

# Fusion-io ioDrive Performance Testing

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A Comparative Study on Storage Performance  
Improvement using Fusion-io Technology

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Product testing of the Fusion-io 160GB and 320GB ioDrive solid state technology to explore performance gains obtained over existing RAID 5 storage in a Windows 2008 Server based Oracle 11g environment.

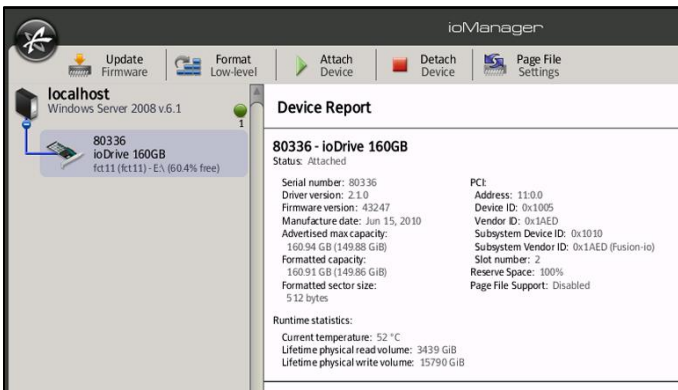
## Purpose

The intent of this test was not to evaluate the maximum performance of the Fusion-io technology, as this has already been shown in other papers, but to document the performance gains possible over conventional RAID storage hardware in an existing application environment. The results obtained from these tests will be used to evaluate technology requirements and assist in the design process of future SPAWAR projects.

## Environment

To carry out the performance testing three identical server platforms were prepared, one for each storage configuration. The server platform selected was the HP Proliant DL380G5 server with two quad-core Intel® Xeon® E5450 3.00GHz processors and 20GB DDR2-667 RAM running the Windows 2008 R2 64-bit Datacenter operating system with an Oracle 11g database.

The first system storage consisted of the C: drive, two 36GB 15,000 rpm SAS drives in RAID 0 for the operating system, and the E: drive, five 36GB 15,000 rpm SAS drives in RAID 5 for the Oracle database. The second system storage consisted of the C: drive, two 36GB 15,000 rpm SAS drives in RAID 0 for the operating system, and the E: drive, one Fusion-io 160GB ioDrive PCIe card for the Oracle database. The third system storage consisted of the C: drive, two 36GB 15,000 rpm SAS drives in RAID 0 for the operating system, and the E: drive, one Fusion-io 320GB ioDrive PCIe card for the Oracle database.

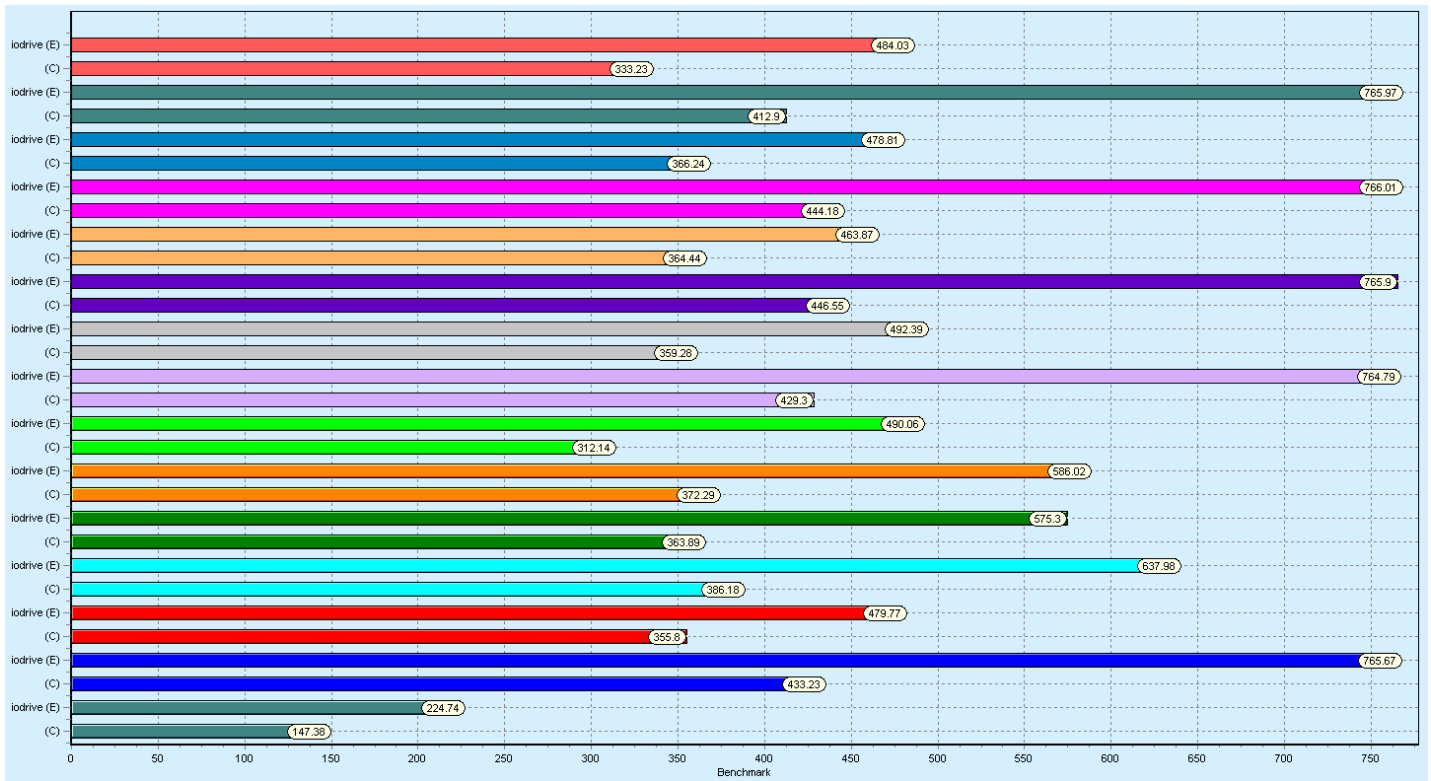


The development and testing computer was an HP EliteBook 8740w with a quad-core Intel® Core™ i7 1.87 GHz processor and 8GB DDR3 memory running the Windows 7 Professional 64-bit operating system on a 256GB Solid State Drive. This computer was used to write and run an application that created and controlled multiple virtual machines which performed concurrent queries to the Oracle database.

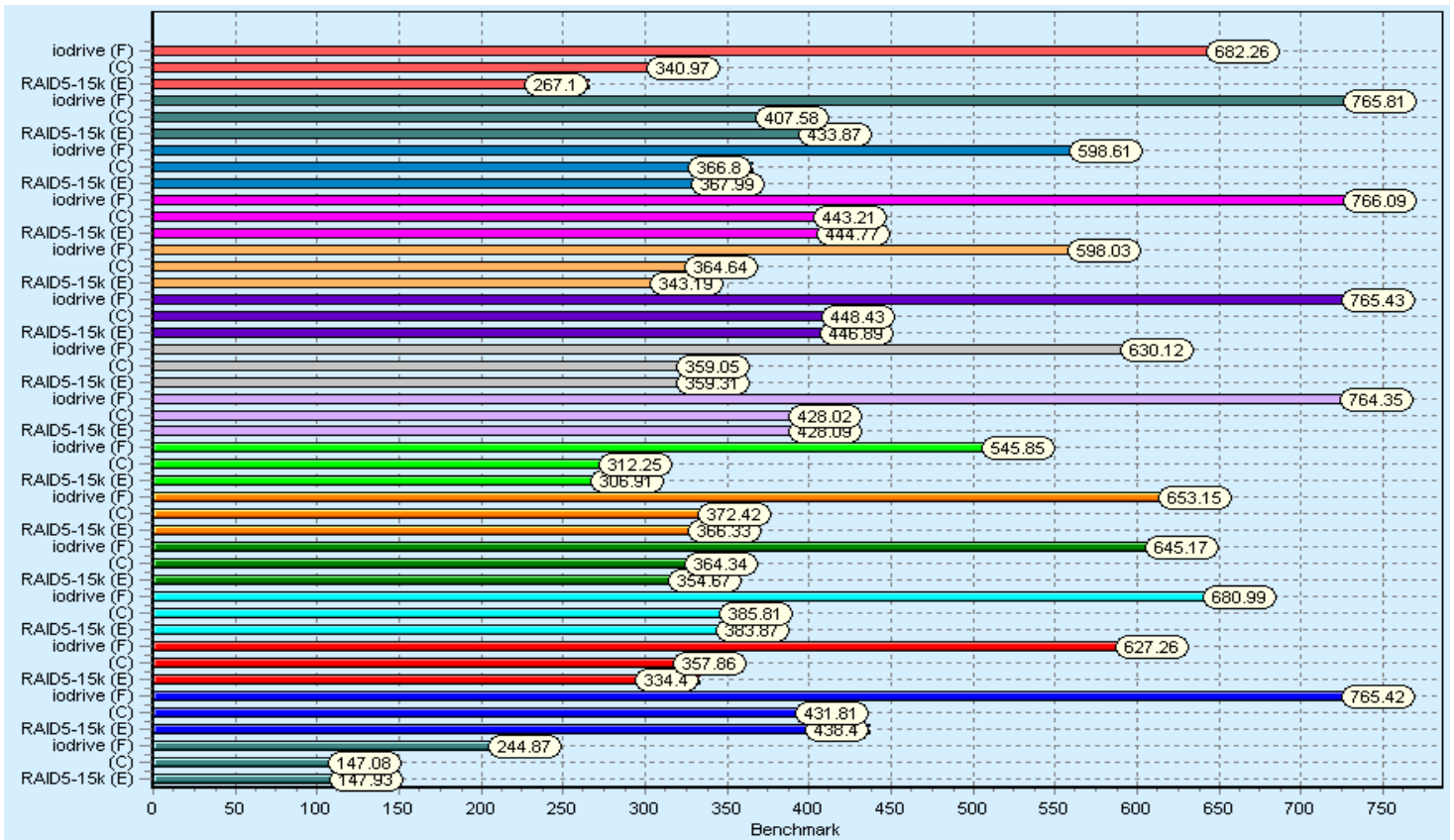
## Benchmark

In order to illustrate a basic system comparison between the Fusion-io 160GB ioDrive, 320GB ioDrive and the RAID 5 array, a benchmarking application was used. The Benchmark utility measured Sequential Reading (large and small files), Sequential Writing (large and small files), Random Reading (large and small files) and Random Writing (large and small files) and stress testing. The Benchmark utility also characterized the results for Gaming, Servers, Media, Reading and Writing. For the benchmark comparison test on the base system, the Fusion-io 160GB ioDrive PCIe card was temporarily installed as the F: drive in the first system as seen in the graph below.

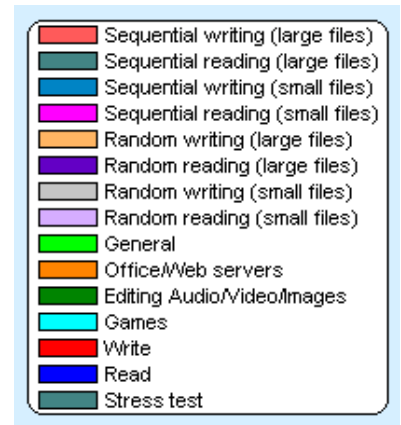
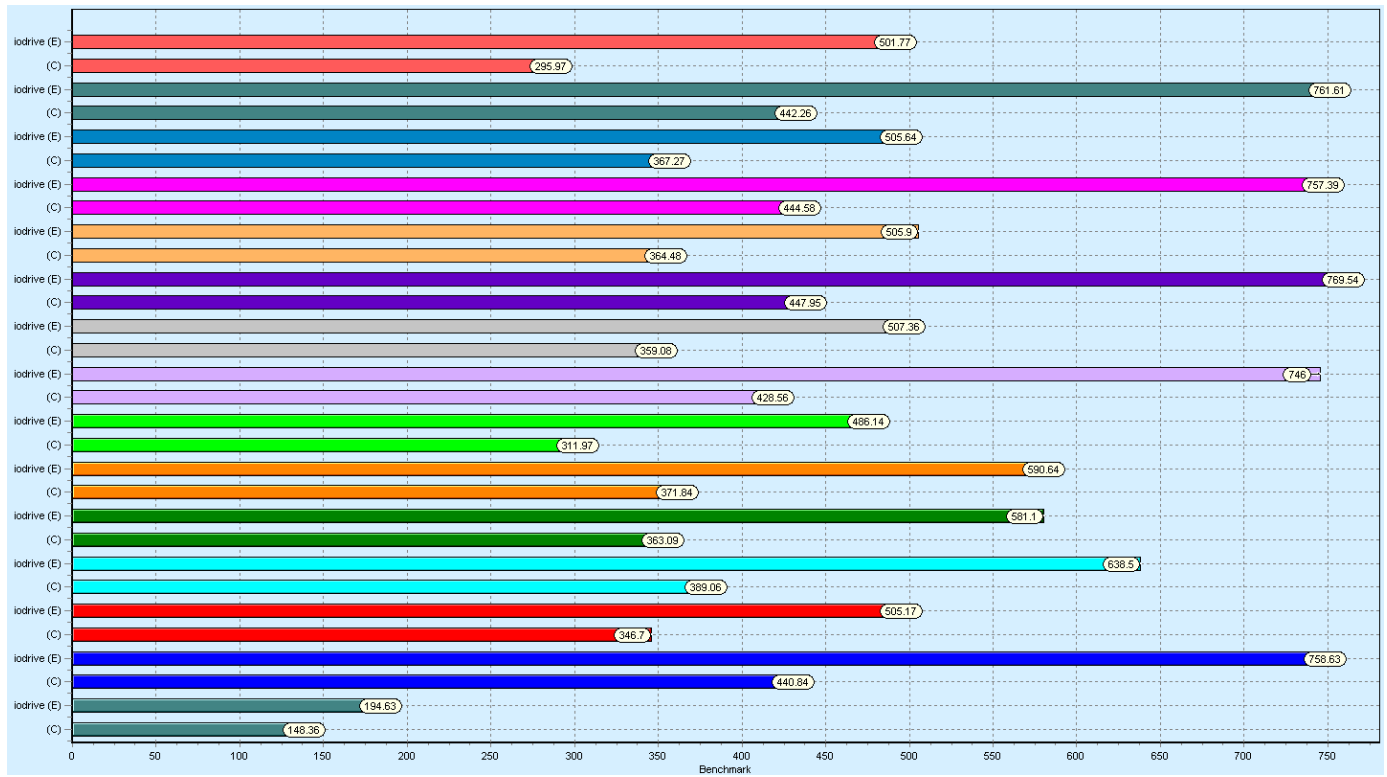
Fusion IO 160 Benchmark



Fusion IO 160 vs. RAID 5 Benchmark



Fusion IO 320 Benchmark



## Performance Test

In order to perform the tests, an Oracle 11g database was installed on the E: drive of each server. A database table with over 37K records was then populated into each Oracle database instance. The initial testing utilized standard SQL queries to read data from the table, but did not generate the expected activity needed to test the performance of the ioDrives. This was noted by a lack of disk activity during the test while viewing ioDrive performance in the ioManager application. It is assumed that after each unique data read, that data was being cached into system memory and therefore the ioDrive was not activated by subsequent queries.

To correct this, the test utility was altered to continually load (write) 1MB character large objects (CLOB) to the database table rows through SQL queries. This corrected the problem and effectively placed load on the Fusion IO drives. The queries were initiated in the following three sequences:

### **Sequence 1 (Fusion-io 160GB database test)**

1. Execute query utility on Fusion-io 320GB host to query remote Fusion-io 160GB database
2. Execute query utility on development workstation to query Fusion-io 160GB database
3. Execute query utility on local Fusion-io 160GB host to query local Fusion-io 160GB database

### **Sequence 2 (Fusion-io 320GB database test)**

1. Execute query utility on Fusion-io 160GB host to query remote Fusion-io 320GB database
2. Execute query utility on development workstation to query Fusion-io 320GB database
3. Execute query utility on local Fusion-io 320GB host to query local Fusion-io 320GB database

### **Sequence 3 (RAID 5 database test)**

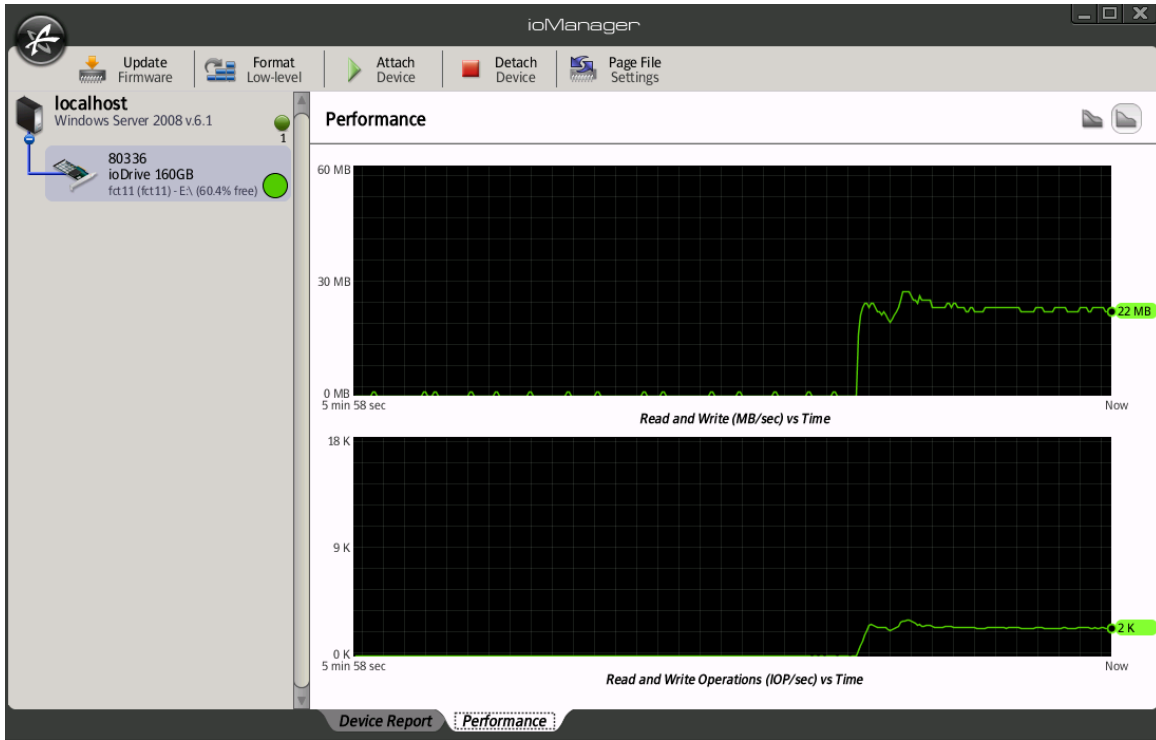
1. Execute query utility on Fusion-io 320GB host to query remote RAID 5 database
2. Execute query utility on development workstation to query RAID 5 database
3. Execute query utility on local RAID 5 host to query local RAID 5 database

Execution of the utilities are cumulative (i.e. after step 3 there are three machines simultaneously running the query utility against the given Fusion-io host). The above procedures were run on each Fusion-io host separately. Performance results were collected using the ioManager after each query utility step was executed.

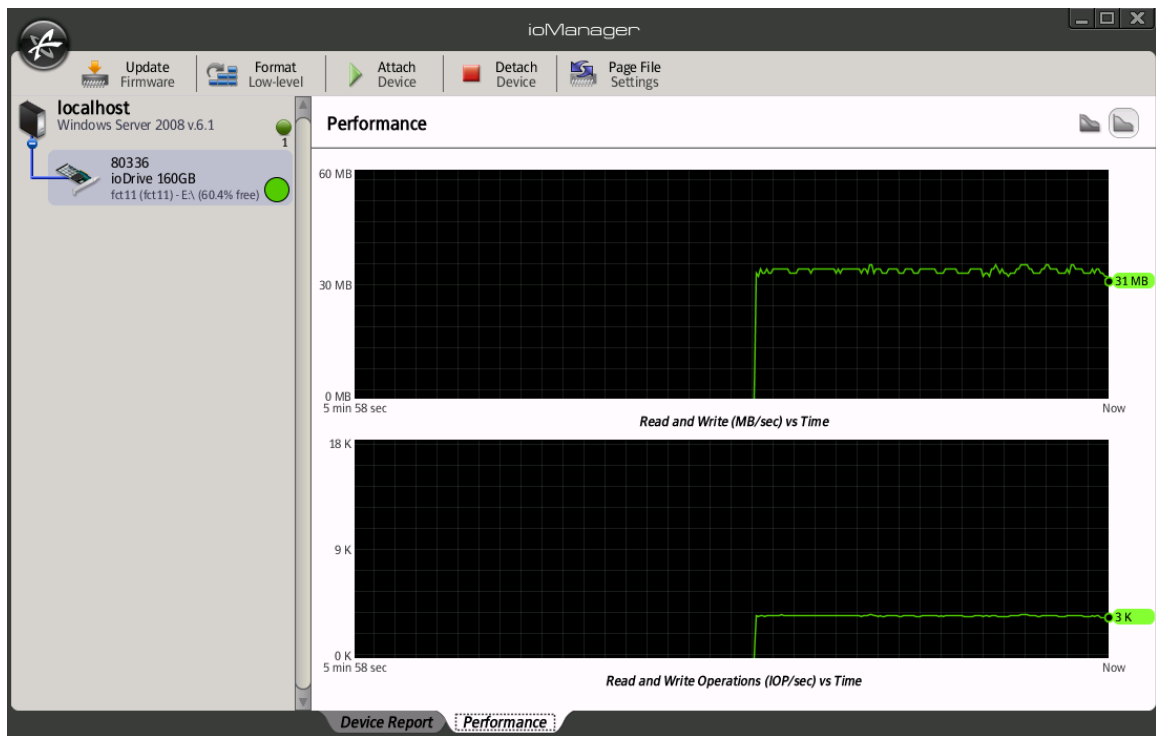
The first set of ioManager screenshots below are the steps from Sequence 1 showing the Fusion-io 160GB host performance results. The second set of ioManager screenshots below are the steps from Sequence 2 showing the Fusion-io 320GB host performance results.

The final set of screenshots below were taken after all three steps of Sequence 3 were completed using the Windows performance monitor on the RAID 5 host and the Fusion-io 320GB host to provide comparative performance results.

Test Sequence 1 - Fusion-io 160 Host

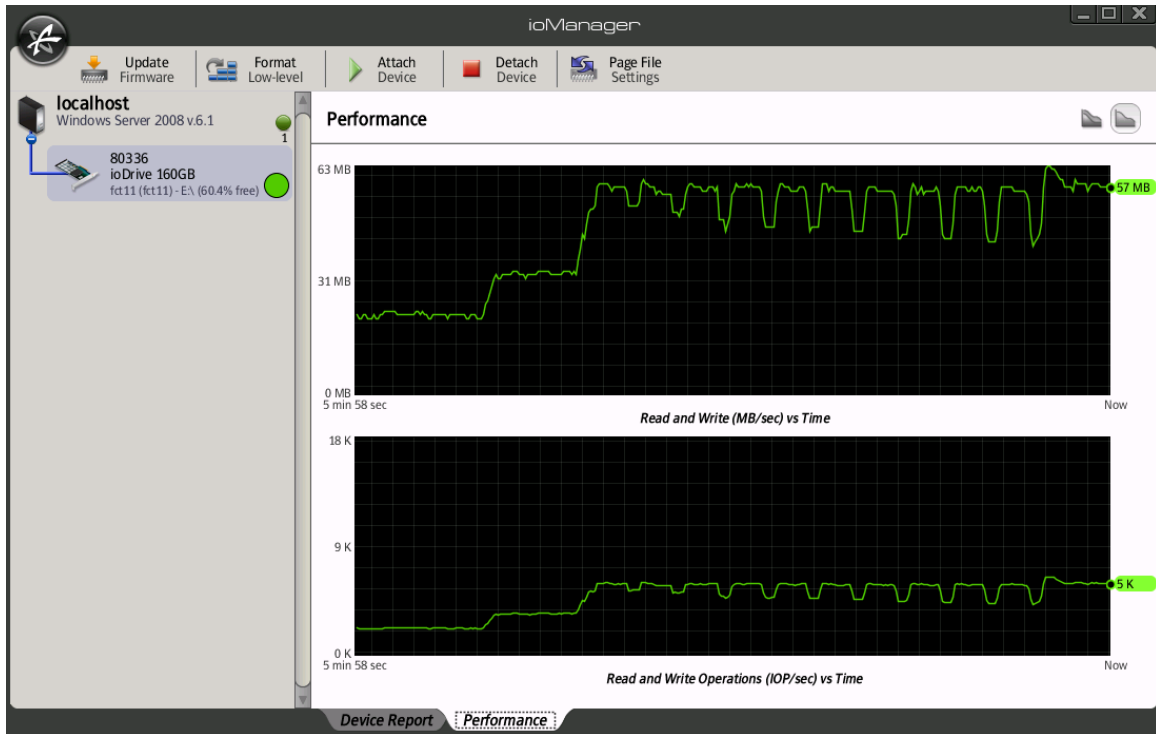


Remote Host Query Started



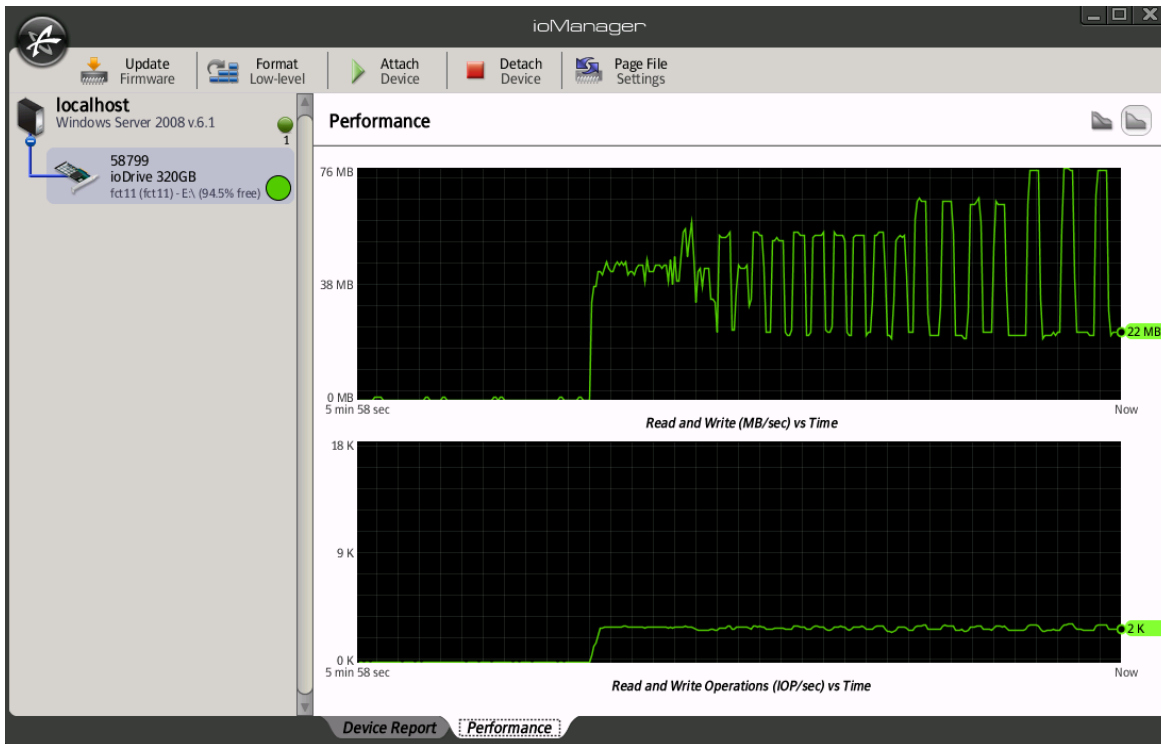
Workstation Query Started

## A COMPARATIVE STUDY ON STORAGE PERFORMANCE IMPROVEMENT USING FUSION-IO TECHNOLOGY

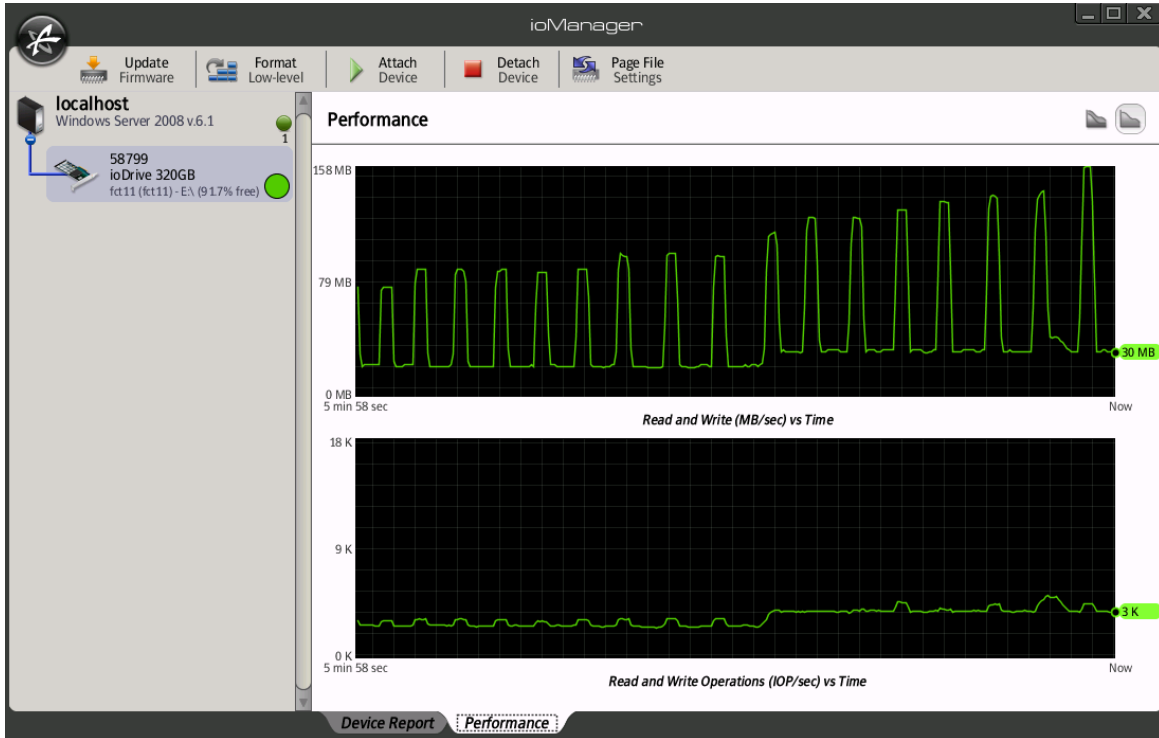


**Local Host Query Started**

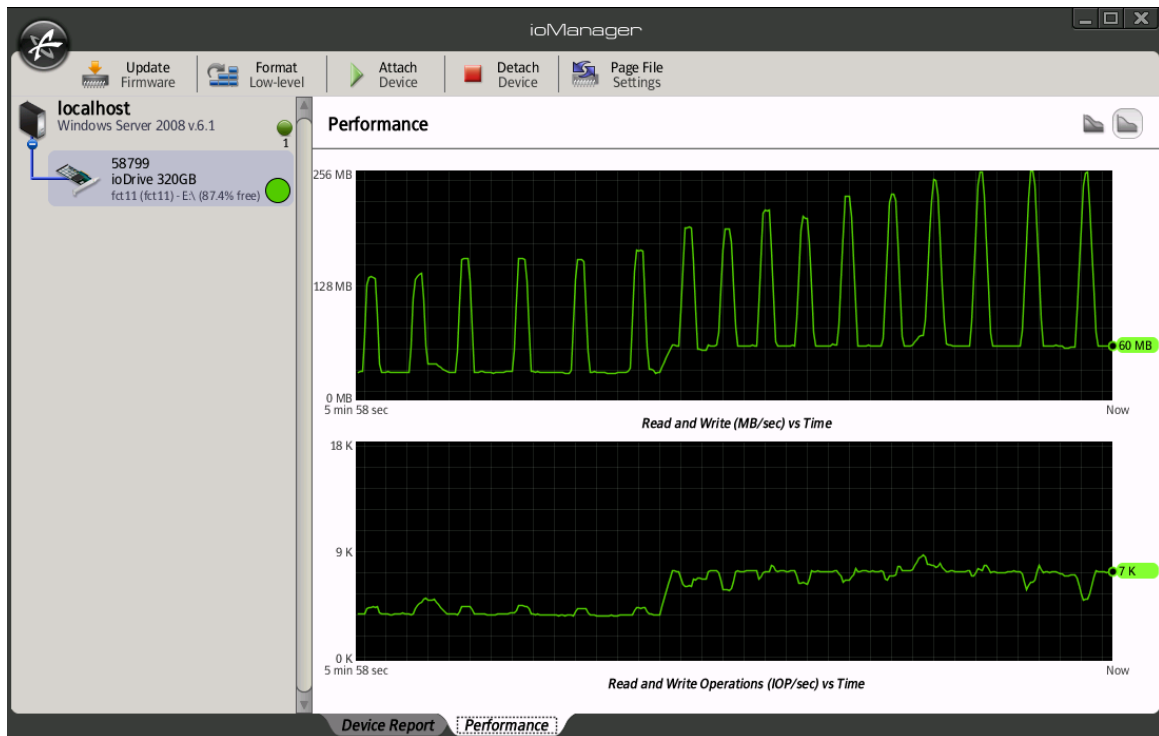
### Test Sequence 2 - Fusion-io 320 Host



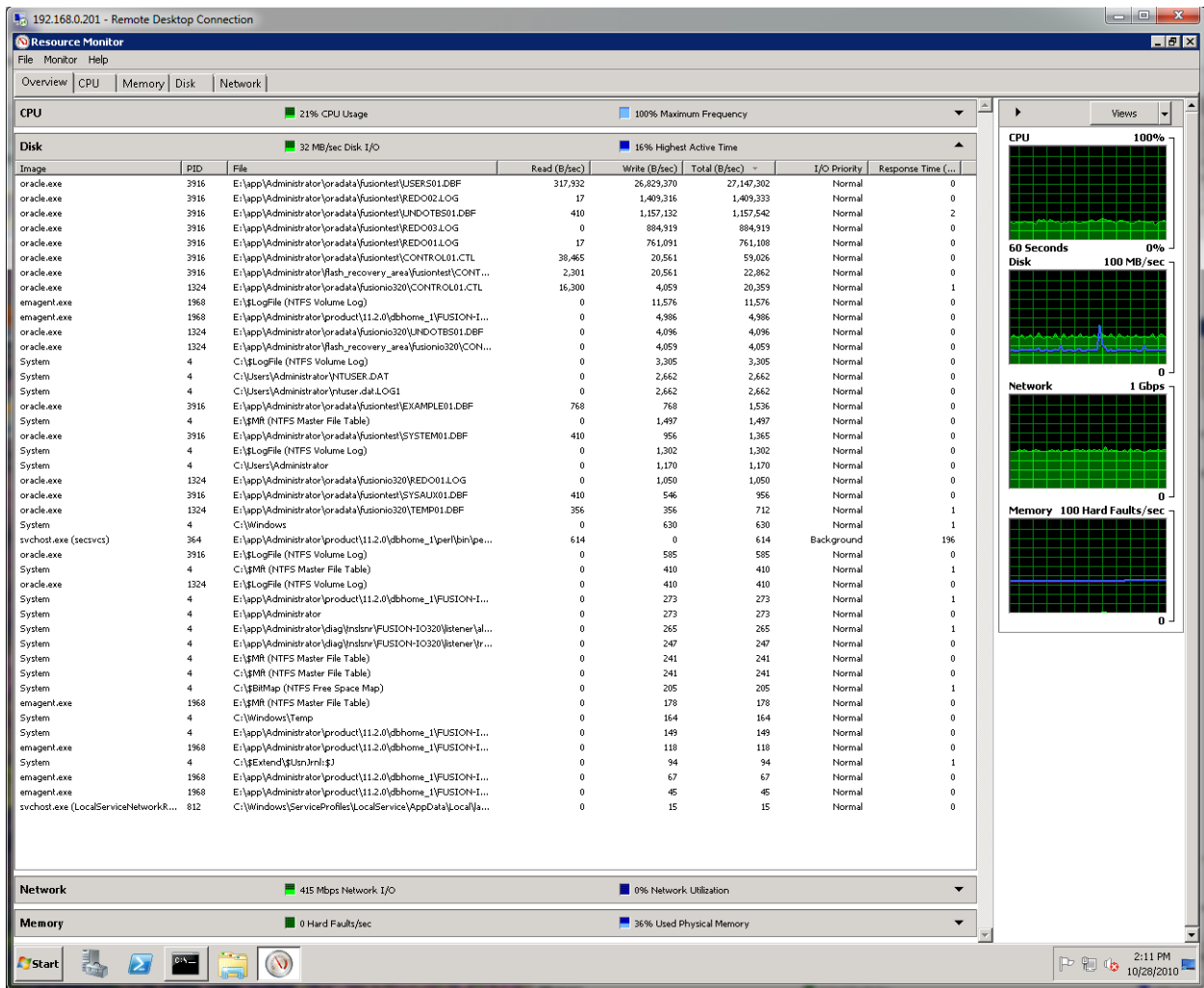
**Remote Host Query Started**



**Workstation Query Started**



**Local Host Query Started**

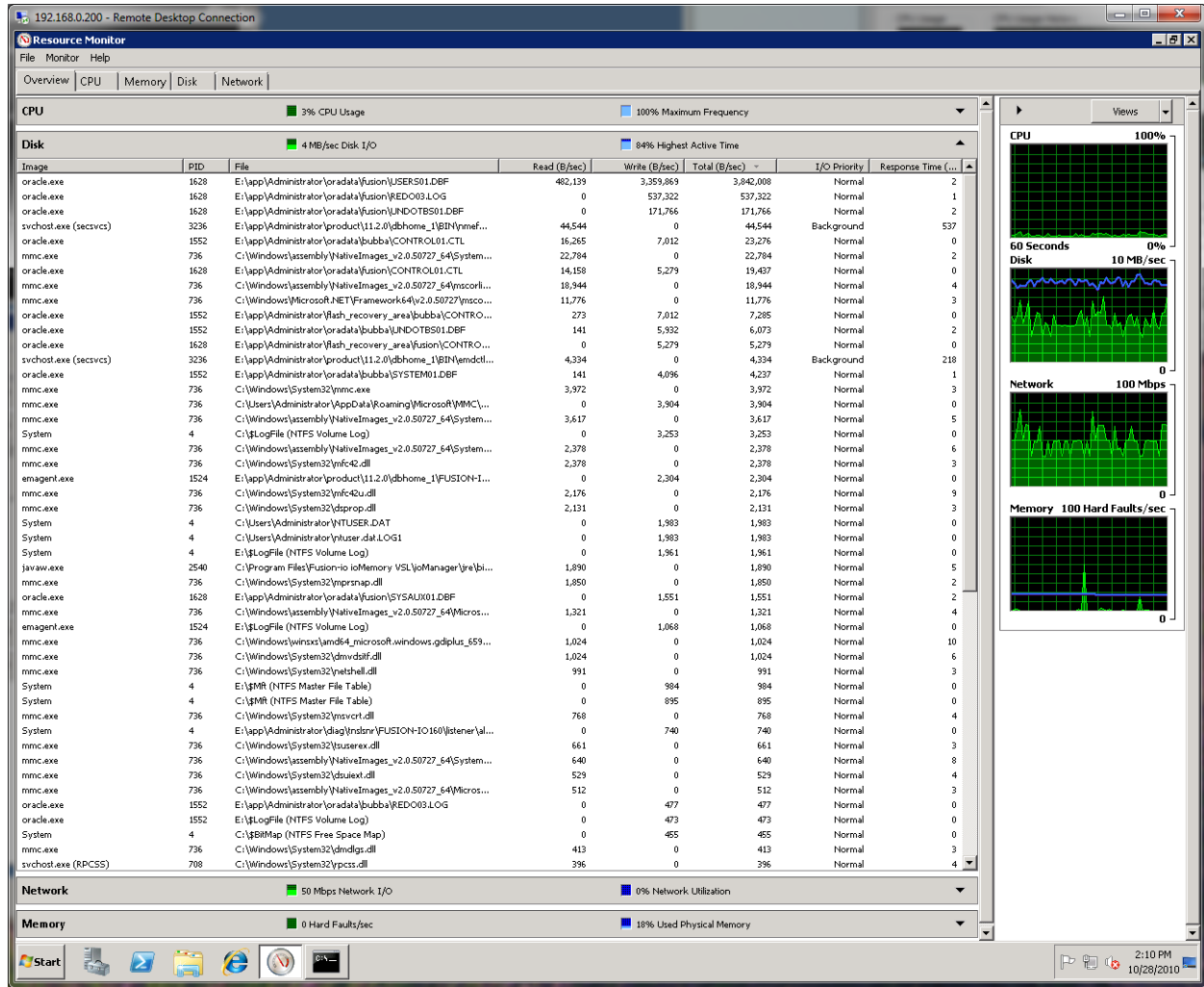


Fusion-io 320GB Host Windows Performance Monitor

## Comparative Technologies

The final sequence of testing compares the Oracle transaction performance of the Fusion-io 320GB ioDrive host and the RAID 5 host. The Windows performance monitor was used on the respective local host to view system operation.

Test Sequence 3 - RAID 5 Host



RAID 5 Host Windows Performance Monitor

Test Results (3 Simultaneous Query Utilities)

Host	ioManager Performance		Windows Performance Monitor	
	Avg. MB/Sec	Avg. IOP/Sec	Avg. Disk MB/Sec	Avg. Net Mb/Sec
Fusion-io 160GB	57	5000	-	-
Fusion-io 320GB	60	7000	32	415
RAID 5	-	-	4	50

## **Conclusion**

Based on the test results, Fusion-io technology exhibits a significant performance gain over conventional RAID 5 rotating disk storage. While evaluating Oracle database queries using the test utility on the 320GB ioDrive host and the RAID 5 host, an average performance increase of 800 percent was observed while using identical server platforms.