# ATA Over Ethernet Storage Area Networks

By

Liam Dolan and Brian Verkamp

Submitted to
the Faculty of the Information Technology Program
in Partial Fulfillment of the Requirements for
the Degree of Bachelor of Science
in Information Technology

University of Cincinnati
College of Applied Science

May 2007

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| Liam Dolan | Date |
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| Brian Verkamp | Date |
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| Prof. John Nyland, Faculty Advisor | Date |
| _____ | _____ |
| Hazem Said, Ph.D., Department Head | Date |

**Acknowledgments**

We wish to thank the College of Education, Criminal Justice, and Human Services at the University of Cincinnati, for generously donating the hardware that made this project possible. We would also like to thank our advisor, Professor John Nyland, for his guidance and insight throughout this project. Finally, we wish to thank our wives, Amy Verkamp and Polly Ireton-Dolan, for their love, support, and infinite patience.

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**Abstract**

The ATA Over Ethernet protocol provides an attractive low-cost alternative to the market-leading Fibre Channel and iSCSI Storage Area Network technologies. As compelling as the proposition of creating a robust, flexible storage infrastructure based on commodity network hardware and inexpensive disks may be, AoE is a relatively new protocol, and little public data exists on its performance compared to traditional storage architectures. ATA Over Ethernet Storage Area Networks provides IT decision makers and administrators with benchmarks and analysis to help them evaluate the suitability of AoE for their storage requirements as compared to the file server and direct attached storage models.

## 1. Problem Statement

Recent trends in business and computing have brought the technical issues related to data storage to the forefront in many Information Technology organizations. With close to 95% of all business data being created electronically, enterprises are finding that traditional directly attached or file server storage solutions are inadequate to address the critical demands of flexibility, reliability, availability, and sheer capacity (5 p. 48). Data-mining and business intelligence systems require huge amounts of working data. Internet-based multimedia services find that their storage requirements increase as a function of their success. Certain sections of the Sarbanes-Oxley Act mandate lengthy corporate data retention and disclosure policies, requiring a critical examination of enterprise storage policies (10).

Storage Area Networking (SAN) technologies have emerged as solutions to these needs. Rather than providing an abstract service that provide a file system via an application-layer protocol to client machines, SAN servers export their "target" disks directly as block devices to an IP or local network, essentially replacing the traditional SCSI or SSA cable with a network cable. Instead of sending SMB, CIFS, or NFS requests to a server, the client machine sends block commands directly over the network. This approach offers two benefits: the simplicity of direct attached storage, without the complexity of the abstraction inherent in the file server method; and the flexibility that comes with separating processing from storage. Processing machines are no longer limited by the maximum number of devices supported by their physical storage bus.

Unfortunately, implementing a SAN using current technologies can be both expensive and highly dependent on a particular vendor's interpretation of the governing

standard for a given technology. Fibre Channel implementations are generally priced starting at $10/GB for slower systems, to $45 for hight end systems with advanced replication features (8 p. 44). iSCSI, the current market leading technology for low-cost SANs, generally requires expensive host bus adapters for acceptable performance, pushing the price to approximately $3.5/GB (2).

Standards compliance and vendor neutrality are issues that plague most areas of enterprise infrastructure management, and networked storage is no exception, as noted by Clark:

> In storage networking, upper-layer storage applications – such as server clustering, backup/restore, and volume management – are predicated on a standards-compliant infrastructure, but these applications themselves are largely free from the constraints of standardization... This situation creates an inherent barrier to uniform operation of storage networking systems. (3 p. 284)

While both iSCSI and Fibre Channel are standardized by the IETF and INCITS, respectively, the standards are so complex that SAN vendors are able to provide "value added" enhancements to their particular interpretations that negatively affect interoperability, while adhering to the letter of the standard.

ATA over Ethernet (AoE) provides an alternative to both of these technologies. Based on an open standard laid out in an eight-page specification developed by Coraid, Inc. (4), AoE is a network protocol stack that encapsulates ATA block commands (used by Parallel and Serial ATA controllers to address hard disks) within standard Ethernet frames. The protocol enables client machines to connect with storage servers and devices using nothing more than an Ethernet equipment and inexpensive PATA/SATA hard drives. Coraid offers several turn-key AoE solutions, priced at about $2/GB. Using off-the-shelf

servers instead of Coraid-branded hardware to host the network disks drops the price a further $1/GB. Organizations can implement a 2TB SAN for as little at $2000.

As compelling as this cost advantage may be to planners and decision makers looking to implement inexpensive networked storage, AoE is a relatively new protocol, and little public data exists on its performance characteristics. Organizations have few metrics to evaluate commodity based AoE solutions against Coraid-built hardware, systems from Fibre Channel or iSCSI vendors, or even the traditional network- and direct-attached storage models. Vendors will generally provide prospective customers with demonstration units for customers to evaluate, and will, on occasion, publish the results of their own performance tests. Such numbers for open protocols based on off-the-shelf hardware, such as AoE, are harder to come by.

## 2. Solution Description

To help IT planners evaluate the suitability of AoE for their needs, we have produced a study of the performance characteristics of an AoE system, and compared them to traditional direct-attached and application layer network storage models. We have built test systems for all three models on commodity hardware, and performed the standard Iozone storage benchmark, producing a comparative analysis of the performance of all three models. We have also included detailed configuration instructions for our AoE SAN, to help administrators implement a similar system for their own testing purposes.

### 2.1 User Profiles

There are two primary user groups for our study and its associated tools:

- **IT Planners:** Those responsible for influencing storage system purchases and platform decisions. Our study will provide them with data points regarding the performance of AoE versus more traditional storage infrastructure models.
- **Systems Administrators:** Those responsible for designing and implementing SAN infrastructures. Our study will provide them with a step-by-step guide to our AoE SAN implementation and performance baselines.

### 2.2 Protocol Description

AoE provides a distinct cost advantage over iSCSI and Fibre Channel SAN solutions, largely due to the simplicity of the protocol itself. As shown in Figure 1, the AoE drivers wrap the ATA commands directly within standard Ethernet frames, bypassing the TCP/IP stack. This simplicity allows AoE to run using standard Cat6 cable, Ethernet cards, and switches.

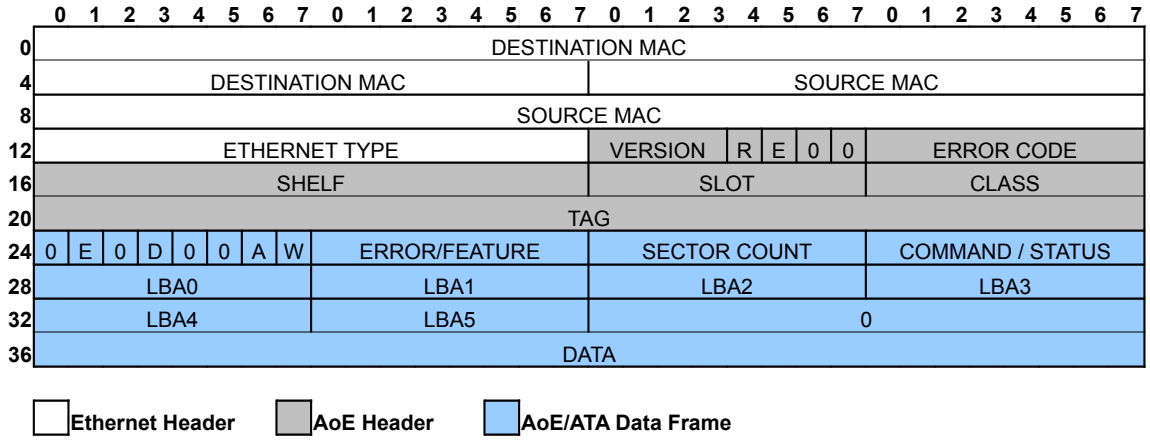



**Figure 1: AoE packet diagram**

Unlike Fibre Channel, AoE uses a protocol that is widely understood by most systems and network administrators, and requires little specialized knowledge, training, or hardware. Unlike iSCSI, it dispenses with the computationally expensive TCP calculations that require specialized network cards to provide adequate performance.

### 2.3 System Components

After acquiring the necessary hardware and software, we assembled a systems in the IT Networking lab with the following specifications (see Figure 4):

- Client System (1):
  - Pentium III CPU: 1GHz Coppermine, 16KB L1 cache, 256 KB L2 cache
  - 256MB PC-100 SDRAM
  - 1 x ATA-100 Western Digital boot drive: 7200RPM, 8MB buffer
  - Debian GNU/Linux Etch, 2.6.18 kernel (6)
  - aoetools v. 11-1.2
  - mdadm v. 2.5.6-8
  - iozone3 v. 263-1

- Server Systems (4):
  - Pentium III CPU: 1GHz Coppermine, 16KB L1 cache, 256 KB L2 cache
  - 1 x ATA-100 Western Digital boot drive (hdc): 7200RPM, 8MB buffer
  - 2 x ATA-100 Western Digital AoE drives (hda, hdb): 7200RPM, 8MB buffer
  - Debian GNU/Linux Etch: 2.6.18 kernel
  - vblade v.11-1 (Server2, Server3)
  - nfs-kernel-server v. 1.0.10-6 (Server0)
- Gigabit Netgear Switch

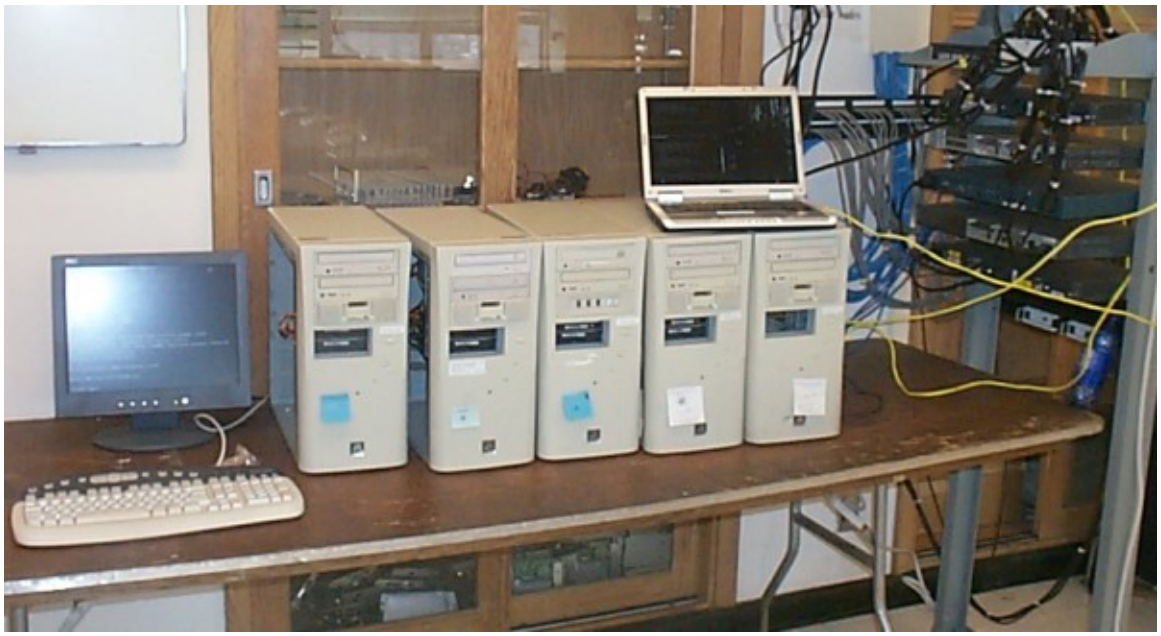


**Figure 2: Assembled hardware**

### 2.4 System Design

Our system build uses a set of hardware, drivers, kernel modules, and services to allow a client system to mount server disks over the LAN at the block level. As shown in Figure 3, each server advertises several local disks (hda, hdb) as AoE drives via the vblade daemon, and tags them with the globally unique shelf/slot identifier. The client

machine uses this identifier to create the appropriate block special files in the /dev/etherd directory. For example, Client0's AoE driver creates the block device node /dev/etherd/e2.0 to access the /dev/hdc disk on Server2 advertised by vblade as Shelf 2, Slot0.

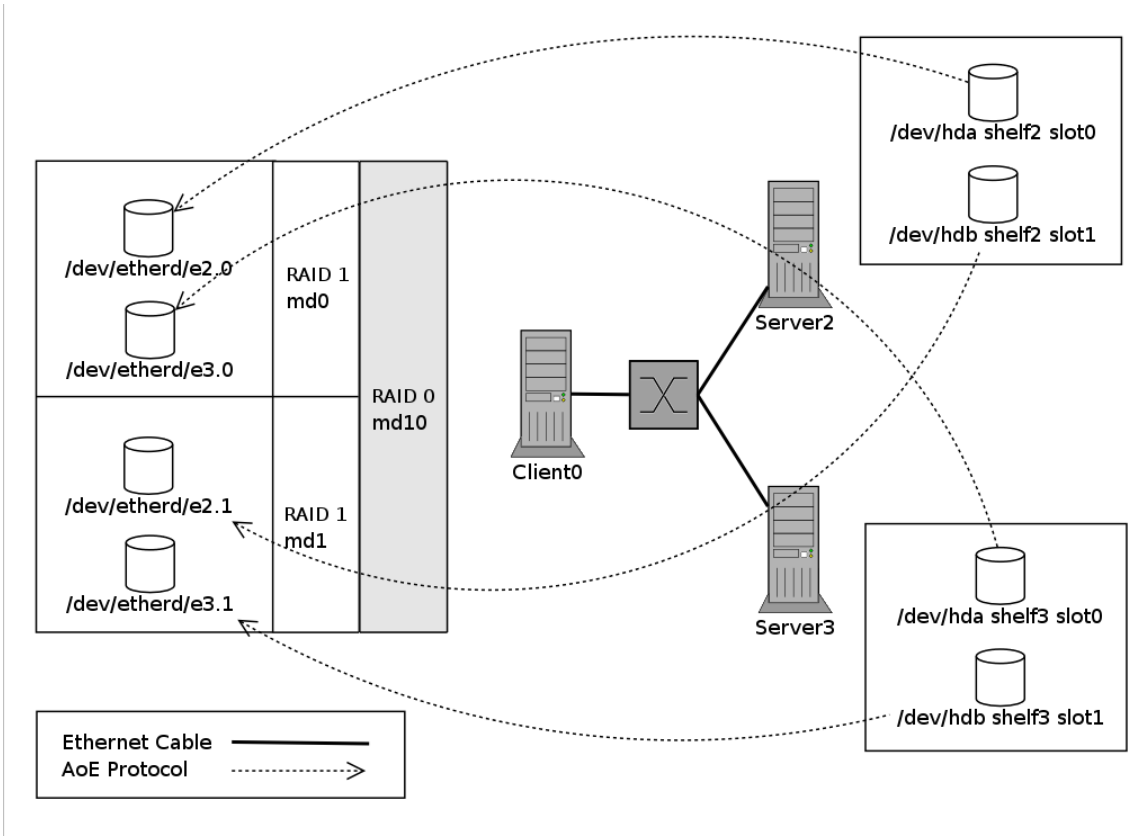



**Figure 3: AoE SAN diagram**

We created the network attached storage baseline system using a machine running the Network File System (NFS) daemon. The NFS server exports a logical directory tree (in this case, an entire file system residing on a single RAID 0 array) to the network, and the client machine mounts it on a local mount point. Figure 4 shows our file server and client configuration.

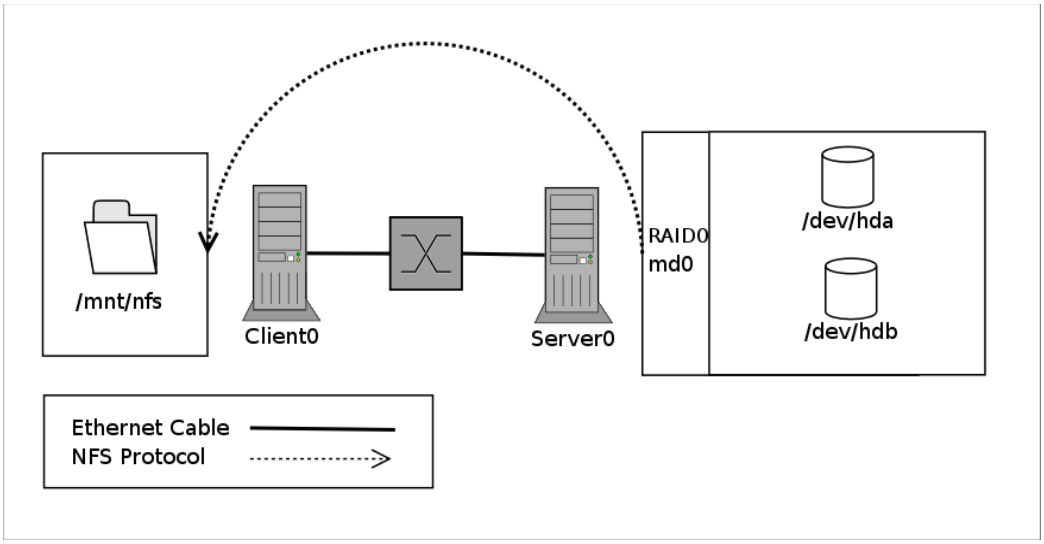



**Figure 4: NFS client/server diagram**

Finally, we configured a machine using direct attached storage devices (DASD), as shown in Figure 5. As there is no networked storage component to this system, it is intended to be representative of systems that only have access to local storage.

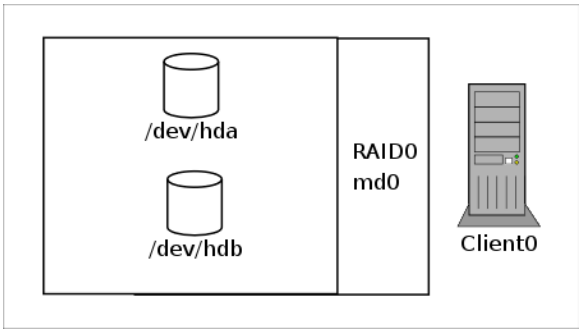



**Figure 5: DASD system diagram**

## 3. Project Planning

### 3.1 Schedule

As shown in Figure 6, the project was completed on schedule. All major milestones were completed, including production build-out, testing, and tuning in the first half of Spring Quarter 2007.

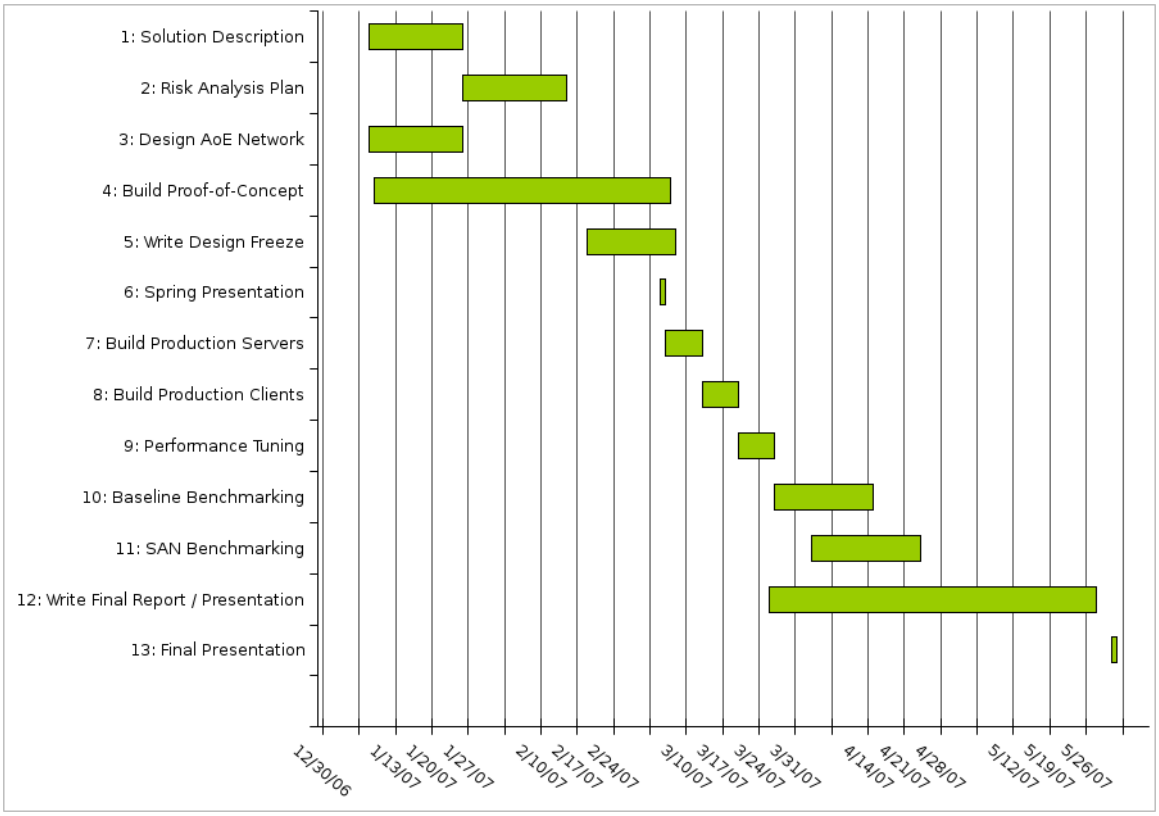



**Figure 6: Project schedule**

### 3.2 Budget

The project was completed on-budget. Other than the US Robotics Ethernet cards, all hardware was donated by the College of Education, Criminal Justice, and Human Services (CECH) or provided in the IT Networking lab. All software is provided under Free/Open Source licenses. See Figure 7 for details.

| Item | Description | Retail Cost | Incurred Cost |
|---|---|---|---|
| Servers | Donated by CECH | $6,000.00 | $0.00 |
| Client Computers | Donated by CECH | 2000.00 | 0.00 |
| Gigabit Cisco Switch | IT Networking Lab | 1899.00 | 0.00 |
| Gigabit USR Cards | Purchased from CDW 01/22/07 | 16.83 | 100.98 |
| Debian Linux | Downloaded | 0.00 | 0.00 |
| | **Retail Total:** | **$9999.98** | |
| | **Incurred Total:** | | **$100.98** |

**Figure 7: Project budget**

## 4. Implementation Guide / Proof of Design

The following sections describe the steps that we took to configure the AoE SAN and run the Iozone benchmarks. These steps may vary in other situations, depending on the specific hardware, operating system, and software configurations.

### 4.1 SAN Configuration

We configured a SAN consisting of two server machines (server2, server3) exporting a total of four AoE disks directly to the LAN via the vblade daemon (Figure 8).

```
server2# vbladed 2 0 eth0 /dev/hda
server2# vbladed 2 1 eth0 /dev/hdb
server3# vbladed 3 0 eth0 /dev/hda
server3# vbladed 3 1 eth0 /dev/hdb
```

**Figure 8: vblade configuration**

The the AoE driver running on the client machine (client0) discovered the AoE disks and created the appropriate hardware device nodes (/dev/etherd/e2.0 - /dev/etherd/e3.1). The following figures show sample output from a packet capture of the sessions: client0's AoE information request broadcast, and the corresponding response packet from server2 for the disk at Shelf 0 , Slot 1. Note the Major and Minor number fields in the packets; these correspond to the shelf and slot numbers, respectively.

```
Frame 19 (32 bytes on wire, 32 bytes captured)
    ...
Ethernet II, Src: USRoboti_32:2d:00 (00:14:c1:32:2d:00), Dst:
Broadcast (ff:ff:ff:ff:ff:ff)
    ...
ATAoverEthernet
```

```
    Version: 1
    Flags: Request
        .... 0... = Response flag: Request
        .... .0.. = Error flag: No error
    Major: 0x0002
    Minor: 0x00
    Command: Query Config Information (1)
    Tag: 0x00000000
```

**Figure 9: AoE configuration packet from client**

```
Frame 20 (60 bytes on wire, 60 bytes captured)
    ...
Ethernet II, Src: USRoboti_32:2c:a4 (00:14:c1:32:2c:a4), Dst:
USRoboti_32:2d:00 (00:14:c1:32:2d:00)
    ...
ATAoverEthernet
    Version: 1
    Flags: Response
        .... 1... = Response flag: Response
        .... .0.. = Error flag: No error
    Major: 0x0002
    Minor: 0x00
    Command: Query Config Information (1)
    Tag: 0x00000000
```

**Figure 10: AoE configuration response from server**

Using the mdadm software RAID package, we assembled a RAID 10 array consisting of a single RAID 0 array (/dev/md10) striped across two RAID 1 mirrors (/dev/md0, /dev/md1):

```
client0# mdadm /dev/md0 –create -l 1 -n 2 /dev/etherd/e2.0 \
```

```
/dev/etherd/e3.0
client0# mdadm /dev/md1 –create -l 1 -n 2 /dev/etherd/e2.1 \
/dev/etherd/e3.1
client0# mdadm /dev/md10 –create -l 0 -n 2 /dev/md0 /dev/md1
```

**Figure 11: Client RAID configuration**

We then formatted the RAID 10 device with the ext3 file system, using 4KB block sizes, and mounted the device on /mnt/aoe:

```
client0# mkfs.ext3 -b 4096 /dev/md3
client0# mkdir /mnt/aoe
client0# mount -t ext3 /dev/md3 /mnt/aoe
```

**Figure 12: Client file tests**

Finally, we confirmed that the Linux kernel was using the Completely Fair Queuing (CFQ) I/O scheduler by default. This is the default for all kernels later than 2.6.18, though some distributions may configure it differently. The CFQ scheduler attempts to provide fair access to I/O bandwidth at the process level, and should therefore best be able to optimize storage requests over a network (7 p. 430).

```
client0# dmesg | grep scheduler
io scheduler noop registered
io scheduler anticipatory registered
io scheduler deadline registered
io scheduler cfq registered (default)
```

**Figure 13: Kernel I/O scheduler**

### 4.2 Benchmark Configuration

The Iozone benchmark performs throughput tests on several file system

operations that mimic the I/O characteristics of a variety of real-world applications. It requires several options to produce useful output. We used the following command-line switches to test the AoE SAN:

```
client0# iozone -azRU -f /mnt/aoe/aoe.test -b aoe.xls > aoe.log
```

**Figure 14: Iozone configuration**

This command will perform the benchmark on the AoE device, and create two output files: aoe.xls, a Microsoft Excel compatible spreadsheet, and aoe.log, which contains the same data but in a text format more suitable for batch processing and statistics generation.

## 5. Performance Analysis

### 5.1 Data Collection Methodology

The Iozone benchmark performs throughput tests on several file system operations that mimic the I/O characteristics of a variety of real-world applications. First, it writes increasingly large files ranging in size from 64KB to 512MB, which simulates the sequential I/O requirements of file server and backup applications. Within these files, it writes "records" – chunks of data sized from 4KB to 16MB – which corresponds to the access patterns of database applications. For this report, we are most interested in the following tests (8):

- **Write:** Performs a sequential block write of the file and records, including all file system meta data
- **Re-Write:** Sequential block write of an existing file. As the file system meta data is already on disk, it is not re-written
- **Read:** Sequential reading of the file created by the write operations
- **Re-Read:** Sequential reading of the file, but with certain data cached by the operating system to improve performance
- **Random Read:** Records are accessed from random points within the file. This test mimics database read operations
- **Random Write:** Records are written to random points within the file. This test mimics database write operations

To get a picture of the broad trends that we could expect in the results, we plotted the statistics for each of these operations on each system type (AoE, NFS, and DASD) in a three-dimensional surface map. An example plot is shown in Figure 15; the full Iozone results, and all of the plots, are available in the Appendices.

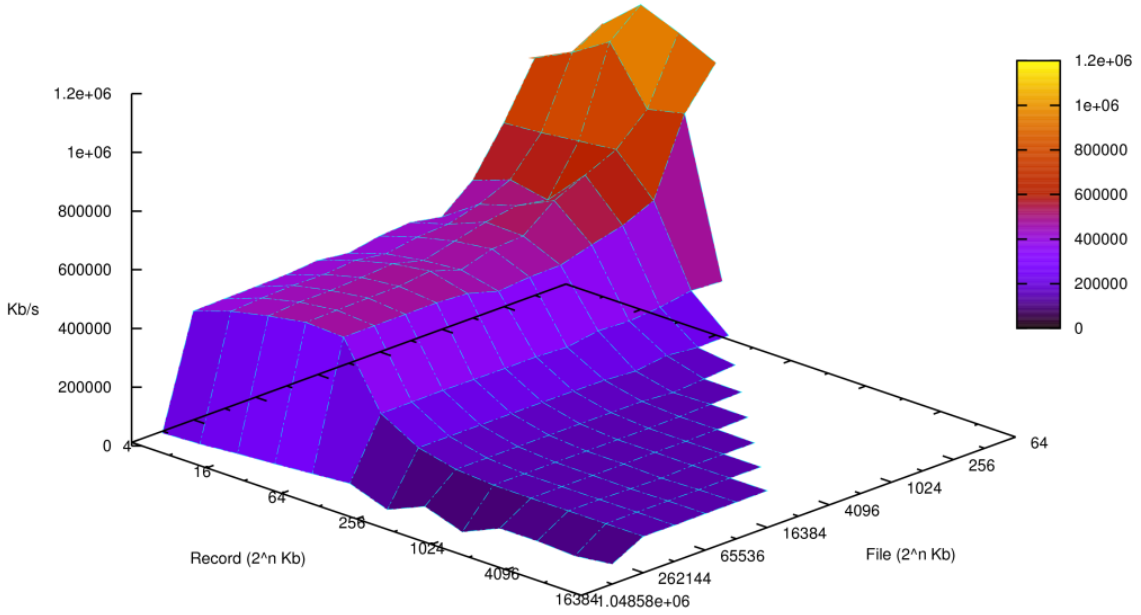



**Figure 15: AoE random read plot**

Two prominent features emerged in virtually all of the tests across the three systems. First, a pronounced peak speed at file sizes smaller than 256KB. This corresponds to the effect of CPU cache in buffering the data writes to the ATA bus, and obscures the raw bus and disk speeds for these data sizes. For this reason, we excluded all results for these file sizes from our analysis, as it does not provide an accurate measure of system performance.

The second interesting feature of the plots was the “knee” curve visible in Figure 15 beginning at record sizes larger than 256KB, across all file sizes. This is evidence of a general property of virtually all storage systems – that response time and throughput decreases with an increasing number of I/O operations (1 p. 251). Comparing results from multiple systems for one specific operation and one particular data size is not particularly useful, as few real world applications match such narrow access patterns. A more accurate analysis should include data that measures the scalability of the systems

using performance across a variety of operations and data sizes.

### 5.2 Performance Results

The following graphs show the performance of each system in each file system operation test. The dependent variable is the mean of I/O throughput for all record sizes of a given file size, for files and records greater than 256KB.

#### 5.2.1 Sequential Write

AoE performance lagged behind the other systems in the sequential write test (Figure 16). For smaller files, AoE protocol limit of 1KB of data per ATA transaction had a negative impact on throughput. As the NFS protocol can write chunks up to 8KB, the system required fewer operations to write the same amount of data to the wire. DASD writes were relatively linear, reflecting the local direct access to the 4KB file system blocks. The efficiency of this 1:1 block size to ATA transaction to block size is most apparent for the largest files, where the DASD system was able to write at 36MB/s, compared to 21MB/s for NFS and 11MB/s for AoE.

#### 5.2.2 Sequential Re-Write

Both the AoE and the DASD systems saw significant benefits in avoiding the file system meta data penalty by re-writing the data portion of the file across the entire curve (Figure 17). NFS again proved to be the most efficient at writing files of sizes 32MB and smaller.

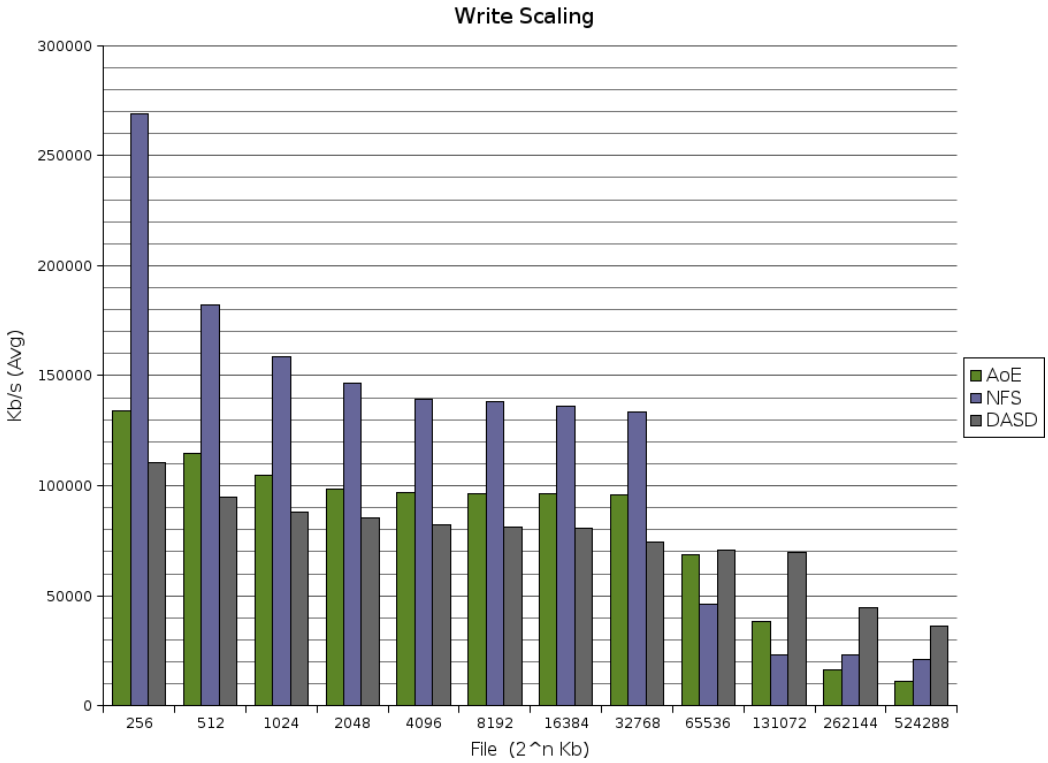



**Figure 16: Write performance**

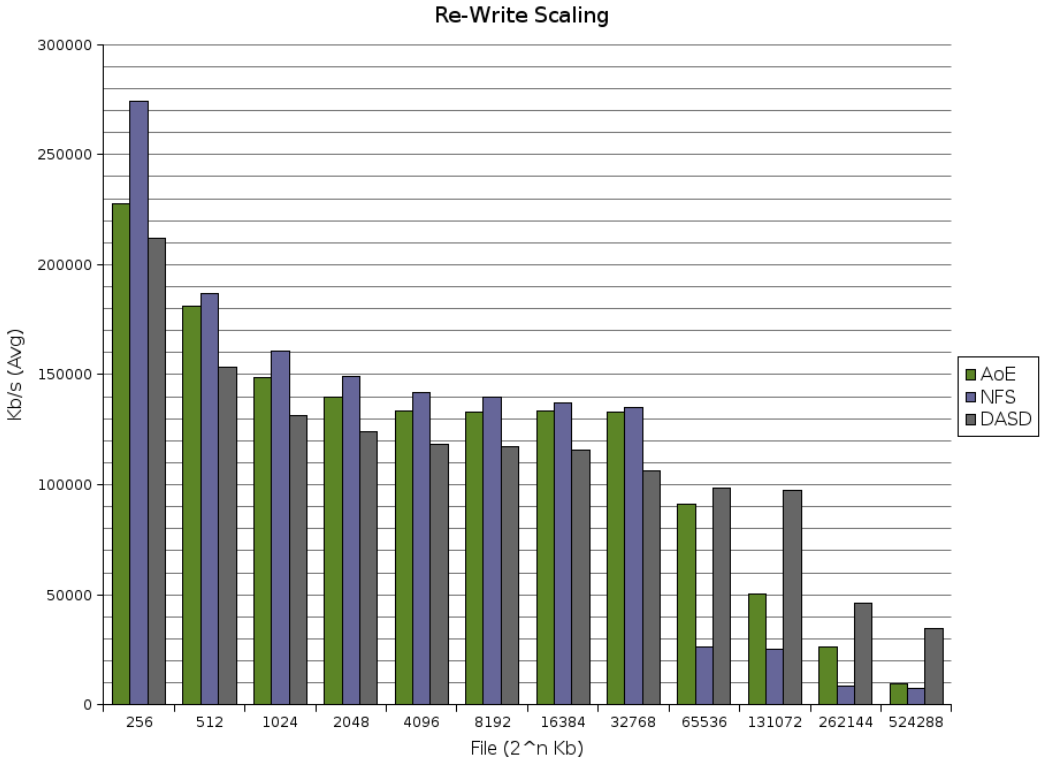



**Figure 17: Re-write performance**

### 5.2.3 Sequential Read

The non-cached sequential read test revealed an edge to the AoE system over the NFS and DASD systems, mainly due to the slight performance advantage provided by the RAID 1 members of the RAID 10 array (Figure 18).

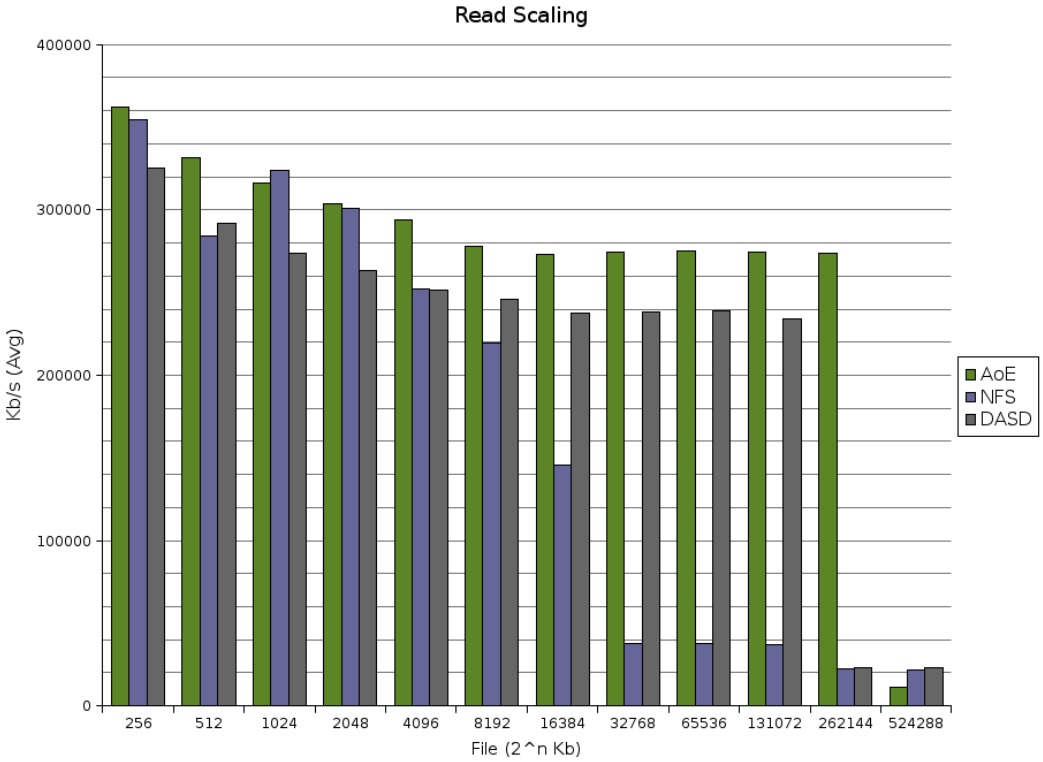



**Figure 18: Read performance**

### 5.2.4 Sequential Re-Read

Operating system caching of the previously read data provided the expected performance benefit for all three systems (Figure 19). The AoE and NFS systems had similar performance characteristics across the curve, with very high apparent throughput for smaller files, given the limitations imposed by the network, ATA bus, and the disks themselves.

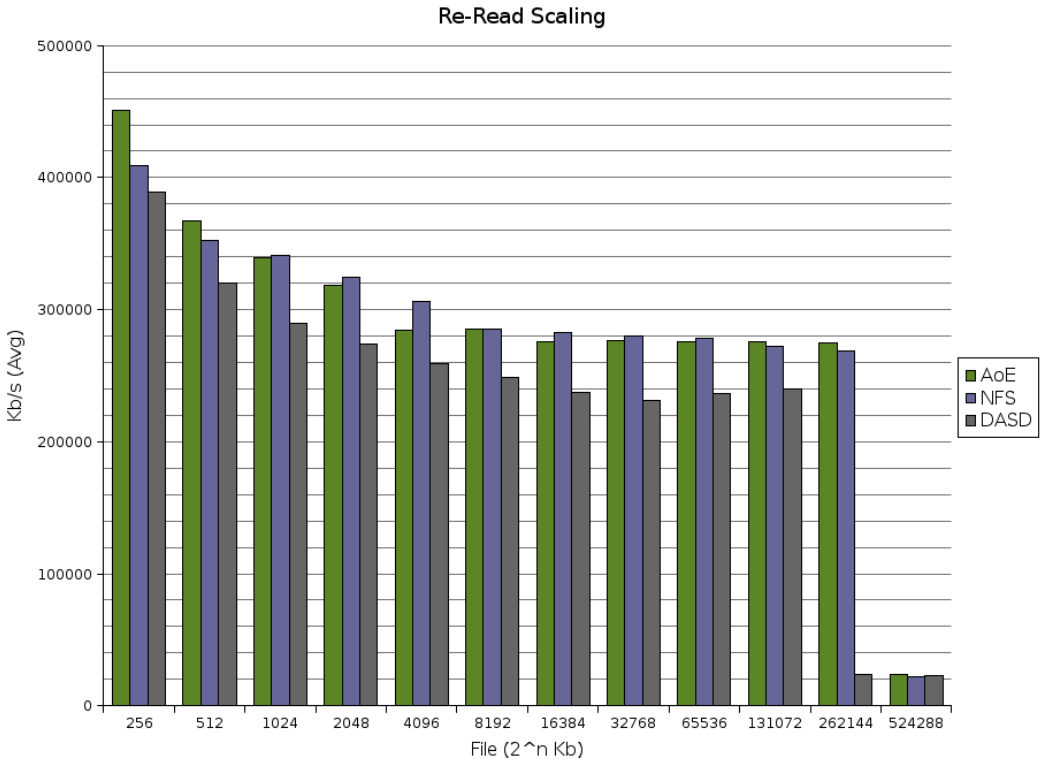



**Figure 19: Re-read performance**

### 5.2.5 Random Read

There was no significant performance differences between AoE and NFS in reading records of varying sizes from random places within each file (Figure 20). Both scaled well for file sizes up to 256MB, and saw throughput of approximately 40MB/s for the largest files.


**Figure 20: Random read performance**

### 5.2.6 Random Write

DASD continued to outperform the other two systems for write operations on larger files (Figure 21). For smaller files, AoE showed a significantly better performance profile than on the non-cached sequential write tests, trailing only slightly behind NFS.

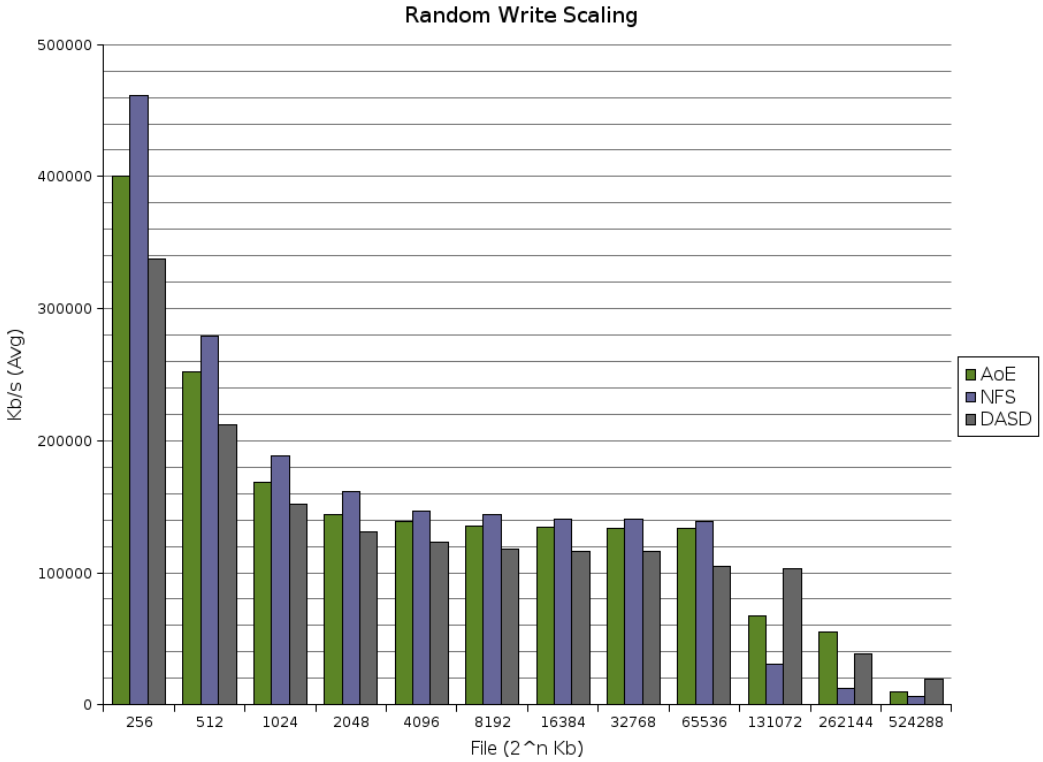



**Figure 21: Random write performance**

## 6. Deliverables

- Evaluation systems including the following:

    1. ATA Over Ethernet Storage Area Network
    2. Baseline NFS network attached storage
    3. Baseline direct attached storage

- Detailed system implementation instructions with appropriate illustrations, provided in section 4 of this report.

- Iozone results and performance analysis with appropriate illustrations. Full Iozone results are provided in the appendices, and the performance analysis in provided in sections 5 and 7 of this report.

## 7. Conclusion and Recommendations

The project was completed on time with an out-of-pocket cost of just over $100. We were able to configure the SAN relatively quickly, and the task should prove no more difficult for any administrator with sufficient Linux experience. Most of the project time was spent in research, resource gathering, and running and analyzing the benchmarks.

Time, cost, and technical constraints limited the scope of variables that were able to consider in performance-tuning the SAN. Some users may find that adjusting the following parameters may significantly improve AoE performance, for example:

- Adding additional Ethernet cards should reduce contention and increase throughput. The vblade daemon allows a specific network interface to be bound to single disk, allowing each target disk to use the full bandwidth available on the wire.
- Performance was limited by the 100MB/s upper theoretical bus bandwidth of the ATA-100 disks, and their 7200RPM rotation speed. The latency and seek times of the SAN should be improved by using more modern Serial ATA drives, which have a theoretical bus bandwidth of 384MB/s, and rotational speeds of up to 10,000RM.
- Modifying the choice of file system to suit a specific application should improve performance for that application's I/O profile. We chose the standard ext3 file system with 4KB blocks, as it is generally accepted as a good general purpose file system. Administrators may find that the Reiser3 file system, with its excellent performance on small files, may mitigate the 1KB/transaction bottleneck in AoE, or that the very large block sizes available in the XFS file system may improve

performance on large files.

- Many database management systems allow the database engine to directly access raw block devices, eliminating the file system layer entirely and allowing the engine to access I/O in an internally optimized fashion.

In the configuration used in this report, AoE performed poorly in the sequential write test compared to the NFS and DASD systems, seeing throughput as low as 11MB/s on average for large files. The 1KB AoE transaction limit and its resulting inefficiencies is a major bottleneck, and makes an AoE SAN an unsuitable back-end for file serving and disk backup systems.

The SAN performed much better in the read and random access tests. It did not perform significantly slower than the other two systems in any test, and scaled much better with increasing file sizes than either NFS or DASD in certain situations. These performance characteristics indicate at an AoE SAN may be especially well suited for applications where the I/O profile is weighted heavily to either read-only operations or random access. Such applications include static Web serving and back-end Web databases.

An AoE SAN can provide excellent flexibility, scalability, and ease of administration, with the caveat that organizations choose their target applications carefully and tune the system properly. Compared to other options of a similar size and cost, AoE performs well on a relatively narrow set of I/O operations. However, if the application I/O requirements match the areas where AoE performs best, organizations can realize many of the benefits of a networked storage infrastructure at a considerably lower cost than the traditional offerings.

# Appendix A: AoE Iozone Results

The top row is records sizes, the left column is file sizes

Writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 66953 | 156475 | 160031 | 158002 | 145458 | | | | | | | | |
| 128 | 147981 | 160612 | 163489 | 163453 | 152000 | 116253 | | | | | | | |
| 256 | 141194 | 145043 | 158315 | 139206 | 131350 | 123318 | 99344 | | | | | | |
| 512 | 123461 | 132879 | 133402 | 121065 | 113498 | 103039 | 101890 | 88673 | | | | | |
| 1024 | 116761 | 119583 | 118435 | 108086 | 101891 | 96448 | 92778 | 98056 | 91510 | | | | |
| 2048 | 110238 | 112064 | 111074 | 103127 | 97094 | 91017 | 91042 | 91241 | 90775 | 88904 | | | |
| 4096 | 107673 | 108656 | 107693 | 100779 | 93109 | 90587 | 91811 | 91731 | 92732 | 92391 | 90043 | | |
| 8192 | 106527 | 108463 | 105442 | 100400 | 92302 | 90992 | 91415 | 92064 | 92813 | 92310 | 92776 | 92514 | |
| 16384 | 106990 | 109217 | 106424 | 100970 | 92652 | 91654 | 91941 | 88661 | 93332 | 93113 | 93230 | 93367 | 93145 |
| 32768 | 107376 | 108713 | 105890 | 99710 | 91509 | 91161 | 91536 | 92282 | 92393 | 92523 | 90613 | 92683 | 92599 |
| 65536 | 72989 | 56133 | 55665 | 80249 | 50420 | 51370 | 74006 | 74988 | 75478 | 74069 | 74830 | 75247 | 75140 |
| 131072 | 34353 | 34927 | 56918 | 19049 | 30916 | 49624 | 30710 | 49891 | 49873 | 49892 | 31145 | 31208 | 31112 |
| 262144 | 21588 | 33770 | 31664 | 5507 | 6355 | 8002 | 8869 | 23288 | 8016 | 22966 | 8315 | 8224 | 22623 |
| 524288 | 8975 | 11388 | 11655 | 11275 | 12240 | 10739 | 11473 | 12270 | 12167 | 12120 | 11844 | 9804 | 10991 |

Re-writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 309142 | 359604 | 357665 | 326709 | 318403 | | | | | | | | |
| 128 | 327451 | 324113 | 333389 | 344015 | 298996 | 200658 | | | | | | | |
| 256 | 269740 | 259924 | 260702 | 256018 | 214579 | 176909 | 154227 | | | | | | |
| 512 | 206528 | 226646 | 220492 | 185300 | 180478 | 143214 | 140542 | 143985 | | | | | |
| 1024 | 180027 | 176278 | 168840 | 153824 | 137895 | 132418 | 128870 | 129521 | 131082 | | | | |
| 2048 | 167882 | 168990 | 162332 | 146004 | 132607 | 123107 | 126372 | 123343 | 124969 | 121076 | | | |
| 4096 | 163018 | 158987 | 151194 | 138001 | 123540 | 120772 | 121944 | 121431 | 124098 | 122366 | 122869 | | |
| 8192 | 163291 | 158122 | 150815 | 138165 | 123184 | 121665 | 122172 | 122844 | 123145 | 123393 | 125110 | 123447 | |
| 16384 | 164540 | 161801 | 152045 | 138525 | 124304 | 122770 | 123385 | 124247 | 124708 | 125594 | 124991 | 125508 | 125873 |
| 32768 | 166827 | 161893 | 152313 | 132817 | 123373 | 122508 | 119602 | 124304 | 124726 | 124817 | 124838 | 124755 | 124768 |
| 65536 | 120895 | 69966 | 68125 | 108662 | 62159 | 60672 | 98646 | 99196 | 99553 | 99610 | 99373 | 99544 | 99155 |
| 131072 | 40629 | 78661 | 29433 | 70320 | 35737 | 63362 | 35573 | 64028 | 64412 | 36223 | 35851 | 64399 | 36013 |
| 262144 | 42093 | 34073 | 29410 | 24002 | 27490 | 33661 | 23489 | 23499 | 7202 | 23137 | 22840 | 23157 | 27011 |
| 524288 | 7951 | 8301 | 11531 | 8089 | 10994 | 10818 | 10975 | 10222 | 10432 | 10564 | 8914 | 8641 | 7976 |

Reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 444588 | 508157 | 496501 | 457315 | 457080 | | | | | | | | |
| 128 | 397423 | 411461 | 448944 | 415594 | 395012 | 247079 | | | | | | | |
| 256 | 382603 | 378761 | 472312 | 405767 | 462072 | 248074 | 185240 | | | | | | |
| 512 | 388441 | 402493 | 430976 | 420721 | 420387 | 250606 | 182340 | 158176 | | | | | |
| 1024 | 392775 | 427716 | 437621 | 443471 | 395514 | 248488 | 186929 | 161384 | 154680 | | | | |
| 2048 | 411572 | 446392 | 454710 | 452384 | 410664 | 251562 | 177393 | 150533 | 143247 | 135529 | | | |
| 4096 | 418775 | 456935 | 471395 | 470368 | 439582 | 251812 | 171970 | 143041 | 135732 | 136802 | 135145 | | |
| 8192 | 427625 | 442453 | 458142 | 464425 | 426798 | 244632 | 177270 | 146345 | 136417 | 135541 | 135872 | 136474 | |
| 16384 | 418365 | 449925 | 476638 | 484790 | 455679 | 249012 | 177945 | 148133 | 138046 | 137868 | 137613 | 138536 | 138519 |
| 32768 | 424538 | 455820 | 474088 | 484075 | 466494 | 251502 | 178171 | 147804 | 137555 | 137042 | 136877 | 137112 | 136344 |
| 65536 | 428183 | 456875 | 474737 | 481885 | 473515 | 252511 | 178465 | 147892 | 137741 | 136825 | 136652 | 137051 | 137093 |
| 131072 | 427076 | 456617 | 460727 | 484019 | 473307 | 253824 | 177748 | 147884 | 137572 | 136819 | 136888 | 135826 | 136773 |
| 262144 | 426409 | 454418 | 468728 | 475523 | 474973 | 252286 | 176758 | 147655 | 137540 | 136731 | 136716 | 136776 | 136601 |
| 524288 | 4512 | 11106 | 4253 | 12765 | 7466 | 10953 | 26703 | 4377 | 25737 | 10223 | 8745 | 5644 | 16063 |

Re-reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 1391082 | 877116 | 1361640 | 1183010 | 1390565 | | | | | | | | |
| 128 | 1143163 | 1000450 | 853959 | 736087 | 780240 | 315242 | | | | | | | |
| 256 | 571409 | 420341 | 544803 | 539973 | 600860 | 288612 | 188389 | | | | | | |
| 512 | 440237 | 449912 | 491889 | 496070 | 447950 | 256125 | 175827 | 176546 | | | | | |
| 1024 | 424538 | 437035 | 505925 | 461452 | 490633 | 273059 | 164896 | 161184 | 136425 | | | | |
| 2048 | 424095 | 474524 | 482097 | 497921 | 449424 | 257610 | 170554 | 150489 | 142987 | 138444 | | | |
| 4096 | 407929 | 418472 | 446571 | 461257 | 415588 | 252293 | 175155 | 145754 | 137708 | 137921 | 133598 | | |
| 8192 | 426958 | 461285 | 478278 | 493020 | 447432 | 246250 | 175937 | 146728 | 137040 | 137331 | 136597 | 136324 | |
| 16384 | 424455 | 462692 | 478267 | 486084 | 459540 | 251307 | 178854 | 148411 | 138029 | 137708 | 137529 | 138422 | 137441 |
| 32768 | 428049 | 461423 | 478560 | 486822 | 472433 | 252597 | 178610 | 148111 | 137661 | 137026 | 136880 | 136609 | 136749 |
| 65536 | 427707 | 458868 | 477034 | 483421 | 475691 | 253419 | 178459 | 148191 | 137789 | 137013 | 136786 | 136898 | 137165 |
| 131072 | 428629 | 456431 | 476062 | 485237 | 475201 | 254163 | 178355 | 148005 | 137646 | 135787 | 136947 | 136930 | 136765 |
| 262144 | 426966 | 454511 | 474205 | 483152 | 476172 | 254339 | 178183 | 147093 | 137019 | 136744 | 136195 | 136835 | 136116 |
| 524288 | 26604 | 26715 | 26771 | 26712 | 25472 | 26097 | 3875 | 23978 | 24568 | 24891 | 25413 | 24867 | 25806 |

Random Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 770998 | 941522 | 1050919 | 999036 | 939719 | | | | | | | | |
| 128 | 820773 | 882754 | 962781 | 776154 | 804823 | 277714 | | | | | | | |
| 256 | 638304 | 648073 | 663338 | 677384 | 547106 | 284147 | 174873 | | | | | | |
| 512 | 481231 | 526686 | 500960 | 628972 | 500531 | 265548 | 172800 | 156380 | | | | | |
| 1024 | 394617 | 481653 | 520035 | 580845 | 473613 | 257413 | 183319 | 147081 | 146013 | | | | |
| 2048 | 414830 | 452298 | 503084 | 498669 | 442805 | 262532 | 169325 | 139471 | 142788 | 142360 | | | |
| 4096 | 407237 | 446919 | 476777 | 493072 | 441049 | 245401 | 176514 | 147688 | 139562 | 138899 | 136830 | | |
| 8192 | 387145 | 428788 | 448754 | 460558 | 431067 | 251419 | 177634 | 147910 | 137970 | 137389 | 137141 | 136948 | |
| 16384 | 400744 | 444709 | 476639 | 494820 | 461780 | 250447 | 178780 | 148510 | 137948 | 138265 | 137085 | 137639 | 138248 |
| 32768 | 391222 | 435010 | 468034 | 481366 | 468918 | 251373 | 178406 | 148113 | 137939 | 136965 | 132372 | 136434 | 137164 |
| 65536 | 388145 | 436458 | 462494 | 480134 | 468301 | 252681 | 178547 | 147967 | 138030 | 136810 | 134694 | 136951 | 136780 |
| 131072 | 385748 | 432242 | 461763 | 477542 | 467795 | 251400 | 177865 | 147767 | 137447 | 136823 | 136959 | 136772 | 135496 |
| 262144 | 382921 | 425260 | 452630 | 474367 | 467630 | 250761 | 177681 | 147475 | 137484 | 136139 | 136571 | 136218 | 136498 |
| 524288 | 6176 | 11915 | 22878 | 31153 | 41155 | 51313 | 5961 | 60275 | 17006 | 71958 | 72437 | 65327 | 80442 |

Random Write Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 556910 | 674351 | 703484 | 762516 | 667388 | | | | | | | | |
| 128 | 571198 | 669779 | 735566 | 691664 | 715350 | 236993 | | | | | | | |
| 256 | 462889 | 543574 | 527721 | 516167 | 353069 | 247132 | 154967 | | | | | | |
| 512 | 331180 | 329258 | 326530 | 316229 | 258582 | 177649 | 168759 | 111866 | | | | | |
| 1024 | 206575 | 209706 | 214762 | 185270 | 165482 | 137855 | 130547 | 129294 | 135789 | | | | |
| 2048 | 167731 | 172014 | 170086 | 157379 | 129685 | 126466 | 128369 | 127656 | 130453 | 128015 | | | |
| 4096 | 165588 | 164862 | 158476 | 145248 | 131353 | 127142 | 127712 | 126716 | 127887 | 128744 | 125968 | | |
| 8192 | 162801 | 161040 | 155540 | 141144 | 126703 | 124369 | 124277 | 125567 | 126671 | 124337 | 126962 | 124813 | |
| 16384 | 161889 | 160789 | 153181 | 140781 | 125928 | 124100 | 124631 | 119240 | 126199 | 127673 | 126998 | 127743 | 125750 |
| 32768 | 160120 | 159099 | 151784 | 137381 | 123944 | 123440 | 121079 | 125806 | 126442 | 126087 | 126337 | 125925 | 126751 |
| 65536 | 159198 | 158094 | 151027 | 136178 | 123137 | 122905 | 124029 | 124994 | 125886 | 126323 | 126162 | 127054 | 125958 |
| 131072 | 57752 | 91306 | 49025 | 81008 | 73990 | 72965 | 49868 | 73735 | 77147 | 53764 | 49419 | 80327 | 69467 |
| 262144 | 93832 | 96852 | 89436 | 69638 | 9867 | 16839 | 50274 | 64779 | 15561 | 33540 | 63204 | 60133 | 57562 |
| 524288 | 2832 | 2567 | 3696 | 4659 | 5173 | 10657 | 13450 | 13445 | 7664 | 14758 | 15932 | 16851 | 16606 |

Backward Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 441142 | 450375 | 508231 | 415846 | 407804 | | | | | | | | |
| 128 | 331668 | 366722 | 393717 | 376454 | 334135 | 239678 | | | | | | | |
| 256 | 345425 | 350725 | 367315 | 396861 | 382075 | 253442 | 189344 | | | | | | |
| 512 | 337042 | 394182 | 416230 | 427379 | 489048 | 253348 | 180477 | 157387 | | | | | |
| 1024 | 378550 | 422094 | 437041 | 449321 | 428469 | 248611 | 176219 | 158146 | 146013 | | | | |
| 2048 | 404020 | 423481 | 466291 | 459393 | 374542 | 256831 | 173149 | 149194 | 138295 | 141935 | | | |
| 4096 | 399999 | 424937 | 464135 | 484910 | 438872 | 257011 | 170808 | 143563 | 135436 | 137467 | 134959 | | |
| 8192 | 397089 | 446623 | 460742 | 476027 | 436441 | 244640 | 175436 | 145653 | 137090 | 135476 | 135501 | 134513 | |
| 16384 | 399698 | 438636 | 443121 | 472665 | 442178 | 247746 | 178447 | 148389 | 138136 | 137505 | 137217 | 137993 | 138149 |
| 32768 | 404588 | 446789 | 471007 | 479205 | 421084 | 235206 | 178308 | 148237 | 137291 | 136816 | 136756 | 136689 | 136676 |
| 65536 | 406816 | 446969 | 468271 | 479737 | 469825 | 252170 | 176945 | 148023 | 137158 | 136707 | 136681 | 136648 | 137132 |
| 131072 | 405972 | 420517 | 452509 | 479342 | 456556 | 242870 | 177977 | 142528 | 136174 | 136746 | 135919 | 136730 | 136644 |
| 262144 | 392577 | 445254 | 451836 | 479207 | 451569 | 249200 | 176889 | 147489 | 137434 | 135005 | 136190 | 136695 | 136585 |
| 524288 | 5511 | 8652 | 11517 | 2052 | 19494 | 2198 | 14980 | 29909 | 7732 | 30980 | 30429 | 21102 | 8312 |

Record Rewrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 423675 | 477221 | 402800 | 274539 | 149154 | | | | | | | | |
| 128 | 600648 | 621501 | 549474 | 416939 | 226115 | 121660 | | | | | | | |
| 256 | 697503 | 773594 | 679196 | 596815 | 337700 | 171459 | 104663 | | | | | | |
| 512 | 746250 | 841956 | 785134 | 747443 | 325682 | 206027 | 133994 | 101488 | | | | | |
| 1024 | 774535 | 842089 | 836578 | 858319 | 679903 | 249326 | 133439 | 102493 | 93695 | | | | |
| 2048 | 788587 | 895877 | 875193 | 925021 | 840748 | 243317 | 152312 | 124460 | 111333 | 95030 | | | |
| 4096 | 785124 | 910645 | 833858 | 873701 | 705465 | 254696 | 156144 | 129235 | 118080 | 108345 | 94364 | | |
| 8192 | 771950 | 892966 | 872505 | 922429 | 872878 | 325195 | 162375 | 131710 | 122530 | 117345 | 108632 | 91803 | |
| 16384 | 800191 | 921171 | 909920 | 968953 | 969012 | 249444 | 163784 | 132745 | 124675 | 122953 | 117909 | 108976 | 92614 |
| 32768 | 803256 | 929354 | 909993 | 974626 | 936041 | 295916 | 166791 | 135188 | 126152 | 125403 | 122484 | 116527 | 106895 |
| 65536 | 800673 | 927062 | 908442 | 971392 | 770985 | 309770 | 164524 | 135489 | 126646 | 126022 | 124809 | 121993 | 116162 |
| 131072 | 796824 | 919371 | 903813 | 964835 | 975455 | 269021 | 160909 | 135721 | 127340 | 126821 | 125885 | 124639 | 121256 |
| 262144 | 801158 | 899595 | 903449 | 963435 | 935156 | 298344 | 166335 | 134122 | 126457 | 127085 | 126132 | 125849 | 123908 |
| 524288 | 786550 | 920567 | 908487 | 945982 | 935438 | 285389 | 165794 | 133706 | 126876 | 126038 | 125890 | 126375 | 124566 |

Stride Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 887858 | 831276 | 653792 | 515953 | 319953 | | | | | | | | |
| 128 | 324036 | 1032519 | 914565 | 677605 | 518210 | 220658 | | | | | | | |
| 256 | 332940 | 370441 | 1107766 | 911378 | 692037 | 302256 | 186045 | | | | | | |
| 512 | 263383 | 378129 | 400652 | 1210079 | 583157 | 324658 | 186999 | 156715 | | | | | |
| 1024 | 369956 | 411758 | 425229 | 437066 | 1168917 | 380541 | 186823 | 151796 | 152156 | | | | |
| 2048 | 377298 | 442895 | 462404 | 449528 | 441000 | 376883 | 179146 | 150799 | 142956 | 142005 | | | |
| 4096 | 395251 | 439533 | 468227 | 464193 | 419247 | 250426 | 170965 | 142415 | 135679 | 135092 | 134910 | | |
| 8192 | 397032 | 443267 | 463979 | 475890 | 442401 | 242603 | 174475 | 146131 | 135615 | 134522 | 135038 | 135883 | |
| 16384 | 391914 | 434426 | 466170 | 473225 | 451075 | 247825 | 177973 | 147735 | 137447 | 137167 | 136817 | 137831 | 138085 |
| 32768 | 395051 | 438931 | 465824 | 478434 | 464887 | 250608 | 177793 | 147897 | 137594 | 136046 | 136031 | 136497 | 137347 |
| 65536 | 395231 | 438895 | 464488 | 476798 | 466750 | 251653 | 177759 | 147836 | 137643 | 136648 | 136493 | 136512 | 136904 |
| 131072 | 395685 | 426545 | 463924 | 478877 | 468197 | 251876 | 177858 | 146370 | 137478 | 136666 | 135909 | 136657 | 135370 |
| 262144 | 394344 | 436852 | 462363 | 476397 | 467174 | 252506 | 176969 | 147505 | 137460 | 136154 | 136575 | 136201 | 135540 |
| 524288 | 5816 | 6755 | 952 | 14057 | 6175 | 27206 | 32743 | 44746 | 52143 | 50576 | 56779 | 58477 | 7687 |

Fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 138219 | 159200 | 177292 | 207755 | 166711 | | | | | | | | |
| 128 | 145288 | 149552 | 165824 | 173701 | 181832 | 123914 | | | | | | | |
| 256 | 133887 | 145293 | 144710 | 146619 | 122605 | 144552 | 107023 | | | | | | |
| 512 | 119013 | 123136 | 122898 | 114821 | 100689 | 100705 | 118463 | 99034 | | | | | |
| 1024 | 111196 | 115720 | 111522 | 104223 | 89800 | 85856 | 80541 | 107563 | 93618 | | | | |
| 2048 | 106130 | 106025 | 104778 | 97971 | 82817 | 76940 | 72882 | 80235 | 106207 | 93729 | | | |
| 4096 | 102443 | 104202 | 102528 | 95187 | 81402 | 76373 | 68548 | 70893 | 80164 | 104524 | 92667 | | |
| 8192 | 102585 | 104344 | 102655 | 94547 | 81368 | 75016 | 66491 | 67398 | 71253 | 80195 | 104714 | 92602 | |
| 16384 | 103226 | 104867 | 102692 | 94858 | 81343 | 75082 | 65162 | 66089 | 68584 | 71796 | 80915 | 105724 | 93614 |
| 32768 | 102570 | 104304 | 101810 | 93705 | 80538 | 74310 | 65333 | 65290 | 66143 | 68167 | 71980 | 80207 | 105918 |
| 65536 | 55713 | 57503 | 80760 | 50245 | 46197 | 60575 | 54029 | 54358 | 54294 | 56929 | 59798 | 64616 | 79979 |
| 131072 | 33259 | 56377 | 19314 | 48541 | 42496 | 40034 | 26417 | 36880 | 36997 | 20855 | 26659 | 29045 | 43089 |
| 262144 | 20975 | 25033 | 6381 | 33688 | 9514 | 10617 | 32717 | 9860 | 26963 | 24075 | 10613 | 9412 | 30072 |
| 524288 | 11193 | 9582 | 8743 | 11665 | 12437 | 12748 | 12385 | 12935 | 12417 | 13046 | 13506 | 11959 | 13358 |

Re-fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 320071 | 335175 | 346071 | 378866 | 321417 | | | | | | | | |
| 128 | 282501 | 284479 | 314574 | 314538 | 312256 | 218058 | | | | | | | |
| 256 | 259893 | 236391 | 246135 | 231672 | 201892 | 204294 | 159605 | | | | | | |
| 512 | 201487 | 187825 | 187883 | 175106 | 143015 | 132674 | 138494 | 139017 | | | | | |
| 1024 | 161334 | 164580 | 167789 | 150015 | 122975 | 110224 | 101437 | 125320 | 137082 | | | | |
| 2048 | 159649 | 157635 | 153466 | 137967 | 114946 | 99071 | 86581 | 94621 | 125937 | 129048 | | | |
| 4096 | 149926 | 148367 | 142976 | 129398 | 106630 | 96777 | 82087 | 84901 | 94338 | 121477 | 124117 | | |
| 8192 | 150926 | 148473 | 143510 | 128689 | 107659 | 96162 | 80151 | 81802 | 86007 | 95520 | 123456 | 124536 | |
| 16384 | 153084 | 150611 | 145731 | 130144 | 107788 | 96852 | 81915 | 80096 | 82935 | 86778 | 97014 | 123706 | 126214 |
| 32768 | 153431 | 151150 | 144130 | 128530 | 106968 | 96278 | 79902 | 79289 | 80217 | 82588 | 86833 | 96038 | 123632 |
| 65536 | 67593 | 67581 | 113616 | 61308 | 55220 | 77460 | 66714 | 65392 | 66362 | 69312 | 72177 | 76979 | 95892 |
| 131072 | 39405 | 75084 | 29038 | 35665 | 54069 | 49939 | 44306 | 43983 | 44391 | 27687 | 29959 | 31033 | 27516 |
| 262144 | 24203 | 36919 | 24089 | 25969 | 8685 | 27163 | 6581 | 33116 | 6503 | 6773 | 7303 | 6642 | 10106 |
| 524288 | 6680 | 9475 | 7952 | 8256 | 10723 | 10911 | 7884 | 8395 | 8064 | 10951 | 9476 | 10763 | 8362 |

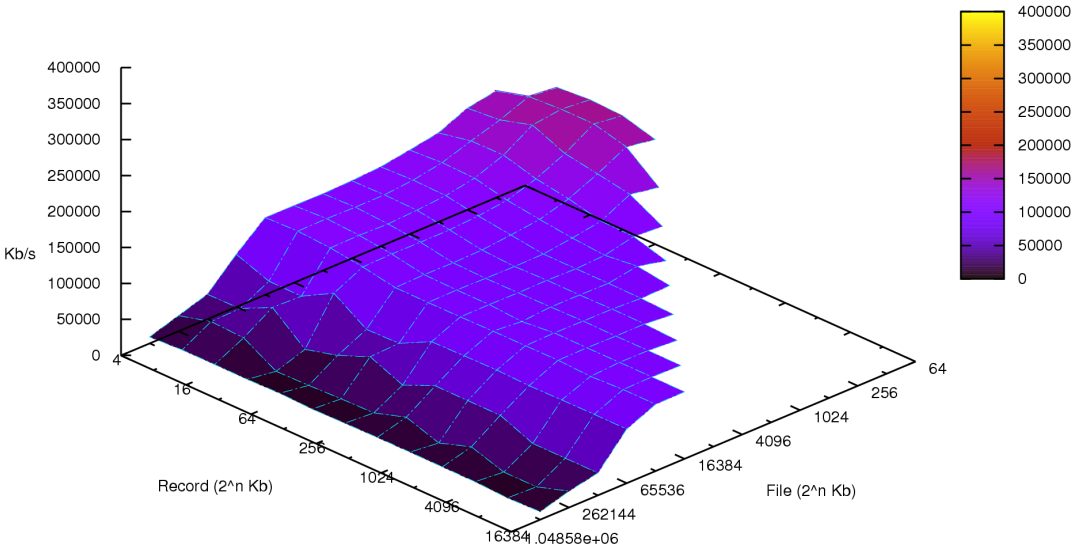
Fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 349679 | 426964 | 346130 | 397790 | 496565 | | | | | | | | |
| 128 | 355612 | 367878 | 380842 | 372192 | 370979 | 218809 | | | | | | | |
| 256 | 331574 | 380338 | 367253 | 410989 | 354548 | 241285 | 184309 | | | | | | |
| 512 | 354299 | 383841 | 405031 | 419369 | 420726 | 266389 | 184102 | 160647 | | | | | |
| 1024 | 383806 | 428441 | 470787 | 463558 | 420379 | 243526 | 177442 | 158047 | 143879 | | | | |
| 2048 | 423046 | 429348 | 447849 | 460110 | 416176 | 253686 | 179210 | 150655 | 142529 | 141729 | | | |
| 4096 | 407239 | 438823 | 460022 | 473145 | 451794 | 247147 | 170368 | 142847 | 135172 | 137399 | 136260 | | |
| 8192 | 418901 | 452648 | 468863 | 475615 | 435561 | 245100 | 176418 | 146390 | 137857 | 135732 | 135923 | 135418 | |
| 16384 | 412819 | 447004 | 472556 | 476059 | 447235 | 245710 | 178208 | 147476 | 138193 | 137033 | 137242 | 137073 | 138467 |
| 32768 | 417283 | 450945 | 470169 | 481571 | 467266 | 251896 | 178129 | 147713 | 137954 | 137018 | 136971 | 136953 | 136368 |
| 65536 | 418533 | 451365 | 463885 | 478983 | 468040 | 252896 | 178372 | 147924 | 137529 | 136880 | 136694 | 136918 | 137260 |
| 131072 | 372874 | 433757 | 421002 | 482937 | 452474 | 249360 | 178153 | 146364 | 137412 | 135501 | 135646 | 129727 | 136754 |
| 262144 | 418203 | 450062 | 471145 | 480552 | 460026 | 253119 | 175704 | 146869 | 137386 | 136522 | 136689 | 136687 | 132957 |
| 524288 | 8615 | 17706 | 3061 | 4878 | 24913 | 27331 | 20113 | 5306 | 27141 | 4118 | 8631 | 7993 | 7398 |

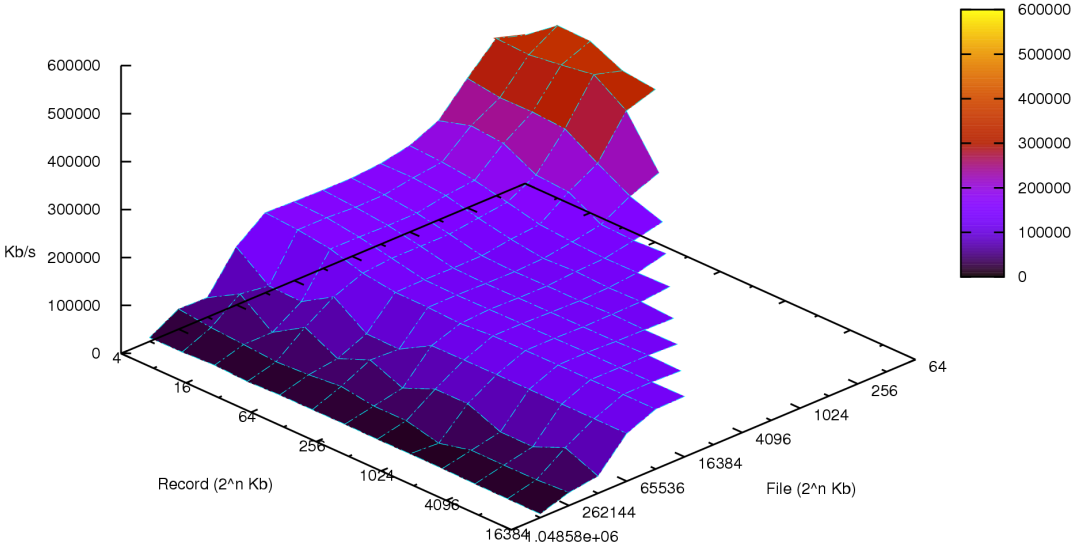
Re-fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 1121552 | 1122385 | 1165186 | 1142304 | 1205641 | | | | | | | | |
| 128 | 934203 | 412917 | 805547 | 687804 | 624115 | 288262 | | | | | | | |
| 256 | 474138 | 562490 | 498003 | 511017 | 396334 | 270626 | 211201 | | | | | | |
| 512 | 368314 | 445195 | 482575 | 466712 | 433555 | 279033 | 181881 | 152654 | | | | | |
| 1024 | 417102 | 437610 | 495148 | 483930 | 492795 | 264949 | 187309 | 152175 | 136952 | | | | |
| 2048 | 390311 | 439667 | 475502 | 466510 | 435290 | 259666 | 171481 | 145568 | 142450 | 141819 | | | |
| 4096 | 394264 | 407036 | 438033 | 455310 | 416262 | 249056 | 174692 | 143146 | 137004 | 136916 | 137931 | | |
| 8192 | 418794 | 453977 | 475066 | 488811 | 442502 | 248565 | 175387 | 145472 | 137272 | 136672 | 136932 | 135532 | |
| 16384 | 421941 | 457066 | 470547 | 485511 | 459799 | 251114 | 179067 | 147894 | 137955 | 137688 | 137478 | 137107 | 138346 |
| 32768 | 422676 | 454757 | 476867 | 485609 | 467459 | 236874 | 178290 | 148051 | 137994 | 137117 | 137260 | 137080 | 136671 |
| 65536 | 420436 | 453665 | 473851 | 485085 | 473447 | 254601 | 178658 | 148015 | 137711 | 137019 | 136899 | 136979 | 137259 |
| 131072 | 419978 | 453114 | 473471 | 482823 | 474007 | 253093 | 178268 | 147784 | 137637 | 135709 | 136791 | 136708 | 136844 |
| 262144 | 413162 | 450852 | 472120 | 481561 | 474288 | 254031 | 177048 | 147658 | 137484 | 136084 | 136691 | 136238 | 136073 |
| 524288 | 27369 | 26139 | 26320 | 27171 | 25676 | 23916 | 24421 | 26097 | 26323 | 26228 | 25690 | 26760 | 25940 |

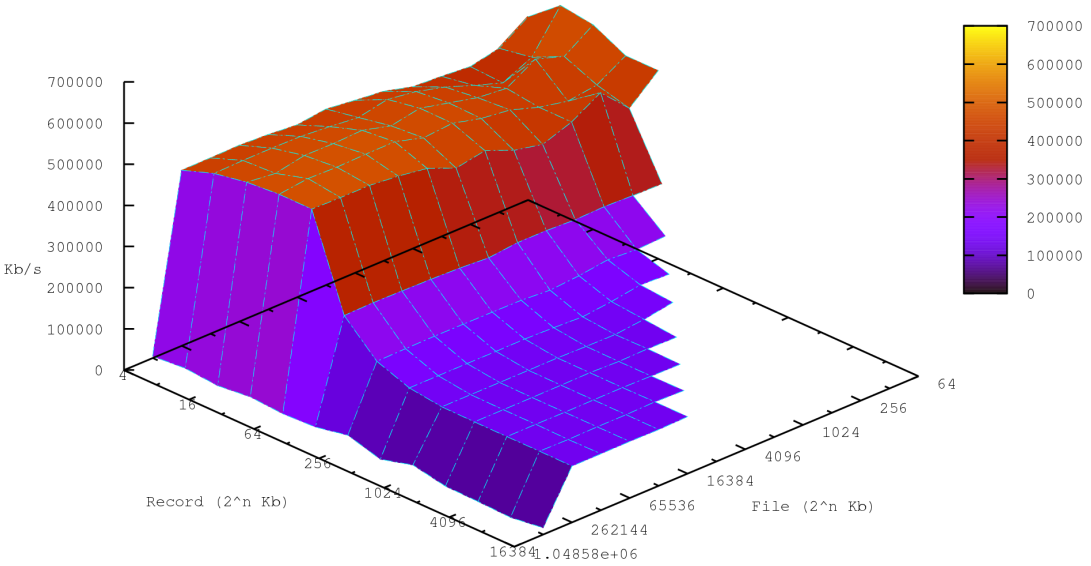
AoE Write



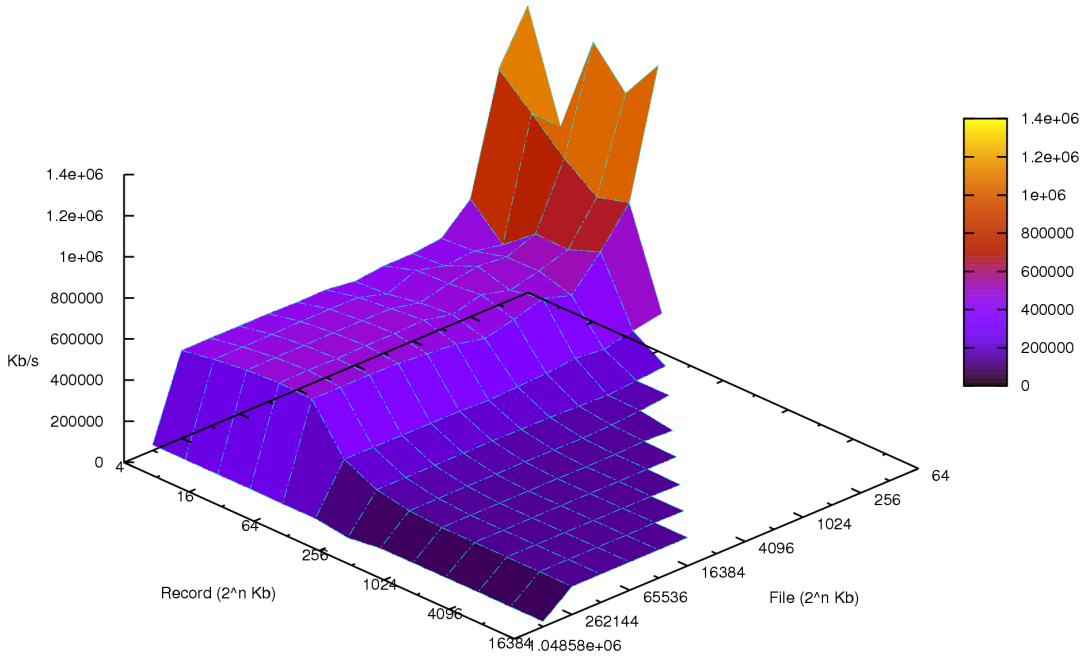

AoE Re-Write



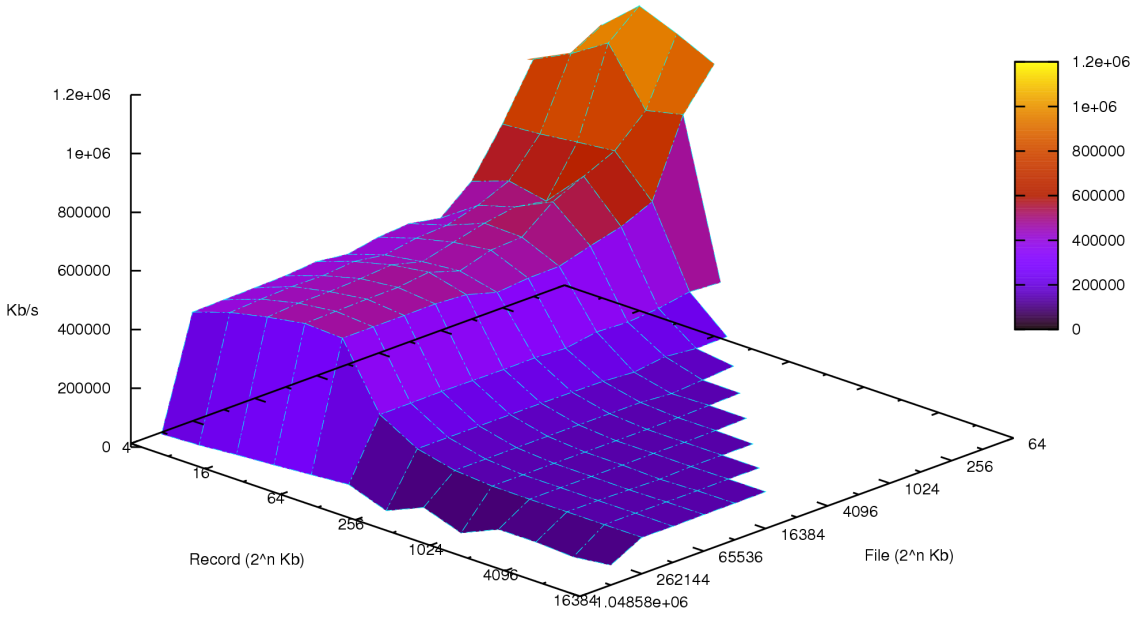
AoE Read



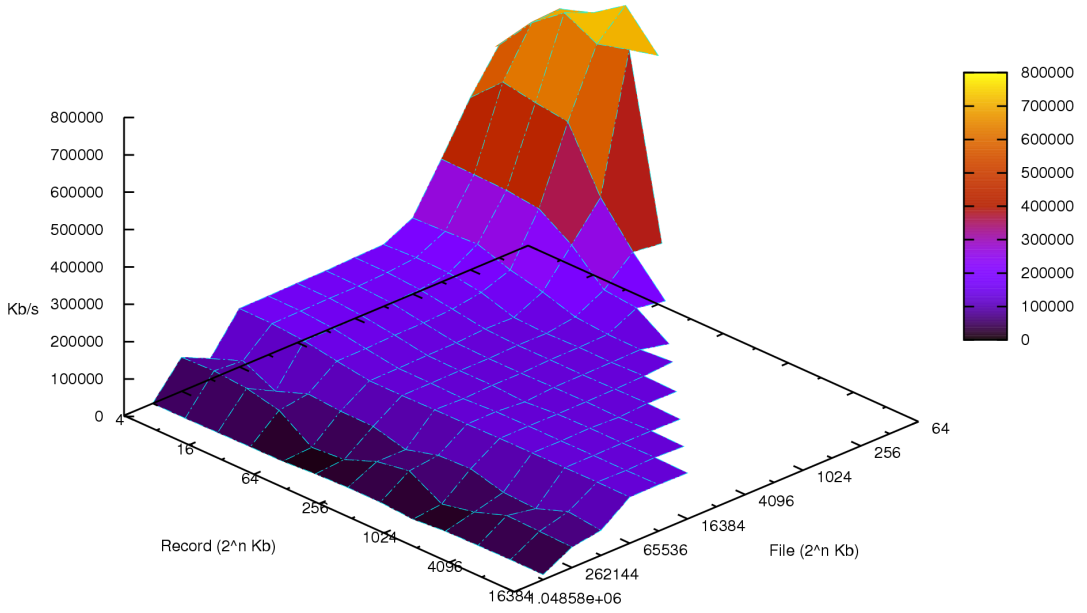

AoE Re-Read



AoE Random Read




AoE Random Write



# Appendix B: NFS Iozone Results

The top row is records sizes, the left column is file sizes

Writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 278344 | 342102 | 392503 | 387720 | 342080 | | | | | | | | |
| 128 | 347720 | 360624 | 371084 | 333350 | 348865 | 234467 | | | | | | | |
| 256 | 303335 | 339975 | 326920 | 311849 | 277946 | 176302 | 147729 | | | | | | |
| 512 | 208132 | 221837 | 217035 | 198688 | 176555 | 150987 | 154678 | 128098 | | | | | |
| 1024 | 190369 | 198368 | 177993 | 162642 | 153987 | 139393 | 139416 | 136388 | 127127 | | | | |
| 2048 | 175117 | 178568 | 164827 | 150366 | 140215 | 134913 | 130769 | 129916 | 133089 | 129547 | | | |
| 4096 | 168261 | 170504 | 155902 | 141183 | 134603 | 124885 | 128168 | 133216 | 132022 | 123014 | 121319 | | |
| 8192 | 166582 | 164247 | 160643 | 136859 | 131283 | 129382 | 125108 | 129653 | 125980 | 130849 | 127238 | 128691 | |
| 16384 | 167383 | 166323 | 158290 | 136214 | 126600 | 128224 | 126704 | 124576 | 126088 | 125798 | 128303 | 128950 | 128017 |
| 32768 | 160114 | 158927 | 152094 | 132282 | 126395 | 126573 | 125875 | 125507 | 126057 | 122555 | 127601 | 127185 | 127088 |
| 65536 | 86892 | 23545 | 23838 | 80281 | 22394 | 23195 | 22969 | 21502 | 69885 | 22474 | 68455 | 68379 | 64669 |
| 131072 | 22213 | 22787 | 23560 | 21314 | 22927 | 22490 | 21912 | 22929 | 22960 | 21776 | 22700 | 22091 | 31545 |
| 262144 | 22992 | 24373 | 23785 | 23534 | 22673 | 23508 | 23385 | 23272 | 23333 | 22486 | 22151 | 22337 | 24865 |
| 524288 | 21335 | 21958 | 21184 | 21492 | 20909 | 20871 | 21293 | 20878 | 21505 | 21682 | 20011 | 19839 | 22962 |

Re-writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 477295 | 542419 | 520793 | 495842 | 402324 | | | | | | | | |
| 128 | 392532 | 386825 | 387789 | 355494 | 288318 | 228994 | | | | | | | |
| 256 | 304413 | 354564 | 361604 | 292908 | 262803 | 178144 | 165377 | | | | | | |
| 512 | 222031 | 219743 | 234221 | 192415 | 175109 | 151798 | 148320 | 151886 | | | | | |
| 1024 | 192733 | 187233 | 189451 | 161999 | 152994 | 139966 | 141986 | 139151 | 142958 | | | | |
| 2048 | 182953 | 174016 | 164311 | 152210 | 140756 | 136369 | 134207 | 132987 | 135314 | 139329 | | | |
| 4096 | 175296 | 172972 | 158944 | 142083 | 135615 | 126528 | 130791 | 134591 | 134339 | 124332 | 126224 | | |
| 8192 | 172633 | 169364 | 154210 | 138861 | 130710 | 131370 | 127189 | 129708 | 130143 | 133073 | 129895 | 130238 | |
| 16384 | 166909 | 161574 | 162940 | 137775 | 130208 | 130709 | 126587 | 126777 | 126594 | 128196 | 129006 | 128652 | 126316 |
| 32768 | 166732 | 165986 | 149840 | 136466 | 129026 | 124000 | 125844 | 125480 | 126334 | 126254 | 127930 | 127923 | 126809 |
| 65536 | 24912 | 25946 | 25287 | 23885 | 24526 | 24471 | 24990 | 24252 | 24670 | 24844 | 24325 | 23275 | 49347 |
| 131072 | 25185 | 24350 | 26047 | 25843 | 25686 | 25443 | 24746 | 24341 | 24716 | 25153 | 24143 | 23900 | 31094 |
| 262144 | 7483 | 8438 | 8289 | 8324 | 7870 | 8244 | 7769 | 8306 | 7954 | 7454 | 9749 | 9909 | 8738 |
| 524288 | 8070 | 6969 | 6999 | 7236 | 6929 | 7344 | 7081 | 6745 | 7618 | 6835 | 6868 | 7405 | 7706 |

Reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 410139 | 516114 | 516147 | 480905 | 456846 | | | | | | | | |
| 128 | 426582 | 405127 | 425281 | 382081 | 385543 | 327321 | | | | | | | |
| 256 | 382104 | 423183 | 418293 | 420399 | 389713 | 262578 | 183653 | | | | | | |
| 512 | 370733 | 398161 | 41843 | 444833 | 435004 | 241176 | 180410 | 162744 | | | | | |
| 1024 | 406195 | 462953 | 440626 | 441779 | 445213 | 234865 | 181399 | 148081 | 152290 | | | | |
| 2048 | 400475 | 445318 | 483716 | 495521 | 462724 | 243868 | 36482 | 148546 | 145745 | 149827 | | | |
| 4096 | 40907 | 452792 | 480523 | 475778 | 485020 | 238043 | 36188 | 155116 | 143936 | 133134 | 134768 | | |
| 8192 | 430049 | 479288 | 488198 | 40236 | 472106 | 37505 | 182555 | 151429 | 141470 | 35205 | 35377 | 141492 | |
| 16384 | 427344 | 457705 | 40993 | 493611 | 40137 | 37109 | 184193 | 35559 | 35429 | 35033 | 34697 | 35653 | 35811 |
| 32768 | 40741 | 40781 | 40609 | 40558 | 39998 | 37283 | 35778 | 35758 | 35517 | 35178 | 35428 | 35526 | 35724 |
| 65536 | 40543 | 40644 | 40699 | 40294 | 39911 | 37234 | 41041 | 34693 | 35101 | 35670 | 35039 | 35494 | 35488 |
| 131072 | 40281 | 40288 | 40340 | 40138 | 39342 | 36817 | 35494 | 34462 | 34786 | 34912 | 34816 | 34821 | 34832 |
| 262144 | 22311 | 22438 | 22562 | 21779 | 22210 | 22302 | 22609 | 22008 | 22618 | 22065 | 22432 | 21326 | 22079 |
| 524288 | 21983 | 22177 | 21651 | 21808 | 22031 | 21832 | 21348 | 21400 | 22417 | 22491 | 22125 | 22045 | 21700 |

Re-reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 810940 | 1017798 | 954024 | 820889 | 460268 | | | | | | | | |
| 128 | 500151 | 547091 | 515939 | 544481 | 369876 | 340326 | | | | | | | |
| 256 | 416286 | 531081 | 551660 | 462095 | 481189 | 245678 | 177170 | | | | | | |
| 512 | 401537 | 444860 | 447939 | 459186 | 474069 | 247714 | 178514 | 164208 | | | | | |
| 1024 | 411908 | 448717 | 474516 | 541489 | 456933 | 248120 | 191013 | 148275 | 152109 | | | | |
| 2048 | 445321 | 451493 | 471994 | 482004 | 510715 | 256576 | 179427 | 148794 | 145413 | 149706 | | | |
| 4096 | 428495 | 452992 | 495637 | 499334 | 500617 | 240402 | 183069 | 154752 | 143905 | 133890 | 134962 | | |
| 8192 | 441115 | 384582 | 495970 | 487157 | 480353 | 247246 | 182129 | 152315 | 141749 | 133253 | 134568 | 142064 | |
| 16384 | 438543 | 479963 | 489191 | 503363 | 492930 | 236483 | 185123 | 155816 | 139506 | 132729 | 134325 | 140661 | 142100 |
| 32768 | 430947 | 464175 | 490854 | 496515 | 494685 | 241354 | 179406 | 154911 | 141710 | 134039 | 137772 | 140216 | 136327 |
| 65536 | 428362 | 460224 | 482531 | 494678 | 491724 | 237890 | 184106 | 142164 | 133733 | 143352 | 133944 | 139892 | 140910 |
| 131072 | 420157 | 450233 | 470066 | 473770 | 476616 | 233635 | 181024 | 141810 | 136593 | 139103 | 136939 | 137010 | 137321 |
| 262144 | 410845 | 441397 | 458644 | 469649 | 470150 | 239524 | 180402 | 146433 | 134913 | 135909 | 135366 | 135489 | 135833 |
| 524288 | 22383 | 22018 | 21818 | 21878 | 21992 | 21861 | 21936 | 21349 | 21573 | 22188 | 21736 | 22047 | 21483 |

Random Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 546664 | 820893 | 696045 | 752075 | 467266 | | | | | | | | |
| 128 | 554293 | 568770 | 670016 | 558802 | 428250 | 251443 | | | | | | | |
| 256 | 494290 | 573946 | 610976 | 664925 | 516030 | 292944 | 178158 | | | | | | |
| 512 | 479830 | 508438 | 515038 | 549400 | 502499 | 242881 | 179705 | 161357 | | | | | |
| 1024 | 416944 | 458374 | 486237 | 499998 | 497306 | 234058 | 176184 | 150347 | 159476 | | | | |
| 2048 | 404111 | 447742 | 489587 | 489016 | 485999 | 258390 | 179053 | 147699 | 144479 | 149369 | | | |
| 4096 | 404825 | 453953 | 479291 | 493320 | 487326 | 238430 | 180543 | 152698 | 143765 | 134167 | 134812 | | |
| 8192 | 405362 | 455340 | 496966 | 494803 | 493375 | 249686 | 181099 | 151675 | 141105 | 133122 | 135067 | 142059 | |
| 16384 | 398782 | 446163 | 485452 | 498569 | 494357 | 238344 | 184587 | 155512 | 140323 | 133194 | 134407 | 141403 | 142553 |
| 32768 | 395748 | 448151 | 485379 | 496117 | 497555 | 242688 | 184604 | 155796 | 141808 | 131241 | 136579 | 140396 | 141765 |
| 65536 | 390364 | 440400 | 472645 | 491171 | 492847 | 239075 | 184255 | 142472 | 135829 | 141405 | 134374 | 140606 | 141814 |
| 131072 | 383525 | 431649 | 462679 | 472712 | 474589 | 235054 | 181297 | 141953 | 136933 | 139928 | 137322 | 137388 | 138130 |
| 262144 | 381324 | 422555 | 451429 | 468085 | 468848 | 237596 | 180572 | 146735 | 135195 | 136437 | 136085 | 135768 | 136084 |
| 524288 | 4940 | 11355 | 19243 | 29180 | 38101 | 43112 | 52339 | 53598 | 54597 | 67700 | 66818 | 60818 | 82646 |

Random Write Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 615667 | 718329 | 687884 | 752210 | 453900 | | | | | | | | |
| 128 | 621388 | 539917 | 727624 | 595513 | 455605 | 239716 | | | | | | | |
| 256 | 506032 | 601024 | 535655 | 748295 | 382698 | 299773 | 155631 | | | | | | |
| 512 | 363117 | 335718 | 387902 | 332492 | 312370 | 174264 | 168032 | 162741 | | | | | |
| 1024 | 234483 | 239310 | 244737 | 203622 | 192044 | 153019 | 143115 | 135075 | 147399 | | | | |
| 2048 | 200627 | 200727 | 192569 | 175642 | 154647 | 144032 | 135782 | 131450 | 136386 | 139517 | | | |
| 4096 | 180998 | 184198 | 168234 | 152482 | 142971 | 129796 | 132887 | 134803 | 134440 | 127672 | 126353 | | |
| 8192 | 177723 | 173595 | 165863 | 150221 | 137861 | 135069 | 128908 | 133891 | 133326 | 126062 | 128667 | 132190 | |
| 16384 | 173434 | 169350 | 160507 | 144703 | 136835 | 126310 | 122328 | 136645 | 132066 | 127101 | 127531 | 134207 | 133011 |
| 32768 | 169369 | 166237 | 158345 | 146549 | 135206 | 124803 | 129474 | 135746 | 133691 | 128028 | 129583 | 132524 | 134262 |
| 65536 | 170386 | 167083 | 163819 | 139330 | 128809 | 123757 | 129535 | 125230 | 128274 | 135274 | 125919 | 133495 | 133363 |
| 131072 | 10017 | 16275 | 22169 | 27111 | 30143 | 33280 | 35702 | 38056 | 39866 | 39613 | 39282 | 41090 | 29632 |
| 262144 | 3057 | 5030 | 7220 | 9302 | 10287 | 12907 | 14891 | 15922 | 16570 | 15707 | 14848 | 17581 | 14335 |
| 524288 | 1519 | 2150 | 3052 | 4039 | 4747 | 5973 | 7086 | 7514 | 8947 | 8986 | 9187 | 8981 | 8787 |

Backward Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 367789 | 421092 | 457397 | 426390 | 355409 | | | | | | | | |
| 128 | 354661 | 391418 | 447542 | 403880 | 372017 | 260706 | | | | | | | |
| 256 | 342726 | 361024 | 367235 | 385488 | 408218 | 244063 | 177027 | | | | | | |
| 512 | 368886 | 442934 | 425210 | 429856 | 489456 | 240934 | 178335 | 35759 | | | | | |
| 1024 | 366112 | 410427 | 427007 | 449118 | 429355 | 248359 | 192481 | 156383 | 35102 | | | | |
| 2048 | 380242 | 441750 | 453400 | 477395 | 488792 | 242709 | 180169 | 148404 | 144683 | 149140 | | | |
| 4096 | 397359 | 439055 | 466566 | 473523 | 483937 | 36436 | 181656 | 155446 | 35021 | 133707 | 34601 | | |
| 8192 | 17797 | 25907 | 469724 | 425602 | 36590 | 250519 | 35715 | 34803 | 141730 | 133129 | 35090 | 35552 | |
| 16384 | 17745 | 25941 | 32360 | 36331 | 36464 | 35803 | 35923 | 35114 | 35589 | 35748 | 35781 | 35098 | 35576 |
| 32768 | 17722 | 26012 | 31754 | 36218 | 36751 | 35819 | 35857 | 34883 | 35304 | 35528 | 34857 | 35170 | 35156 |
| 65536 | 17742 | 25912 | 32088 | 35852 | 36733 | 36312 | 35746 | 34873 | 35148 | 34865 | 35509 | 35159 | 35045 |
| 131072 | 17545 | 25862 | 31998 | 35912 | 36347 | 35626 | 35252 | 34581 | 34764 | 34819 | 34897 | 34683 | 34629 |
| 262144 | 3751 | 6771 | 10509 | 14939 | 16553 | 19068 | 22524 | 24101 | 25562 | 26891 | 27251 | 29218 | 29010 |
| 524288 | 1057 | 1918 | 3226 | 4957 | 6127 | 8302 | 10396 | 13661 | 15076 | 17260 | 19840 | 21030 | 22207 |

Record Rewrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 726930 | 659151 | 551630 | 480926 | 390079 | | | | | | | | |
| 128 | 847991 | 864598 | 771297 | 684510 | 522560 | 219966 | | | | | | | |
| 256 | 927317 | 1004223 | 917239 | 879624 | 737565 | 239002 | 155633 | | | | | | |
| 512 | 1005977 | 1118157 | 1040577 | 1051300 | 962389 | 267219 | 164630 | 140973 | | | | | |
| 1024 | 1031292 | 1192094 | 1102376 | 1135339 | 1088214 | 283895 | 160727 | 150654 | 139033 | | | | |
| 2048 | 1050241 | 1185871 | 1108788 | 1169665 | 1139057 | 326847 | 172317 | 136035 | 143478 | 132410 | | | |
| 4096 | 1065253 | 1211814 | 1122830 | 1198370 | 1207871 | 290579 | 181769 | 146568 | 130176 | 125505 | 124616 | | |
| 8192 | 1044754 | 1209320 | 1124496 | 1207027 | 1212924 | 279686 | 173765 | 139953 | 131170 | 139147 | 126758 | 129552 | |
| 16384 | 1068756 | 1223227 | 1141031 | 1219142 | 1240468 | 336932 | 179633 | 135265 | 136805 | 121238 | 128299 | 129122 | 126366 |
| 32768 | 1056417 | 1225292 | 1142335 | 1225884 | 1255334 | 303323 | 178614 | 136520 | 138696 | 137456 | 127890 | 130591 | 131510 |
| 65536 | 1034489 | 1208325 | 1139042 | 1204149 | 1266348 | 346487 | 172570 | 143883 | 137734 | 135673 | 133349 | 129601 | 130471 |
| 131072 | 1052296 | 1204662 | 1135432 | 1203743 | 1148152 | 248499 | 173606 | 139627 | 130567 | 128366 | 128746 | 128482 | 129132 |
| 262144 | 1051406 | 1207202 | 1122090 | 1218282 | 1235414 | 292721 | 171373 | 137063 | 129288 | 128387 | 129753 | 128901 | 129148 |
| 524288 | 1051954 | 1208816 | 1146102 | 1226132 | 1247574 | 320002 | 175793 | 142646 | 131340 | 133526 | 128978 | 130639 | 130490 |

Stride Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 942427 | 864365 | 781127 | 516394 | 300611 | | | | | | | | |
| 128 | 389010 | 1093096 | 907437 | 723302 | 376549 | 263353 | | | | | | | |
| 256 | 369999 | 398763 | 1196816 | 1028121 | 713273 | 273212 | 178386 | | | | | | |
| 512 | 367286 | 405381 | 428823 | 1255116 | 960638 | 323256 | 179274 | 167810 | | | | | |
| 1024 | 376465 | 414393 | 430788 | 442906 | 1241354 | 247160 | 190726 | 150433 | 150855 | | | | |
| 2048 | 403142 | 425244 | 483468 | 491256 | 468645 | 364930 | 186690 | 159168 | 144490 | 149085 | | | |
| 4096 | 385756 | 431928 | 465140 | 489656 | 489252 | 245489 | 184937 | 142316 | 136505 | 133904 | 134922 | | |
| 8192 | 404044 | 448505 | 473336 | 483848 | 484764 | 248573 | 181584 | 140770 | 139879 | 132872 | 135308 | 141563 | |
| 16384 | 403387 | 449836 | 485813 | 495268 | 494522 | 252468 | 184317 | 142085 | 142229 | 144784 | 143578 | 136637 | 142555 |
| 32768 | 402021 | 446734 | 485093 | 496064 | 495343 | 243188 | 184601 | 141845 | 135556 | 144514 | 134045 | 136361 | 134819 |
| 65536 | 400056 | 444800 | 476674 | 491646 | 493962 | 246609 | 183830 | 142293 | 135606 | 132760 | 140408 | 137244 | 134906 |
| 131072 | 389727 | 436377 | 453258 | 473187 | 480155 | 242922 | 181130 | 141904 | 134453 | 139963 | 138946 | 136007 | 136256 |
| 262144 | 384760 | 428439 | 455445 | 470432 | 473979 | 235486 | 180738 | 147225 | 138047 | 138592 | 137904 | 136653 | 134008 |
| 524288 | 4434 | 8748 | 9495 | 11747 | 15840 | 23528 | 28552 | 34427 | 39085 | 45085 | 49687 | 64457 | 73890 |

Fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 335209 | 390441 | 390475 | 421286 | 353603 | | | | | | | | |
| 128 | 348775 | 335881 | 335170 | 366702 | 340439 | 237065 | | | | | | | |
| 256 | 288576 | 300829 | 296950 | 274951 | 230856 | 212987 | 173690 | | | | | | |
| 512 | 205617 | 216942 | 219658 | 179519 | 145493 | 132779 | 134488 | 139280 | | | | | |
| 1024 | 171814 | 180920 | 171265 | 151456 | 129786 | 112144 | 104148 | 128787 | 142400 | | | | |
| 2048 | 165000 | 163136 | 158268 | 140590 | 118958 | 107778 | 88256 | 97352 | 125954 | 136998 | | | |
| 4096 | 158790 | 153396 | 148653 | 133807 | 114458 | 103762 | 88224 | 88754 | 99145 | 125829 | 124373 | | |
| 8192 | 156521 | 152018 | 145201 | 131244 | 109168 | 101220 | 82757 | 81631 | 88520 | 100482 | 123804 | 127210 | |
| 16384 | 153854 | 150061 | 145742 | 131095 | 105418 | 99959 | 82067 | 81580 | 84347 | 87330 | 98168 | 124966 | 128250 |
| 32768 | 153108 | 149945 | 146140 | 129089 | 110306 | 99799 | 81608 | 80451 | 81168 | 82599 | 88553 | 97221 | 124542 |
| 65536 | 22804 | 23491 | 78228 | 23020 | 22077 | 21962 | 20017 | 20061 | 19705 | 19808 | 54023 | 56493 | 98017 |
| 131072 | 23996 | 24095 | 22402 | 23154 | 22108 | 21606 | 20788 | 21165 | 20983 | 21118 | 20526 | 20993 | 31083 |
| 262144 | 23855 | 24026 | 23858 | 23513 | 22947 | 22183 | 21030 | 21006 | 20847 | 20167 | 20204 | 20234 | 23336 |
| 524288 | 21635 | 21414 | 21310 | 21170 | 20722 | 20212 | 18820 | 19251 | 18240 | 18486 | 18385 | 20029 | 21043 |

Re-fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 400288 | 454005 | 453711 | 447477 | 381097 | | | | | | | | |
| 128 | 335141 | 324041 | 384380 | 323992 | 371055 | 248978 | | | | | | | |
| 256 | 280710 | 277678 | 319618 | 272340 | 228969 | 230014 | 179403 | | | | | | |
| 512 | 202698 | 210187 | 218329 | 176730 | 147124 | 145953 | 140541 | 141361 | | | | | |
| 1024 | 177377 | 175583 | 172682 | 149797 | 130179 | 118547 | 106755 | 125521 | 144492 | | | | |
| 2048 | 170410 | 165642 | 159661 | 141986 | 117843 | 110769 | 90719 | 99114 | 129138 | 138923 | | | |
| 4096 | 165174 | 157205 | 147539 | 131670 | 115308 | 105586 | 89516 | 88617 | 99822 | 124695 | 127086 | | |
| 8192 | 163310 | 155298 | 148707 | 133989 | 111002 | 103004 | 83121 | 82421 | 89519 | 103280 | 129152 | 129445 | |
| 16384 | 161588 | 155652 | 149483 | 132414 | 111282 | 100024 | 82310 | 82275 | 84135 | 87615 | 97946 | 125306 | 127800 |
| 32768 | 153471 | 150088 | 145488 | 130800 | 109640 | 100173 | 81794 | 80358 | 81630 | 81334 | 89478 | 97753 | 128821 |
| 65536 | 25614 | 25305 | 25398 | 24680 | 24280 | 23357 | 22624 | 21433 | 22016 | 21544 | 22251 | 42598 | 99809 |
| 131072 | 25950 | 25878 | 26013 | 25415 | 24614 | 23455 | 22220 | 22513 | 22429 | 22980 | 21849 | 22139 | 34541 |
| 262144 | 7531 | 8360 | 7799 | 8279 | 7618 | 7881 | 7984 | 7874 | 7946 | 7486 | 7483 | 7507 | 8676 |
| 524288 | 7042 | 7841 | 7476 | 7133 | 7138 | 6813 | 7234 | 7045 | 6699 | 6602 | 7330 | 7304 | 7456 |

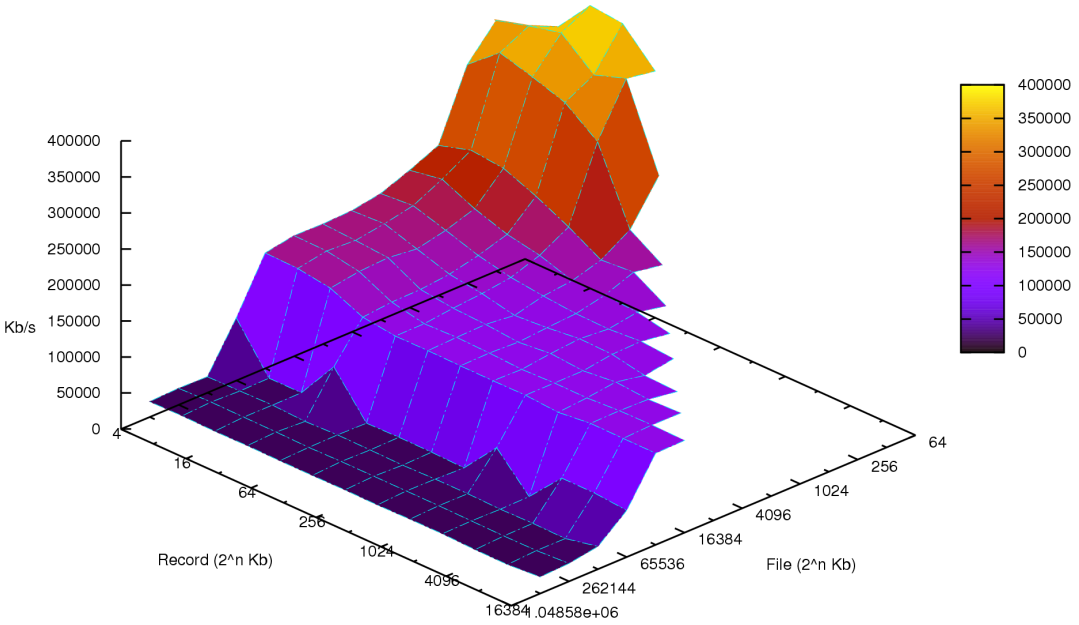
Fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 392638 | 426727 | 421112 | 385303 | 372156 | | | | | | | | |
| 128 | 362511 | 383237 | 379875 | 411675 | 398758 | 313719 | | | | | | | |
| 256 | 331195 | 344124 | 449111 | 391390 | 398762 | 255497 | 198444 | | | | | | |
| 512 | 364387 | 416910 | 425953 | 432441 | 440595 | 239596 | 182007 | 151388 | | | | | |
| 1024 | 378973 | 429156 | 422249 | 443120 | 435730 | 37466 | 191653 | 153568 | 156503 | | | | |
| 2048 | 395757 | 428902 | 40264 | 487507 | 450706 | 243054 | 186063 | 158539 | 140978 | 148675 | | | |
| 4096 | 403066 | 40609 | 468539 | 478007 | 469135 | 244305 | 182109 | 155428 | 142732 | 35435 | 34852 | | |
| 8192 | 427088 | 452445 | 40570 | 482194 | 39869 | 245622 | 181087 | 34425 | 35266 | 34910 | 140681 | 35112 | |
| 16384 | 40477 | 40478 | 40513 | 40233 | 486809 | 37290 | 36251 | 34932 | 35682 | 35766 | 35121 | 35164 | 35592 |
| 32768 | 40309 | 40630 | 40618 | 40504 | 39794 | 37280 | 36180 | 35782 | 35134 | 34978 | 35100 | 35454 | 35094 |
| 65536 | 40476 | 40454 | 40588 | 40284 | 39514 | 37581 | 35921 | 35371 | 35306 | 34717 | 35460 | 35374 | 34937 |
| 131072 | 39983 | 40124 | 40040 | 39667 | 39307 | 37045 | 35468 | 34399 | 34570 | 34875 | 34765 | 34650 | 34808 |
| 262144 | 22038 | 22288 | 22354 | 22453 | 21751 | 22286 | 22558 | 22377 | 22021 | 22990 | 22080 | 23051 | 21947 |
| 524288 | 21824 | 21908 | 21406 | 22044 | 21922 | 21756 | 22030 | 21767 | 21362 | 21476 | 21388 | 21794 | 21323 |

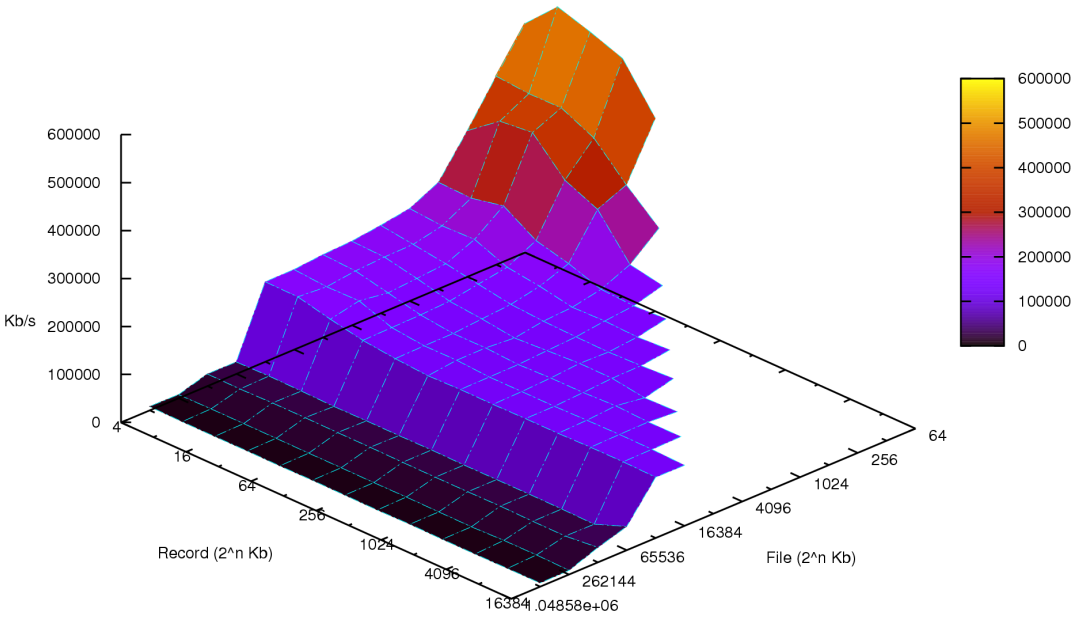
Re-fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 770362 | 927213 | 727740 | 586906 | 444800 | | | | | | | | |
| 128 | 503983 | 494370 | 467171 | 508014 | 409071 | 276450 | | | | | | | |
| 256 | 407014 | 458793 | 520442 | 516202 | 446028 | 243104 | 182197 | | | | | | |
| 512 | 392914 | 472370 | 451079 | 472316 | 465913 | 244041 | 193934 | 165587 | | | | | |
| 1024 | 434991 | 434286 | 467805 | 488568 | 483024 | 227359 | 177099 | 161008 | 148512 | | | | |
| 2048 | 436210 | 460730 | 452396 | 476717 | 477273 | 253338 | 184055 | 158636 | 140890 | 149367 | | | |
| 4096 | 426047 | 447507 | 480355 | 486055 | 494922 | 250566 | 183487 | 155895 | 143271 | 145104 | 134246 | | |
| 8192 | 432092 | 479539 | 474817 | 492040 | 483677 | 246161 | 181644 | 140750 | 135844 | 133387 | 141129 | 136790 | |
| 16384 | 421257 | 458241 | 486346 | 498827 | 504262 | 236295 | 183294 | 133941 | 141935 | 144249 | 133974 | 136137 | 142000 |
| 32768 | 421214 | 456144 | 489278 | 495823 | 492337 | 241134 | 183284 | 155277 | 135302 | 132218 | 133792 | 137073 | 134703 |
| 65536 | 418543 | 454486 | 478938 | 491897 | 490817 | 249726 | 183282 | 153930 | 141102 | 132621 | 141796 | 139654 | 134980 |
| 131072 | 410497 | 443573 | 466800 | 472953 | 474752 | 240895 | 180734 | 141553 | 134344 | 139482 | 136322 | 134349 | 137772 |
| 262144 | 397044 | 435565 | 456209 | 468139 | 470216 | 236824 | 179915 | 143939 | 135860 | 134992 | 135228 | 134579 | 136345 |
| 524288 | 22237 | 21605 | 21818 | 22215 | 21962 | 22012 | 21758 | 21677 | 21877 | 21829 | 22161 | 21941 | 21166 |

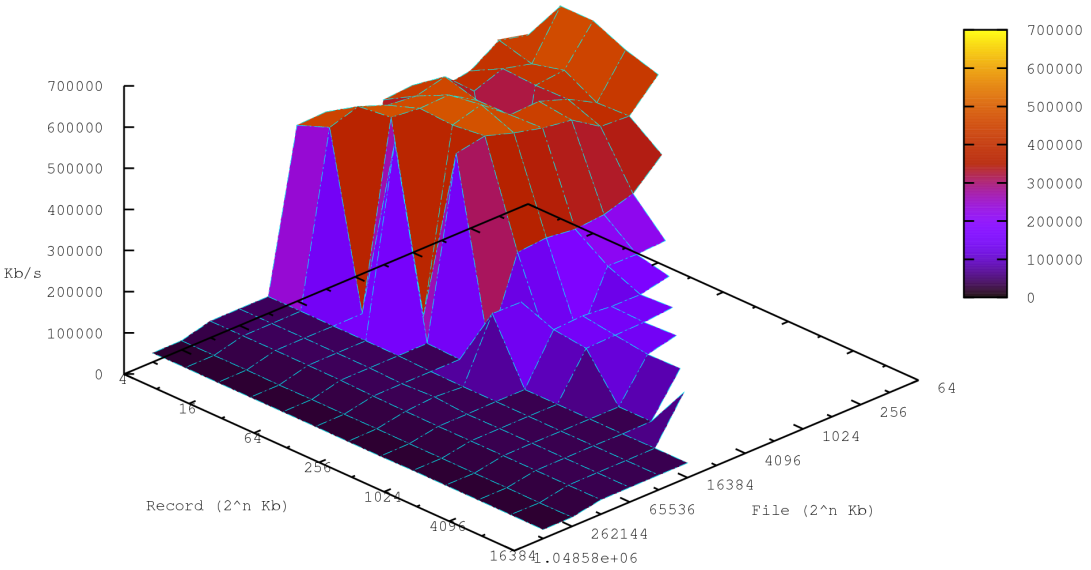
NFS Write



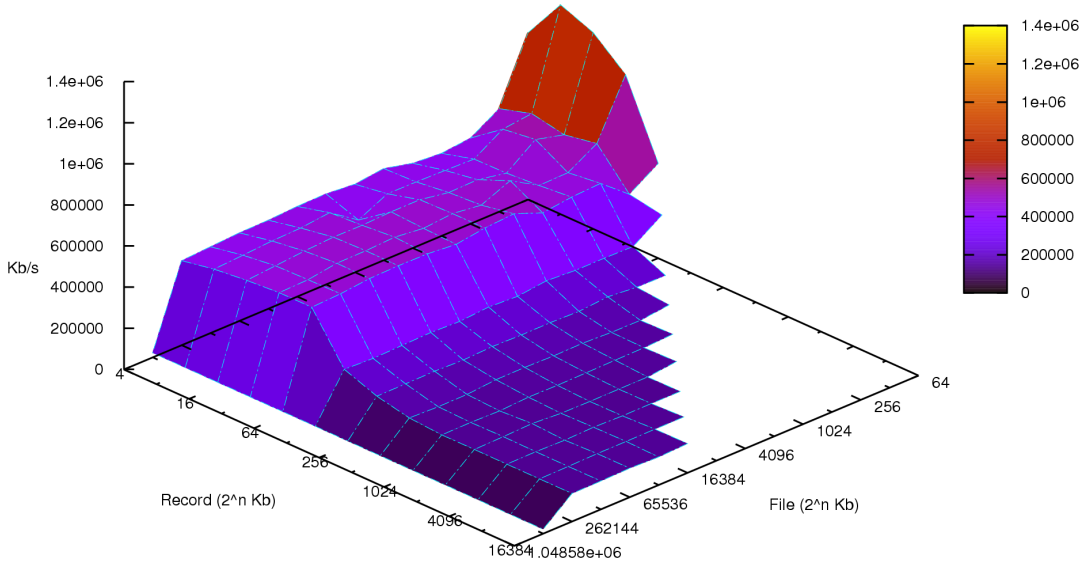

NFS Re-Write



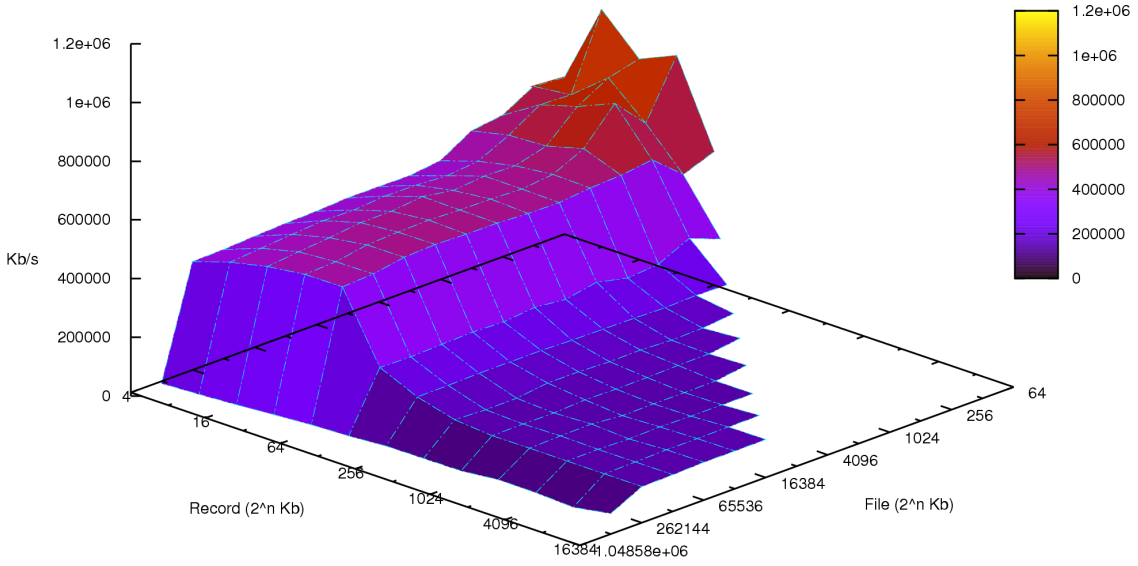
NFS Read



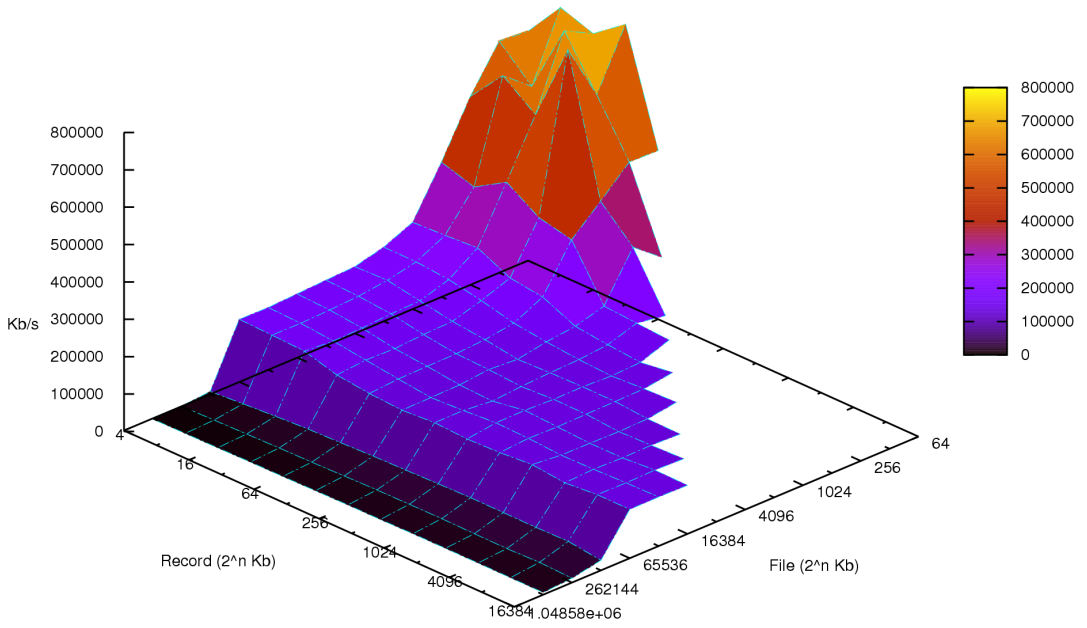

NFS Re-Read



NFS Random Read




NFS Random Write



# Appendix C: DASD Iozone Results

The top row is records sizes, the left column is file sizes

Writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 104573 | 136148 | 140997 | 139706 | 128794 | | | | | | | | |
| 128 | 121913 | 138545 | 144152 | 141741 | 124988 | 105429 | | | | | | | |
| 256 | 108199 | 127051 | 127751 | 116252 | 112819 | 99806 | 82023 | | | | | | |
| 512 | 96784 | 106911 | 106158 | 103685 | 96241 | 87944 | 84156 | 77529 | | | | | |
| 1024 | 92812 | 97998 | 97126 | 93235 | 87126 | 83252 | 81606 | 82288 | 74700 | | | | |
| 2048 | 90471 | 93541 | 94057 | 89140 | 83851 | 80814 | 80411 | 81554 | 82302 | 78007 | | | |
| 4096 | 89305 | 91553 | 91653 | 86748 | 80260 | 78013 | 78469 | 77670 | 72417 | 78953 | 77439 | | |
| 8192 | 87801 | 90897 | 89747 | 85282 | 78933 | 77165 | 77398 | 78429 | 77810 | 77933 | 77827 | 78101 | |
| 16384 | 87528 | 90104 | 88798 | 84479 | 78106 | 76580 | 77341 | 77074 | 78007 | 77765 | 77684 | 77546 | 77391 |
| 32768 | 71765 | 84936 | 81272 | 78899 | 71707 | 72152 | 72326 | 72774 | 72900 | 72965 | 72908 | 72900 | 72801 |
| 65536 | 77253 | 79722 | 78383 | 73984 | 67628 | 66598 | 67060 | 68150 | 67885 | 68368 | 68248 | 67884 | 67757 |
| 131072 | 76854 | 78837 | 77180 | 72489 | 66745 | 66287 | 66461 | 66470 | 66223 | 66528 | 66252 | 67005 | 66940 |
| 262144 | 43327 | 45091 | 44224 | 44910 | 45627 | 43964 | 44605 | 45236 | 44494 | 44397 | 44461 | 44710 | 44217 |
| 524288 | 35196 | 37232 | 36535 | 36369 | 35723 | 36280 | 35870 | 36510 | 36022 | 36219 | 36541 | 35951 | 36521 |

Re-writer Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 277194 | 321624 | 344306 | 349701 | 283274 | | | | | | | | |
| 128 | 280699 | 304002 | 320760 | 316069 | 250990 | 207082 | | | | | | | |
| 256 | 239683 | 246847 | 247324 | 229412 | 207448 | 170449 | 141042 | | | | | | |
| 512 | 180212 | 181241 | 171805 | 162693 | 146623 | 130748 | 124002 | 128450 | | | | | |
| 1024 | 156765 | 154544 | 146979 | 137948 | 124545 | 118503 | 115430 | 116415 | 111134 | | | | |
| 2048 | 146485 | 143690 | 140245 | 128918 | 117965 | 112620 | 111249 | 114031 | 115322 | 112534 | | | |
| 4096 | 144235 | 140466 | 136007 | 124359 | 111084 | 106736 | 107721 | 106317 | 105985 | 108979 | 108271 | | |
| 8192 | 141695 | 140700 | 134213 | 122947 | 110239 | 106712 | 107058 | 108657 | 107643 | 108421 | 107704 | 109707 | |
| 16384 | 141914 | 140219 | 133796 | 122130 | 109460 | 106230 | 107100 | 106419 | 108596 | 107844 | 107509 | 107161 | 108156 |
| 32768 | 129283 | 127845 | 121193 | 111480 | 100803 | 97968 | 98114 | 98877 | 99020 | 99002 | 99077 | 99316 | 98935 |
| 65536 | 117776 | 118931 | 113913 | 103403 | 93638 | 90646 | 90774 | 91627 | 91957 | 91864 | 90155 | 91932 | 90354 |
| 131072 | 120377 | 118806 | 113065 | 102307 | 91632 | 90001 | 90349 | 90316 | 90374 | 90621 | 89460 | 90340 | 91484 |
| 262144 | 46757 | 45886 | 47023 | 46089 | 45410 | 47268 | 47341 | 46692 | 46299 | 45829 | 45648 | 45213 | 45350 |
| 524288 | 33396 | 34586 | 34488 | 35340 | 33160 | 34028 | 35606 | 35198 | 34235 | 35194 | 34980 | 34821 | 34251 |

Reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 508303 | 571270 | 581614 | 615109 | 528966 | | | | | | | | |
| 128 | 460286 | 477530 | 475997 | 468726 | 380826 | 282559 | | | | | | | |
| 256 | 345055 | 371553 | 386750 | 394383 | 378115 | 231864 | 169421 | | | | | | |
| 512 | 325717 | 343404 | 367305 | 384390 | 365686 | 242303 | 159456 | 148109 | | | | | |
| 1024 | 335396 | 362345 | 372221 | 385411 | 362611 | 224315 | 160175 | 135828 | 123879 | | | | |
| 2048 | 344034 | 365254 | 381942 | 394983 | 369879 | 223314 | 160174 | 134967 | 129784 | 126350 | | | |
| 4096 | 352856 | 372977 | 391403 | 399572 | 383702 | 226912 | 156025 | 126030 | 117573 | 121744 | 121043 | | |
| 8192 | 360245 | 381468 | 399883 | 411390 | 394300 | 232015 | 156694 | 130474 | 120087 | 121002 | 119844 | 122664 | |
| 16384 | 363507 | 385860 | 404913 | 414083 | 403089 | 233686 | 156966 | 127226 | 121929 | 120285 | 119961 | 119712 | 120632 |
| 32768 | 365314 | 386985 | 405921 | 417113 | 404323 | 237978 | 156073 | 128390 | 120362 | 119606 | 119522 | 119541 | 119396 |
| 65536 | 365947 | 388090 | 407033 | 418015 | 408214 | 238997 | 153125 | 127945 | 120003 | 119480 | 119228 | 117945 | 119693 |
| 131072 | 330213 | 388867 | 407558 | 418139 | 409925 | 228558 | 148961 | 124394 | 116489 | 116101 | 115942 | 116301 | 119923 |
| 262144 | 23116 | 22924 | 23263 | 22975 | 22711 | 23349 | 23366 | 23402 | 22780 | 22851 | 23387 | 23375 | 23436 |
| 524288 | 23112 | 23259 | 23380 | 23047 | 23311 | 23302 | 23371 | 23209 | 22587 | 22679 | 23261 | 23349 | 23415 |

Re-reader Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 1001818 | 913427 | 942371 | 1000094 | 843406 | | | | | | | | |
| 128 | 692099 | 757832 | 719165 | 752433 | 535326 | 401373 | | | | | | | |
| 256 | 476686 | 454621 | 462171 | 483076 | 438430 | 254704 | 152648 | | | | | | |
| 512 | 369130 | 391764 | 417245 | 428126 | 415285 | 236822 | 154868 | 148143 | | | | | |
| 1024 | 370486 | 385702 | 411560 | 416246 | 378404 | 229230 | 158511 | 136153 | 123926 | | | | |
| 2048 | 368418 | 381159 | 401734 | 419151 | 388326 | 227883 | 159675 | 135004 | 129826 | 126015 | | | |
| 4096 | 367683 | 390057 | 408664 | 417956 | 397012 | 232252 | 155392 | 126166 | 117653 | 121079 | 121223 | | |
| 8192 | 368163 | 388705 | 408010 | 418923 | 402437 | 226963 | 156526 | 130387 | 120066 | 120256 | 119785 | 122539 | |
| 16384 | 362238 | 384230 | 399775 | 418590 | 401204 | 232829 | 157156 | 127236 | 121820 | 120240 | 119991 | 119759 | 120675 |
| 32768 | 328201 | 386173 | 405323 | 368776 | 402817 | 236932 | 156008 | 128399 | 120314 | 119642 | 119640 | 115391 | 119487 |
| 65536 | 366913 | 387649 | 407005 | 417708 | 385796 | 230531 | 156506 | 127941 | 120090 | 119511 | 119302 | 119732 | 119630 |
| 131072 | 367297 | 388619 | 407470 | 418552 | 409538 | 242210 | 156164 | 128208 | 118886 | 119330 | 118249 | 119530 | 119991 |
| 262144 | 23270 | 23435 | 23383 | 23453 | 23436 | 23366 | 23110 | 23525 | 23492 | 23429 | 23457 | 23410 | 23471 |
| 524288 | 22986 | 22929 | 23277 | 23081 | 22724 | 23013 | 22855 | 23243 | 23531 | 23568 | 23133 | 22818 | 22972 |

Random Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 551203 | 779779 | 799384 | 865612 | 666471 | | | | | | | | |
| 128 | 691661 | 726944 | 757835 | 563845 | 627675 | 304828 | | | | | | | |
| 256 | 445984 | 494155 | 501059 | 557734 | 452318 | 274404 | 154122 | | | | | | |
| 512 | 419003 | 455876 | 444875 | 465008 | 431361 | 222612 | 151839 | 144431 | | | | | |
| 1024 | 365712 | 403796 | 423478 | 441554 | 416431 | 231098 | 156075 | 130478 | 123211 | | | | |
| 2048 | 350625 | 386626 | 412240 | 423314 | 379956 | 227963 | 158184 | 134075 | 127103 | 126147 | | | |
| 4096 | 343505 | 377058 | 398950 | 419969 | 399104 | 228788 | 154641 | 125686 | 117684 | 122756 | 121179 | | |
| 8192 | 339719 | 360816 | 400019 | 415691 | 393050 | 225228 | 155774 | 129599 | 119083 | 121239 | 118094 | 122631 | |
| 16384 | 336668 | 372135 | 396726 | 414094 | 396466 | 231883 | 156136 | 126468 | 121366 | 119867 | 119890 | 119204 | 120431 |
| 32768 | 334767 | 369279 | 395576 | 410878 | 397033 | 233711 | 155613 | 128152 | 120219 | 119610 | 119500 | 119649 | 119529 |
| 65536 | 332502 | 366893 | 395636 | 410685 | 399558 | 235650 | 156006 | 127574 | 120000 | 119420 | 119223 | 119772 | 119594 |
| 131072 | 332389 | 367206 | 394554 | 400152 | 398746 | 237667 | 155714 | 127761 | 119802 | 119201 | 119173 | 119624 | 119989 |
| 262144 | 3880 | 7849 | 14522 | 26303 | 38881 | 48695 | 45793 | 44464 | 51018 | 54835 | 48864 | 74668 | 47930 |
| 524288 | 929 | 1837 | 3566 | 6639 | 11402 | 17378 | 16089 | 17761 | 22765 | 27261 | 31388 | 33791 | 29066 |

Random Write Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 303290 | 451067 | 463417 | 516438 | 415363 | | | | | | | | |
| 128 | 393820 | 379934 | 512176 | 509832 | 502005 | 250925 | | | | | | | |
| 256 | 370482 | 404353 | 420417 | 481110 | 304734 | 250027 | 133956 | | | | | | |
| 512 | 255868 | 264178 | 273343 | 258190 | 235950 | 146118 | 134917 | 125825 | | | | | |
| 1024 | 180469 | 193536 | 188653 | 172189 | 151299 | 130364 | 118025 | 116921 | 112010 | | | | |
| 2048 | 156972 | 157380 | 158403 | 146045 | 126232 | 103023 | 112899 | 114894 | 115368 | 114420 | | | |
| 4096 | 147402 | 147158 | 144914 | 133751 | 117410 | 111370 | 110885 | 108228 | 108036 | 112540 | 108532 | | |
| 8192 | 141913 | 141419 | 135867 | 128074 | 113233 | 108442 | 108583 | 109918 | 108739 | 96950 | 108123 | 109663 | |
| 16384 | 138093 | 138719 | 133904 | 124192 | 111301 | 107584 | 108241 | 107649 | 109563 | 109598 | 108861 | 108738 | 108090 |
| 32768 | 136544 | 137709 | 132715 | 121926 | 109716 | 106822 | 107212 | 108263 | 108673 | 108467 | 109095 | 108421 | 108877 |
| 65536 | 128407 | 128417 | 122597 | 112698 | 100733 | 97223 | 96762 | 97252 | 96141 | 94994 | 96991 | 94005 | 94626 |
| 131072 | 126090 | 126855 | 123731 | 113142 | 100265 | 96782 | 95745 | 93761 | 93024 | 91505 | 92329 | 91242 | 91867 |
| 262144 | 1867 | 5978 | 11210 | 13294 | 18462 | 24106 | 45079 | 58662 | 59146 | 61744 | 73814 | 66776 | 56122 |
| 524288 | 1384 | 2775 | 5421 | 7731 | 12675 | 18108 | 25354 | 28807 | 24931 | 29760 | 30544 | 34359 | 30462 |

Backward Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 466971 | 576551 | 566953 | 597834 | 484500 | | | | | | | | |
| 128 | 479483 | 496212 | 484897 | 486675 | 354684 | 273544 | | | | | | | |
| 256 | 334660 | 365654 | 374833 | 412266 | 357555 | 237501 | 157637 | | | | | | |
| 512 | 317018 | 335951 | 361609 | 384082 | 361312 | 227259 | 160398 | 147000 | | | | | |
| 1024 | 315267 | 346887 | 373178 | 394301 | 351761 | 227961 | 158315 | 135379 | 123417 | | | | |
| 2048 | 327622 | 354078 | 378348 | 393843 | 372290 | 222054 | 159786 | 134382 | 129916 | 125705 | | | |
| 4096 | 329446 | 362025 | 387111 | 401447 | 373553 | 226423 | 154992 | 126007 | 117738 | 121730 | 121162 | | |
| 8192 | 341904 | 370110 | 392129 | 406754 | 394264 | 232793 | 155939 | 130118 | 119999 | 120802 | 119832 | 122603 | |
| 16384 | 347132 | 374302 | 397391 | 409978 | 401225 | 234023 | 156736 | 127187 | 121212 | 120160 | 119780 | 119767 | 120676 |
| 32768 | 349078 | 375335 | 399195 | 412778 | 400895 | 238847 | 155706 | 128328 | 120325 | 119539 | 119504 | 119526 | 119506 |
| 65536 | 339541 | 377343 | 400910 | 414593 | 405989 | 240880 | 156270 | 125694 | 120081 | 119467 | 119255 | 119792 | 119649 |
| 131072 | 349596 | 378081 | 392032 | 415258 | 397268 | 241537 | 152193 | 125605 | 119734 | 119248 | 119111 | 119530 | 118206 |
| 262144 | 13100 | 16545 | 20933 | 31634 | 36869 | 46582 | 45137 | 42955 | 47255 | 56656 | 50029 | 59236 | 53575 |
| 524288 | 5684 | 6217 | 6978 | 10406 | 10885 | 11791 | 17267 | 16884 | 18762 | 21642 | 24117 | 24844 | 25478 |

Record Rewrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 333240 | 392658 | 307798 | 201250 | 131944 | | | | | | | | |
| 128 | 484653 | 473998 | 416890 | 344021 | 206121 | 107296 | | | | | | | |
| 256 | 543396 | 539993 | 503960 | 453138 | 340913 | 148584 | 91624 | | | | | | |
| 512 | 547034 | 601013 | 569561 | 532759 | 431004 | 193281 | 109120 | 84293 | | | | | |
| 1024 | 591185 | 625170 | 605875 | 621738 | 555615 | 221263 | 125520 | 99042 | 79937 | | | | |
| 2048 | 590217 | 637205 | 620793 | 656223 | 408530 | 231413 | 132308 | 110338 | 94213 | 81240 | | | |
| 4096 | 610429 | 646878 | 629174 | 668516 | 653676 | 257837 | 133398 | 112068 | 103085 | 92015 | 78843 | | |
| 8192 | 609609 | 647125 | 636271 | 664714 | 617332 | 267800 | 136537 | 111903 | 108119 | 102007 | 91126 | 77017 | |
| 16384 | 604176 | 642784 | 640599 | 681899 | 566822 | 280682 | 138909 | 114128 | 108710 | 105795 | 100701 | 91419 | 78084 |
| 32768 | 612017 | 652488 | 640837 | 685724 | 694091 | 303694 | 136784 | 115516 | 108737 | 107294 | 104570 | 99811 | 90822 |
| 65536 | 611993 | 644227 | 589352 | 688750 | 432281 | 287645 | 140263 | 116087 | 110178 | 107587 | 107107 | 103197 | 99152 |
| 131072 | 613411 | 646018 | 635894 | 682588 | 618550 | 280113 | 140290 | 115657 | 109812 | 109120 | 108582 | 107301 | 104155 |
| 262144 | 613318 | 642275 | 642587 | 681422 | 679154 | 267376 | 134793 | 117215 | 109515 | 110286 | 108958 | 108786 | 106581 |
| 524288 | 611616 | 646365 | 640205 | 687082 | 685337 | 286940 | 139071 | 114544 | 109436 | 109607 | 109186 | 109114 | 108195 |

Stride Read Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 718486 | 726939 | 616023 | 547518 | 298962 | | | | | | | | |
| 128 | 329979 | 841774 | 753077 | 681176 | 449270 | 239753 | | | | | | | |
| 256 | 308070 | 337250 | 839152 | 807379 | 675384 | 270894 | 164103 | | | | | | |
| 512 | 308977 | 335756 | 365437 | 927412 | 831096 | 314698 | 157246 | 146200 | | | | | |
| 1024 | 313239 | 351156 | 376758 | 390676 | 960668 | 334980 | 159081 | 131567 | 123107 | | | | |
| 2048 | 324661 | 356677 | 380946 | 394447 | 368010 | 351108 | 160212 | 129121 | 127062 | 126138 | | | |
| 4096 | 335435 | 370246 | 384778 | 399339 | 375948 | 224487 | 153926 | 128675 | 118121 | 122697 | 121140 | | |
| 8192 | 335916 | 370563 | 396554 | 410975 | 384654 | 228112 | 156342 | 128238 | 120456 | 119945 | 118055 | 122548 | |
| 16384 | 338078 | 372396 | 395500 | 412061 | 393893 | 234362 | 156760 | 126310 | 119827 | 119939 | 118167 | 119142 | 120475 |
| 32768 | 338911 | 372740 | 398090 | 411994 | 394895 | 238068 | 155629 | 123804 | 120268 | 119723 | 118773 | 119269 | 119369 |
| 65536 | 340583 | 372689 | 398036 | 412106 | 402402 | 238474 | 152944 | 127701 | 120091 | 119423 | 119303 | 119978 | 119533 |
| 131072 | 339628 | 372712 | 398517 | 412849 | 403652 | 240019 | 154321 | 128058 | 119726 | 119266 | 118269 | 119405 | 119910 |
| 262144 | 3102 | 3829 | 4907 | 9910 | 19398 | 31912 | 30182 | 31405 | 32720 | 36793 | 42801 | 39915 | 118213 |
| 524288 | 2155 | 2165 | 2179 | 4359 | 8613 | 16254 | 16370 | 17019 | 17853 | 22446 | 25238 | 25286 | 26383 |

Fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 121002 | 147829 | 172086 | 213327 | 133605 | | | | | | | | |
| 128 | 128270 | 138384 | 150066 | 159221 | 164328 | 107748 | | | | | | | |
| 256 | 113878 | 120301 | 122665 | 122083 | 111063 | 132780 | 88429 | | | | | | |
| 512 | 97005 | 101586 | 102854 | 97280 | 86588 | 87236 | 94745 | 84684 | | | | | |
| 1024 | 89942 | 93286 | 94126 | 88314 | 77097 | 73121 | 70209 | 91436 | 81328 | | | | |
| 2048 | 86724 | 89444 | 89218 | 84286 | 72583 | 68212 | 61675 | 69423 | 90916 | 80661 | | | |
| 4096 | 85631 | 88032 | 87148 | 81297 | 70395 | 65026 | 58761 | 61981 | 69463 | 89622 | 80142 | | |
| 8192 | 84127 | 86081 | 85564 | 79717 | 68836 | 63739 | 56987 | 57911 | 61802 | 69149 | 89089 | 77874 | |
| 16384 | 83147 | 85970 | 85099 | 79033 | 68053 | 62879 | 56156 | 56280 | 57518 | 60872 | 67987 | 88991 | 77354 |
| 32768 | 78397 | 80638 | 79761 | 74106 | 63727 | 59205 | 52698 | 52512 | 53291 | 55513 | 58436 | 67373 | 89064 |
| 65536 | 73315 | 76133 | 74826 | 68347 | 58481 | 54173 | 48915 | 48780 | 48554 | 49847 | 51522 | 54965 | 61347 |
| 131072 | 72972 | 74844 | 73793 | 67808 | 57750 | 53433 | 47650 | 47221 | 47390 | 47593 | 48487 | 49826 | 52633 |
| 262144 | 45153 | 45289 | 45726 | 43667 | 43399 | 43247 | 46298 | 43714 | 45897 | 46225 | 46823 | 46910 | 48037 |
| 524288 | 36289 | 35441 | 36200 | 36695 | 36327 | 35837 | 34681 | 35775 | 36565 | 35858 | 36022 | 36656 | 36714 |

Re-fwrite Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 271082 | 309312 | 346140 | 400167 | 289519 | | | | | | | | |
| 128 | 258527 | 280025 | 295677 | 312116 | 259098 | 213346 | | | | | | | |
| 256 | 218260 | 221275 | 222798 | 222590 | 181553 | 192617 | 141436 | | | | | | |
| 512 | 164098 | 164202 | 164731 | 147171 | 123757 | 117567 | 120301 | 122723 | | | | | |
| 1024 | 144305 | 142104 | 141028 | 127345 | 106059 | 97366 | 87387 | 109564 | 114284 | | | | |
| 2048 | 135244 | 132145 | 129187 | 119703 | 99171 | 89440 | 76395 | 86071 | 113286 | 112700 | | | |
| 4096 | 132947 | 129896 | 125682 | 114917 | 92825 | 85076 | 72764 | 75993 | 84326 | 106550 | 111295 | | |
| 8192 | 131263 | 128015 | 124405 | 113436 | 94157 | 83912 | 71166 | 71631 | 76735 | 84845 | 105469 | 107611 | |
| 16384 | 131002 | 128560 | 124791 | 112856 | 93264 | 82938 | 70195 | 69595 | 66836 | 75114 | 83484 | 107800 | 107661 |
| 32768 | 119786 | 117475 | 113684 | 103452 | 85870 | 77328 | 65212 | 64590 | 65380 | 68281 | 70428 | 80268 | 105386 |
| 65536 | 111594 | 110087 | 106857 | 95617 | 79308 | 70874 | 60306 | 59049 | 59776 | 60726 | 62576 | 66335 | 74887 |
| 131072 | 111117 | 109346 | 104271 | 94931 | 77379 | 69073 | 58937 | 57997 | 58032 | 58464 | 59474 | 61092 | 64114 |
| 262144 | 44922 | 45205 | 46007 | 46836 | 47928 | 46880 | 43439 | 46749 | 46155 | 46471 | 47901 | 48102 | 47483 |
| 524288 | 32784 | 35783 | 35507 | 33007 | 32597 | 33777 | 35637 | 35060 | 32989 | 33690 | 32312 | 34054 | 34369 |

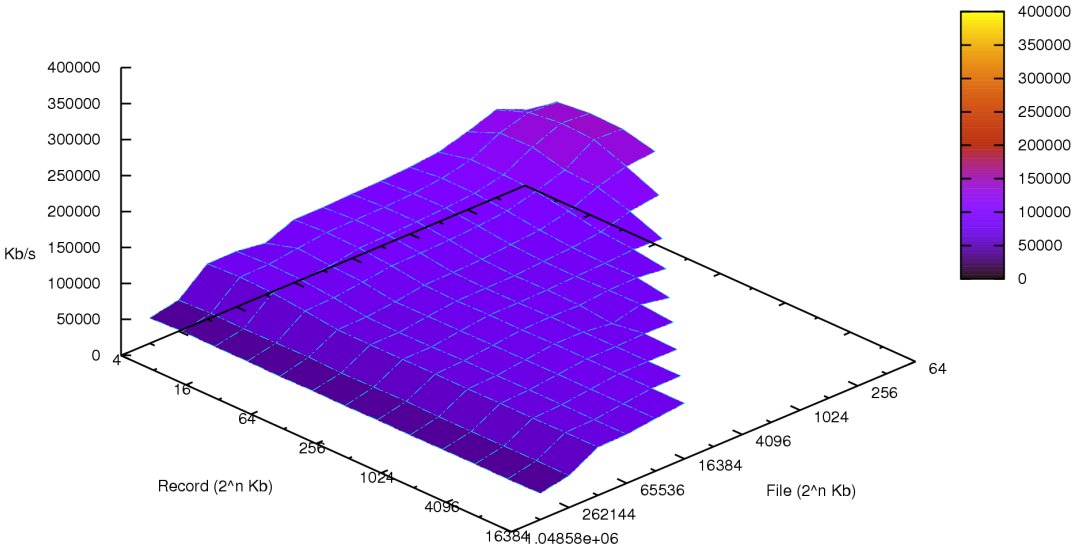
Fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 426676 | 551297 | 441437 | 423872 | 441443 | | | | | | | | |
| 128 | 426544 | 435528 | 393883 | 377591 | 262775 | 250925 | | | | | | | |
| 256 | 329862 | 347320 | 359500 | 355076 | 329089 | 219365 | 166549 | | | | | | |
| 512 | 314876 | 332877 | 347830 | 368848 | 341784 | 221060 | 165476 | 140083 | | | | | |
| 1024 | 327779 | 355557 | 367167 | 377033 | 355173 | 226143 | 157779 | 136878 | 128482 | | | | |
| 2048 | 336012 | 357477 | 378766 | 389496 | 358480 | 221742 | 158341 | 126294 | 123210 | 125474 | | | |
| 4096 | 345043 | 367291 | 389131 | 399607 | 386598 | 227138 | 157218 | 133912 | 127672 | 123024 | 124426 | | |
| 8192 | 352512 | 375006 | 396514 | 409887 | 388613 | 227948 | 154490 | 131463 | 119640 | 120792 | 119818 | 119953 | |
| 16384 | 356950 | 376695 | 401903 | 411574 | 396188 | 234815 | 156176 | 128556 | 122361 | 120512 | 119509 | 119663 | 119964 |
| 32768 | 359594 | 382776 | 403696 | 415048 | 402386 | 239502 | 156055 | 128220 | 120423 | 119722 | 119603 | 119751 | 120516 |
| 65536 | 359146 | 383459 | 405060 | 416252 | 406037 | 239904 | 155952 | 127498 | 120336 | 119439 | 119425 | 119392 | 119141 |
| 131072 | 360468 | 381298 | 404661 | 417000 | 408740 | 230442 | 155924 | 123590 | 119126 | 116132 | 114724 | 116067 | 116370 |
| 262144 | 22863 | 23334 | 22382 | 21804 | 22673 | 23348 | 23289 | 23214 | 23256 | 23291 | 22613 | 22422 | 23270 |
| 524288 | 23182 | 23349 | 23145 | 23115 | 23253 | 23069 | 22620 | 23095 | 23233 | 22978 | 22986 | 23121 | 22887 |

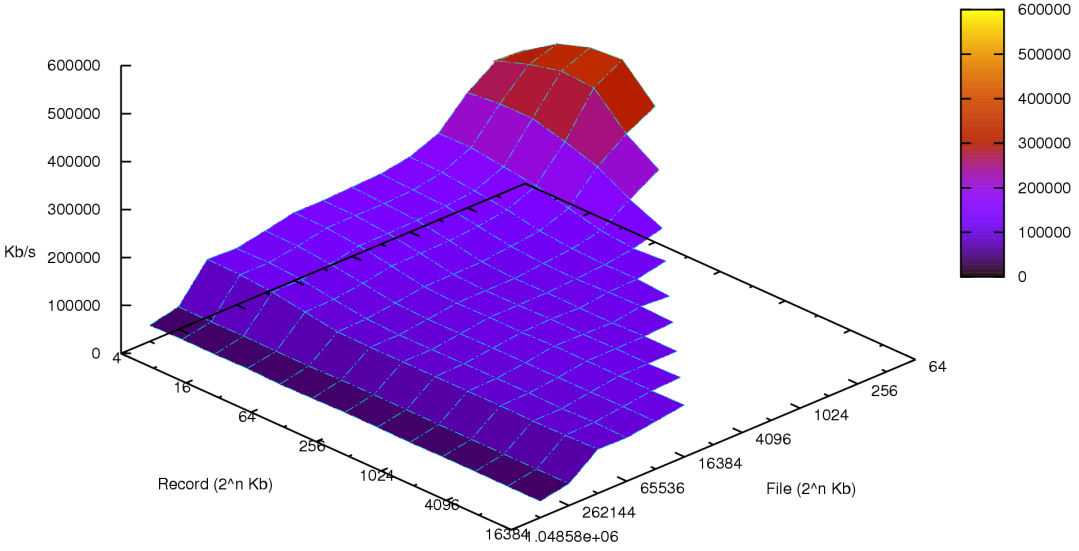
Re-fread Report

| | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 | 2048 | 4096 | 8192 | 16384 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 64 | 901531 | 969231 | 841432 | 915650 | 830766 | | | | | | | | |
| 128 | 711315 | 814751 | 680936 | 549472 | 462258 | 336902 | | | | | | | |
| 256 | 416315 | 408999 | 438371 | 428878 | 371603 | 250504 | 149451 | | | | | | |
| 512 | 356821 | 381226 | 405721 | 416266 | 371039 | 237794 | 157881 | 138082 | | | | | |
| 1024 | 360295 | 377719 | 406195 | 408788 | 390839 | 230729 | 155932 | 136080 | 128144 | | | | |
| 2048 | 359677 | 375649 | 400858 | 395906 | 375431 | 224807 | 157743 | 127434 | 122980 | 124626 | | | |
| 4096 | 359737 | 384962 | 389760 | 400857 | 389243 | 226712 | 157665 | 133961 | 127776 | 123040 | 124305 | | |
| 8192 | 360737 | 383446 | 404664 | 417594 | 397362 | 233476 | 155558 | 131769 | 119551 | 120854 | 120226 | 119761 | |
| 16384 | 361088 | 381422 | 399667 | 416841 | 401765 | 236141 | 156795 | 128038 | 122350 | 120538 | 119735 | 119681 | 120064 |
| 32768 | 357870 | 381568 | 402628 | 414631 | 401425 | 239266 | 156009 | 128252 | 120451 | 119755 | 119619 | 119780 | 120612 |
| 65536 | 343269 | 383152 | 404458 | 416099 | 405168 | 239378 | 155842 | 127491 | 118504 | 119520 | 119387 | 119414 | 119114 |
| 131072 | 361673 | 384335 | 404918 | 416274 | 407620 | 240180 | 156163 | 127357 | 120092 | 119347 | 118706 | 118399 | 118669 |
| 262144 | 22736 | 22116 | 23430 | 22917 | 23466 | 23444 | 23411 | 23430 | 23469 | 23440 | 23468 | 23230 | 23448 |
| 524288 | 22566 | 22978 | 23240 | 23170 | 23059 | 23026 | 23189 | 23112 | 23372 | 23144 | 23217 | 23160 | 23464 |

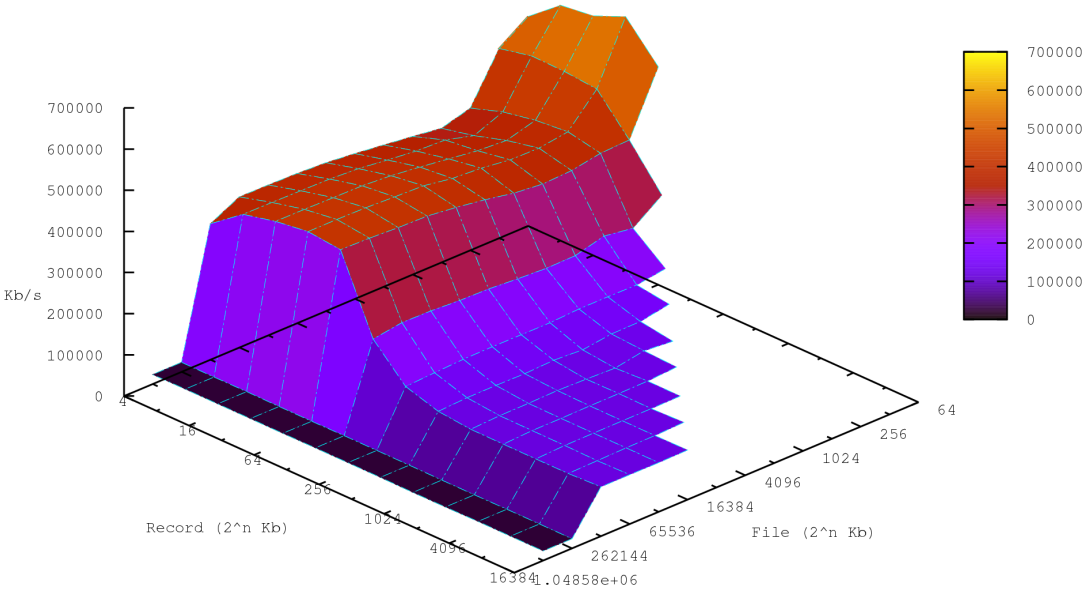
DASD Write



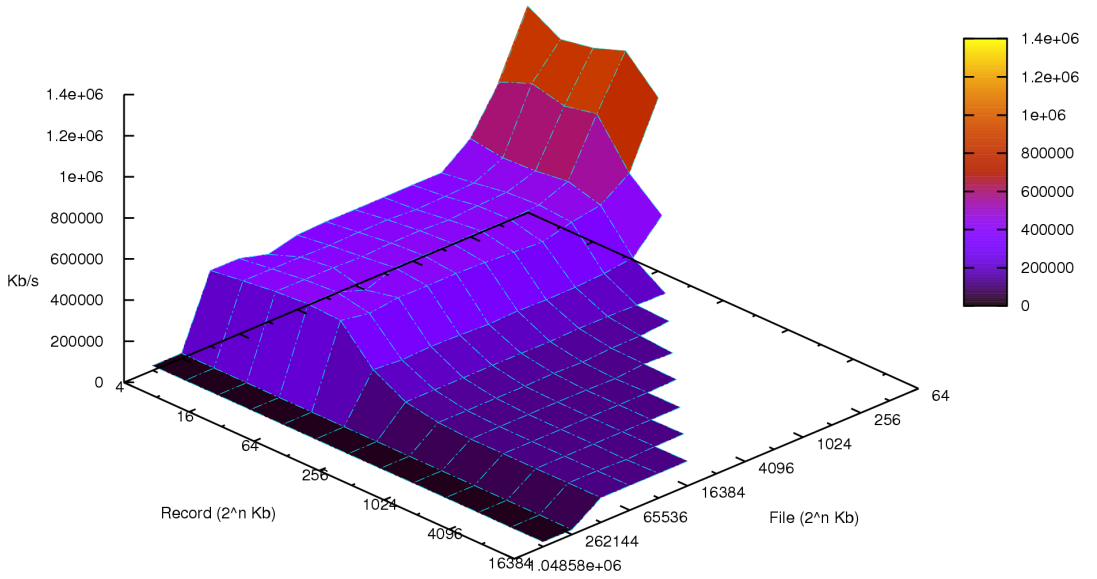

DASD Re-Write



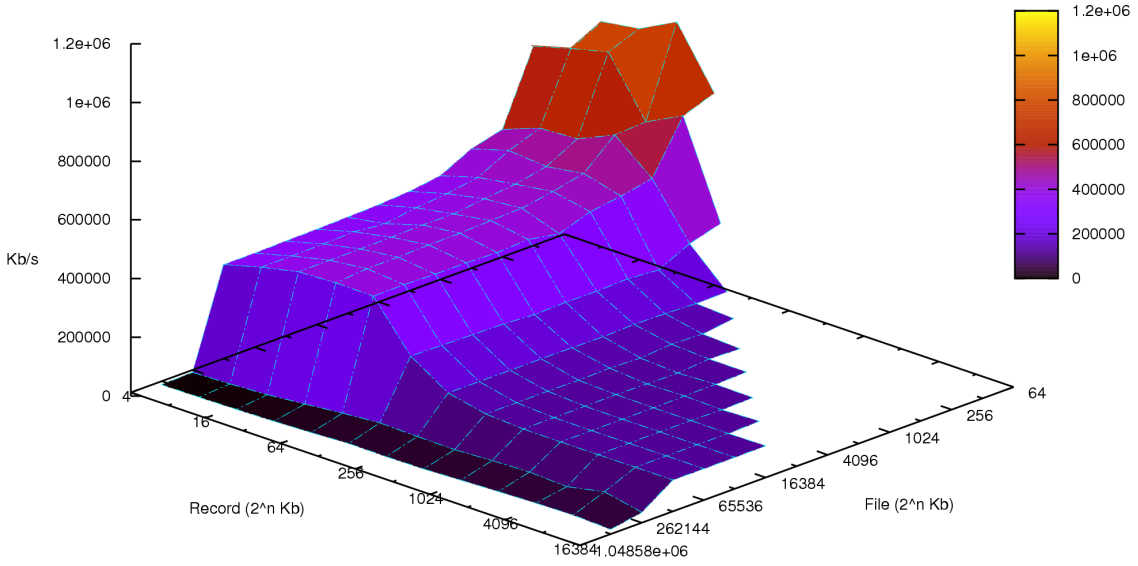
DASD Read



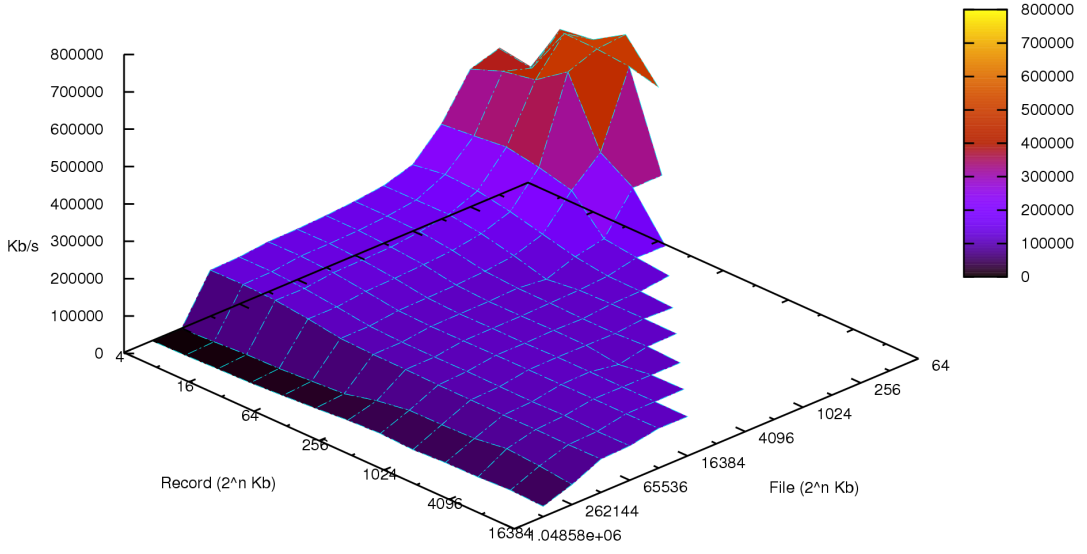

DASD Re-Read



DASD Random Read




DASD Random Write



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