Linux and Unix Test Disk I/O Performance With dd Command

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How can I use dd command on a Linux to test I/O performance of my hard disk drive? How do I check the performance of a hard drive including the read and write speed on a Linux operating systems?

You can use the following commands on a Linux or Unix-like systems for simple I/O performance test:

- **`dd` command** : It is used to monitor the writing performance of a disk device on a Linux and Unix-like system.
- **`hdparm` command** : It is used to get/set hard disk parameters including test the reading and caching performance of a disk device on a Linux based system.

In this tutorial you will learn how to use the dd command to test disk I/O performance.

Use dd command to monitor the reading and writing performance of a disk device:

1. Open a shell prompt.
2. Or login to a remote server via ssh.
3. Use the dd command to measure **server throughput** (write speed) `dd if=/dev/zero of=/tmp/test1.img bs=1G count=1 oflag=dsync`
4. Use the dd command to measure **server latency** `dd if=/dev/zero of=/tmp/test2.img bs=512 count=1000 oflag=dsync`

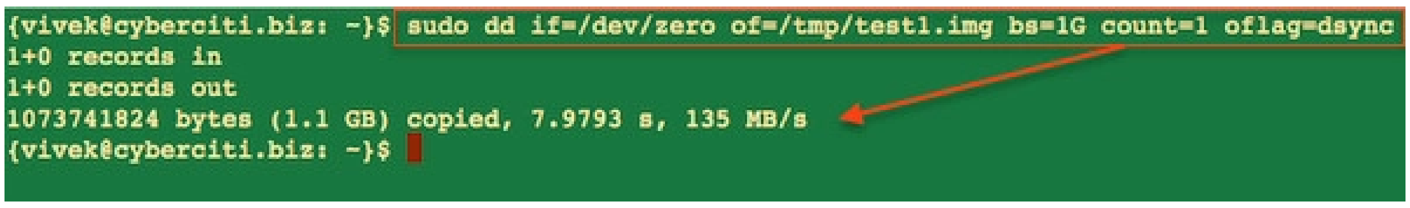
The dd command is useful to find out **simple sequential I/O performance**.

Understanding dd command options

In this example, I'm using RAID-10 (Adaptec 5405Z with SAS SSD) array running on a Ubuntu Linux 14.04 LTS server. The basic syntax is as follows to find out **server throughput**:

```
dd if=/dev/input.file  of=/path/to/output.file  bs=block-size  count=number-of-blocks  oflag=dsync
## GNU dd syntax ##
##########################################################
##***[Adjust bs and count as per your needs and setup]**##
##########################################################
dd if=/dev/zero of=/tmp/test1.img bs=1G count=1 oflag=dsync
dd if=/dev/zero of=/tmp/test2.img bs=64M count=1 oflag=dsync
dd if=/dev/zero of=/tmp/test3.img bs=1M count=256 conv=fdatasync
dd if=/dev/zero of=/tmp/test4.img bs=8k count=10k
dd if=/dev/zero of=/tmp/test4.img bs=512 count=1000 oflag=dsync
## OR alternate syntax for GNU/dd ##
dd if=/dev/zero of=/tmp/testALT.img bs=1G count=1 conv=fdatasync
```

Sample outputs:



```
{vivek@cyberciti.biz: ~}$ sudo dd if=/dev/zero of=/tmp/test1.img bs=1G count=1 oflag=dsync
1+0 records in
1+0 records out
1073741824 bytes (1.1 GB) copied, 7.9793 s, 135 MB/s
{vivek@cyberciti.biz: ~}$
```

Fig.01: Ubuntu Linux Server with RAID10 and testing server throughput with dd

Please note that one gigabyte was written for the test and 135 MB/s was server throughput for this test. Where,

- `if=/dev/zero` (`if=/dev/input.file`) : The name of the input file you want dd the read from.
- `of=/tmp/test1.img` (`of=/path/to/output.file`) : The name of the output file you want dd write the input.file to.
- `bs=1G` (`bs=block-size`) : Set the size of the block you want dd to use. 1 gigabyte was written for the test. Please note that Linux will need 1GB of free space in RAM. If your test system does not have sufficient RAM available, use a smaller parameter for bs (such as 128MB or 64MB and so on).
- `count=1` (`count=number-of-blocks`): The number of blocks you want dd to read.
- `oflag=dsync` (`oflag=dsync`) : Use synchronized I/O for data. Do not skip this option. This option get rid of caching and gives you good and accurate results
- `conv=fdatasyn`: Again, this tells dd to require a complete "sync" once, right before it exits. This option is equivalent to `oflag=dsync`.

Finding server latency time

In this example, 512 bytes were written one thousand times to get RAID10 server latency time:

```
dd if=/dev/zero of=/tmp/test2.img bs=512 count=1000 oflag=dsync
```

Sample outputs:

```
1000+0 records in
1000+0 records out
512000 bytes (512 kB) copied, 0.60362 s, 848 kB/s
```

Please note that server throughput and latency time depends upon server/application load too. So I recommend that you run these tests on a newly rebooted server as well as peak time to get better idea about your workload. You can now compare these numbers with all your devices.

But why the server throughput and latency time are so low?

Low values does not mean you are using slow hardware. The value can be low because of the HARDWARE RAID10 controller's cache.

Use hdparm command to see buffered and cached disk read speed

I suggest you run the following commands 2 or 3 times Perform timings of device reads for benchmark and comparison purposes:

```
### Buffered disk read test for /dev/sda ##
hdparm -t /dev/sda1
## OR ##
hdparm -t /dev/sda
```

To perform timings of cache reads for benchmark and comparison purposes again run the following command 2-3 times (note the `-T` option):

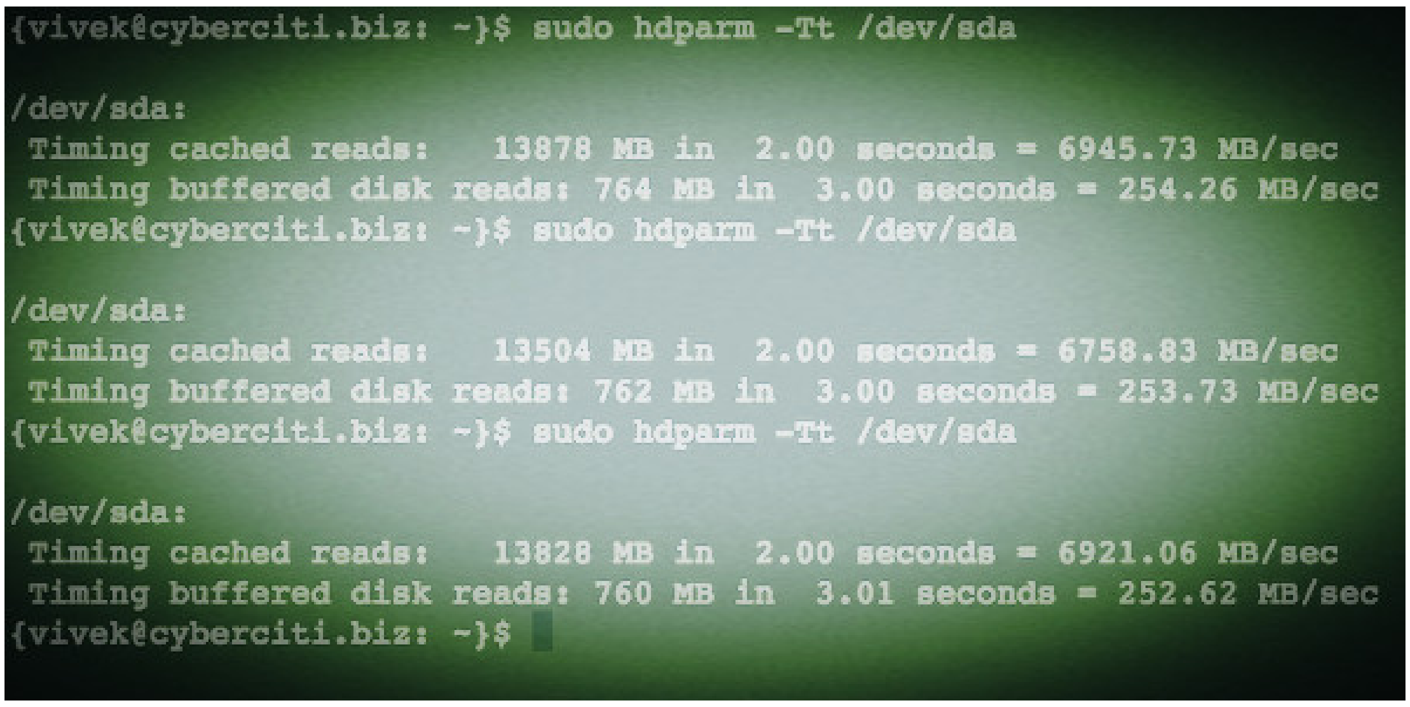
```
## Cache read benchmark for /dev/sda ###
```

```
hdparm -T /dev/sda1
## OR ##
hdparm -T /dev/sda
```

OR combine both tests:

```
hdparm -Tt /dev/sda
```

Sample outputs:



```
{vivek@cyberciti.biz: ~}$ sudo hdparm -Tt /dev/sda

/dev/sda:
 Timing cached reads:   13878 MB in  2.00 seconds = 6945.73 MB/sec
 Timing buffered disk reads: 764 MB in  3.00 seconds = 254.26 MB/sec
{vivek@cyberciti.biz: ~}$ sudo hdparm -Tt /dev/sda

/dev/sda:
 Timing cached reads:   13504 MB in  2.00 seconds = 6758.83 MB/sec
 Timing buffered disk reads: 762 MB in  3.00 seconds = 253.73 MB/sec
{vivek@cyberciti.biz: ~}$ sudo hdparm -Tt /dev/sda

/dev/sda:
 Timing cached reads:   13828 MB in  2.00 seconds = 6921.06 MB/sec
 Timing buffered disk reads: 760 MB in  3.01 seconds = 252.62 MB/sec
{vivek@cyberciti.biz: ~}$
```

Fig.02: Linux hdparm command to test reading and caching disk performance

Again note that due to filesystems caching on file operations, you will always see high read rates.

Use dd command on Linux to test read speed

To get accurate read test data, first discard caches before testing by running the following commands:

```
flush
echo 3 | sudo tee /proc/sys/vm/drop_caches
time dd if=/path/to/bigfile of=/dev/null bs=8k
```

Linux Laptop example

Run the following command:

```
### Debian Laptop Throughput With Cache ##
dd if=/dev/zero of=/tmp/laptop.bin bs=1G count=1 oflag=direct

### Deactivate the cache ###
hdparm -W0 /dev/sda

### Debian Laptop Throughput Without Cache ##
dd if=/dev/zero of=/tmp/laptop.bin bs=1G count=1 oflag=direct
```

Apple OS X Unix (Macbook pro) example

GNU dd has many more options but OS X/BSD and Unix-like dd command need to run as follows to test real disk I/O and not memory add sync option as follows:

```
## Run command 2-3 times to get good results ###
time sh -c "dd if=/dev/zero of=/tmp/testfile bs=100k count=1k && sync"
```

Sample outputs:

```
1024+0 records in
1024+0 records out
104857600 bytes transferred in 0.165040 secs (635346520 bytes/sec)

real	0m0.241s
user	0m0.004s
sys	0m0.113s
```

So I'm getting 635346520 bytes (635.347 MB/s) write speed on my MBP.

Not a fan of command line...?

You can use disk utility (gnome-disk-utility) on a Linux or Unix based system to get the same information. The following screenshot is taken from my Fedora Linux v22 VM.

Graphical method

Click on the "Activities" or press the "Super" key to switch between the Activities overview and desktop. Type "Disks"

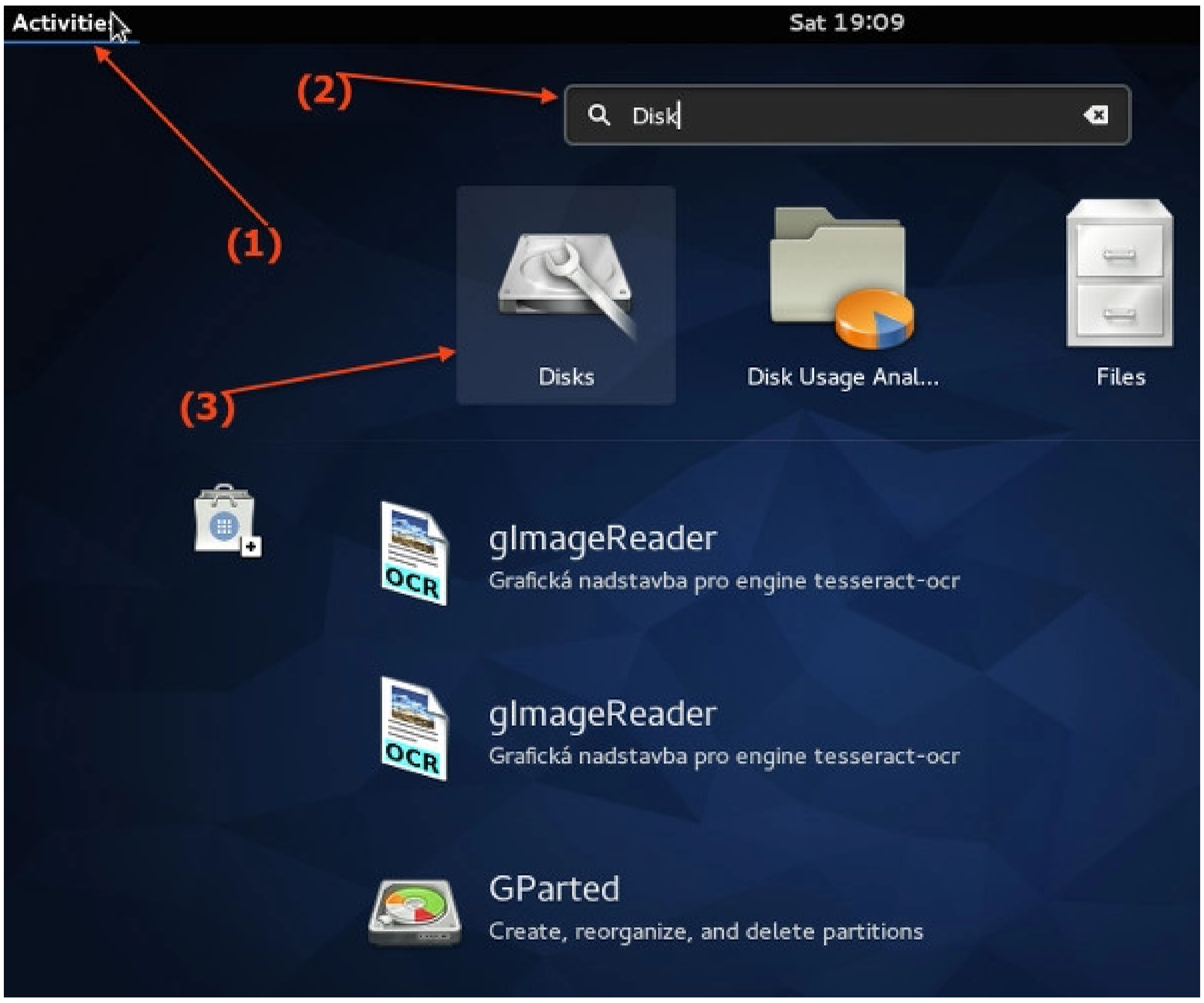
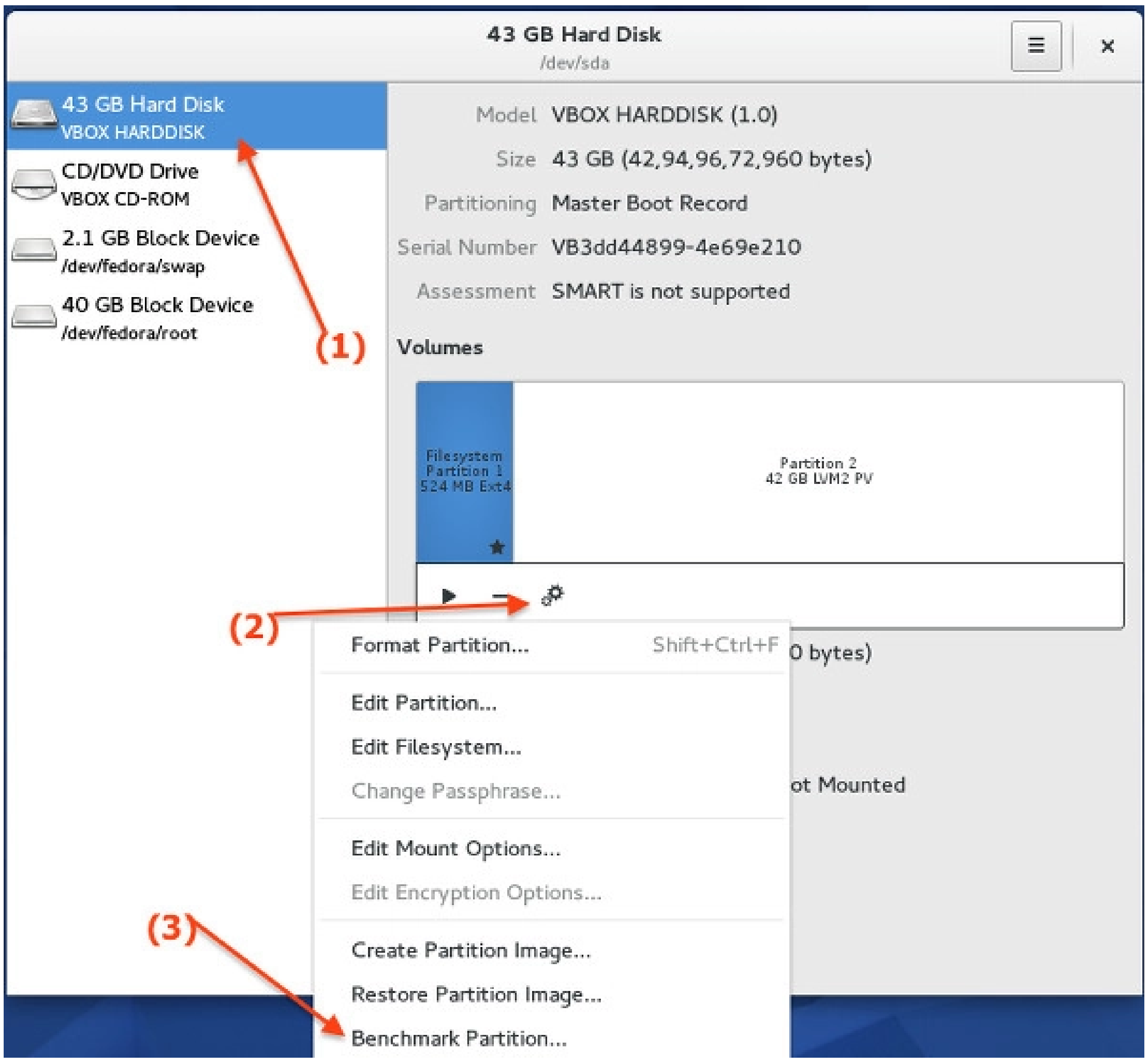

Activities
Sat 19:09
(2)
Disk
(1)
Disks
Disk Usage Anal...
Files
(3)
gImageReader
Grafická nadstavba pro engine tesseract-ocr
gImageReader
Grafická nadstavba pro engine tesseract-ocr
GParted
Create, reorganize, and delete partitions

Fig.03: Start the Gnome disk utility

Select your hard disk at left pane and click on configure button and click on "Benchmark partition":



Model VBOX HARDDISK (1.0)

Size 43 GB (42,94,96,72,960 bytes)

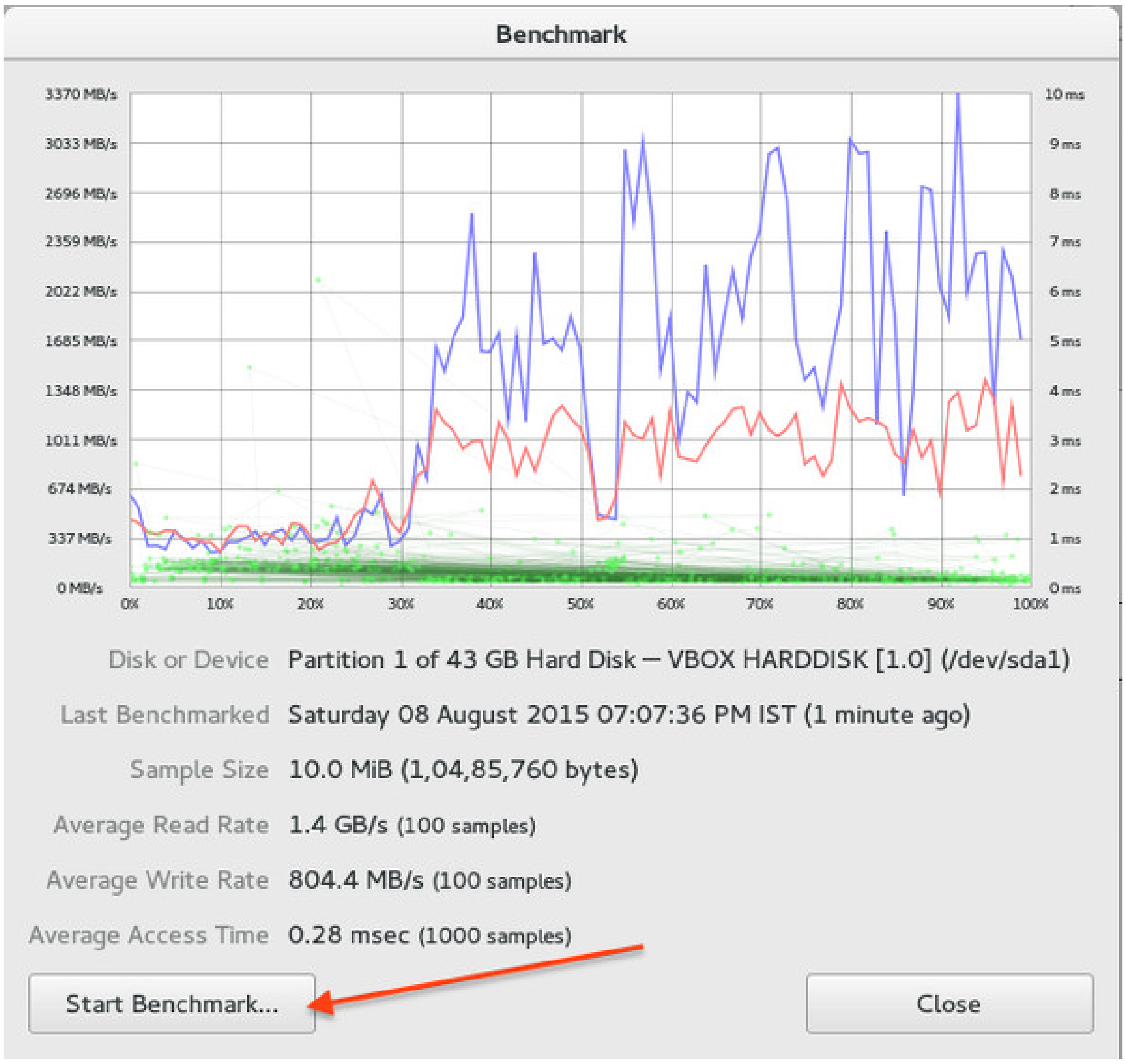
Partitioning Master Boot Record

Serial Number VB3dd44899-4e69e210

Assessment SMART is not supported

Fig.04: Benchmark disk/partition

Finally, click on the “Start Benchmark…” button (you may be promoted for the admin username and password):



Disk or Device Partition 1 of 43 GB Hard Disk — VBOX HARDDISK [1.0] (/dev/sda1)

Last Benchmarked Saturday 08 August 2015 07:07:36 PM IST (1 minute ago)

Sample Size 10.0 MiB (1,04,85,760 bytes)

Average Read Rate 1.4 GB/s (100 samples)

Average Write Rate 804.4 MB/s (100 samples)

Average Access Time 0.28 msec (1000 samples)

Fig.05: Final benchmark result

Which method and command do you recommend to use?

- I recommend dd command on all Unix-like systems (`time sh -c "dd if=/dev/zero of=/tmp/testfile bs=100k count=1k && sync"`
- If you are using GNU/Linux use the dd command (`dd if=/dev/zero of=/tmp/testALT.img bs=1G count=1 conv=fdatasync`)
- Make sure you adjust count and bs arguments as per your setup to get a good set of result.
- The GUI method is recommended only for Linux/Unix laptop users running Gnome2 or 3 desktop.

See also: HowTo: Linux Check IDE / SATA Hard Disk Transfer Speed and man pages: dd(1),hdparm(1)

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The author is the creator of nixCraft and a seasoned sysadmin, DevOps engineer, and a trainer for the Linux operating system/Unix shell scripting. Get the **latest tutorials on SysAdmin, Linux/Unix and open source topics via RSS/XML feed** or weekly email newsletter.

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