Receive I/O Rate	For SVC, the average rate per second of port receive operations from backend storage during the sample interval.
Total Port to Disk I/O Rate	For SVC, the average of port to disk send and port to disk receive rates during the sample interval.
Port to Local Node Send I/O Rate	For SVC, the average rate per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive I/O Rate	For SVC, the average rate at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node I/O Rate	For SVC, the average of port to local node send and receive rates during the sample interval.
Port to Remote Node Send I/O Rate	For SVC, the average number of exchanges (I/Os) per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive I/O Rate	For SVC, the average number of exchanges (I/Os) per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node I/O Rate	For SVC, the average of port to remote node send and receive I/O per second during the sample interval.

Port to Host Send Data Rate	For SVC, the average megabytes per second of port send to host (server) during the sample interval.
Port to Host Receive Data Rate	For SVC, the average megabytes per second of port receive operations from host (server) during the sample interval.
Total Port to Host Data Rate	For SVC, average of port send and receive megabytes per second during the sample interval.
Port to Disk Send Data Rate	For SVC, the average megabytes per second of port send to backend storage during the sample interval.
Port to Disk Receive Data Rate	For SVC, the average megabytes per second of port receive operations from backend storage during the sample interval.
Total Port to Disk Data Rate	For SVC, the average of port to disk send and port to disk receive megabytes per second during the sample interval.
Port to Local Node Send Data Rate	For SVC, the average megabytes per second at which a port sends I/O to other nodes in the local cluster during the sample interval.
Port to Local Node Receive Data Rate	For SVC, the average megabytes per second at which a port receives I/O from other nodes in the local cluster during the sample interval.
Total Port to Local Node Data Rate	For SVC, the average of port to local node send and receive megabytes per second during the sample interval.
Port to Remote Node Send Data Rate	For SVC, the average number of megabytes per second sent to nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Port to Remote Node Receive Data Rate	For SVC, the average number of megabytes per second received from nodes in the remote SVC cluster during the sample interval. Typically, some form of remote mirroring.
Total Port to Remote Node Data Rate	For SVC, the average of port to remote node send and receive megabytes per second during the sample interval.

By Port report for Fabric

The metrics in the By Port report for Fabric are shown in Table 10. Note that not all the metrics are supported by all vendor CIM agents.

Table 10   By Port: Fabric report metrics

Switch	Switch name.
Port	Port ID.
WWPN	WWPN for the port.

Time	Interval start time.
Interval	Number of seconds in the interval.
Port Send Packet Rate	Average number of packets per second for send operations, for a particular port during the sample interval.
Port Receive Packet Rate	Average number of packets per second for receive operations, for a particular port during the sample interval.
Total Port Packet Rate	Average number of packets per second for send and receive operations, for a particular port during the sample interval.
Port Send Data Rate	Average number of megabytes (2^20 bytes) per second that were transferred for send (write) operations, for a particular port during the sample interval.
Port Receive Data Rate	Average number of megabytes (2^20 bytes) per second that were transferred for receive (read) operations, for a particular port during the sample interval.
Total Port Data Rate	Average number of megabytes (2^20 bytes) per second that were transferred for send and receive operations, for a particular port during the sample interval.
Port Peak Send Data Rate	Peak number of megabytes (2^20 bytes) per second that were sent by a particular port during the sample interval.
Port Peak Receive Data Rate	Peak number of megabytes (2^20 bytes) per second that were received by a particular port during the sample interval.
Port Send Packet Size	Average number of KB sent per packet by a particular port during the sample interval.
Port Receive Packet Size	Average number of KB received per packet by a particular port during the sample interval.
Overall Port Packet Size	Average number of KB transferred per packet by a particular port during the sample interval.
Error Frame Rate	The average number of frames per second that were received in error during the sample interval.
Dumped Frame Rate	The average number of frames per second that were lost due to a lack of available host buffers during the sample interval.
Link Failure Rate	The average number of link errors per second during the sample interval.
Loss of Sync Rate	The average number of times per second that synchronization was lost during the sample interval.
Loss of Signal Rate	The average number of times per second that the signal was lost during the sample interval.
CRC Error Rate	The average number of frames received per second in which the cyclic redundancy check (CRC) in the frame did not match the CRC computed by the receiver during the sample interval.

Short Frame Rate	The average number of frames received per second that were shorter than 28 octets (24 header + 4 CRC) not including any SOF/EOF bytes during the sample interval.
Long Frame Rate	The average number of frames received per second that were longer than 2140 octets (24 header + 4 CRC + 2112 data) not including any SOF/EOF bytes during the sample interval.
Encoding Disparity Error Rate	The average number of disparity errors received per second during the sample interval.
Discarded Class3 Frame Rate	The average number of class-3 frames per second that were discarded during the sample interval.
F-BSY Frame Rate	The average number of F-BSY frames per second during the sample interval.
F-RJT Frame Rate	The average number of F-RJT frames per second during the sample interval.

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Thanks to Brian Smith for allowing us to convert his materials into this Redpaper and his continued support of this project.

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