Cloud Analysis: Performance Benchmarks of Linux & Windows Environments

Benchmarking comparable offerings from HOSTING, Amazon EC2, Rackspace Public Cloud

By Cloud Spectator
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CLOUD SPECTATOR

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Introduction

Performance Testing

Cloud Spectator monitors the CPU, RAM, storage, and internal network performance of over 20 of the world's most well-known IaaS services to understand important aspects of virtual server performance. Tests are run at least three times per day, 365 days per year to capture variability in addition to performance level. Tests are chosen based on reliability and practicality. The goal is to provide an indication of where certain providers perform well relative to others. This can give consumers an indication of which services would be best for their application(s) by understanding the performance of provider resources most critical to that application.

Singular benchmarks alone should not be the only deciding factor in the provider selection process. Feature sets, configuration matches, pricing and ancillary services such as security, compliance, and disaster recovery should always factor into any vendor selection process. However, performance is a very important piece to the puzzle.

The Comparison

For the purpose of generating this document, Cloud Spectator measured the performance of HOSTING's virtual machines against comparable offerings from Amazon and Rackspace. Over a period of twenty days, Cloud Spectator ran benchmark tests across HOSTING Cloud Enterprise, Amazon AWS, and Rackspace OpenCloud. Each test was run to understand the unique performance capabilities of each provider's CPU, internal network, and disk IO. Cloud Spectator accounted for performance capability and stability for each provider to understand the value each one delivers to its users. Tests were run on 4GB servers for HOSTING and Rackspace, and 3.75GB servers for Amazon (for more details, see Methodology section in the Appendix).

While other factors can sway the perception of provider comparisons, including value-added services, features, support, security, etc., Cloud Spectator chose to focus objectively on performance to derive numerical relationships between the levels of service delivered from each provider.

Performance testing and benchmarking of cloud computing platforms is a complex task, compounded by the differences between providers and the use cases of cloud infrastructure users. IaaS services are utilized by a large variety of industries, and performance metrics cannot be completely understood by simply representing cloud performance with a single value. When selecting a cloud computing provider, IT professionals consider many factors: feature-sets, cost, security, location and more. However, performance is a key issue that drives many others, including cost. In many cases, three primary resources affect overall server performance: central processing unit (CPU), disk, and internal network. These three resources are what this comparison focuses on.

Executive Summary

Overall System Performance
HOSTING outperforms both Amazon and Rackspace across the 14-day testing period.

In the general server test, using UnixBench in a Linux environment, HOSTING outperforms both Amazon and Rackspace across the 14-Day testing period. The results of the test are a reflection of HOSTING's overall superior performance when compared to Amazon and Rackspace based upon the specific server sizes in this report. Specifically, HOSTING outperformed Amazon and Rackspace in 66% of the Windows tests shown in this report. HOSTING performs better than Amazon and Rackspace in more than 70% of Linux tests shown on the report.

CPU Performance
HOSTING offers the fastest CPUs on average, as well as greater performance predictability.

HOSTING outperforms Rackspace by an average of 10%, and Amazon by 49%, in Virtual Machines (VM) running Linux environments. HOSTING performs an even higher 26% better than Rackspace and 81% better than Amazon in Windows based VMs. The stability of CPU performance did not present itself as an issue with HOSTING or Amazon. The Coefficient of Variations (CV, *see Terms and Definitions in the Appendix*) of the CPU tests are all relatively low, staying below 7%. Rackspace's CPUs on the other hand measured CVs up to 31% in the tests.

Network Performance
HOSTING offers superior network performance across the board, as shown by the results of the internal network tests.

Out of the network tests, HOSTING outperformed Amazon and Rackspace in every benchmark (7 out of 7 network tests). Compared to Rackspace and Amazon, HOSTING has higher speed, lower latency and more stable performance.

Rackspace showed relatively stable throughput speeds with 15.6% CV in the Iperf test, and an average 11% CV in the five remaining network speed tests. Amazon had the least stable throughput with 37% CV in the Iperf test, and an average 29% CV in the five remaining network speed tests. HOSTING showed the most stable speeds with a 4.2% CV in the Iperf test, and an average 8% CV in the five remaining network speed tests. Amazon's network speed is at least 100 Mibits/sec, as is HOSTING's, but Rackspace's speed appears to be throttled to around 90 MiBits/sec.

Both Amazon and Rackspace have high network latency at 1,757 microseconds and 1,353 microseconds respectively. HOSTING's average network latency of 474 microseconds is about 70% less than either provider. Both providers also have a problem with the stability of their latency, with Rackspace showing 88% CV on the Ping test, and Amazon at a smaller 39% CV. End users could face lag and unreliable network performance when transferring large amounts of data between multiple VMs if using either of these providers.

Disk Performance
HOSTING offers superior disk write speed and disk performance stability.

HOSTING's disk performance is about equal to or greater than Amazon in Windows environments, but varies greatly compared to Rackspace. HOSTING's disk performance in Linux environments is slightly below Rackspace in the Dbench and File Copy tests, but significantly outperforms in throughput and IOPS tests for write speed. HOSTING has a smaller CV in five out of eight disk performance tests compared to Rackspace and Amazon.

Rackspace offers high performance and a stable sustained disk read rate, as shown in the H2bench benchmark results of 199 MiBits/sec, with a 5.7% CV. Comparably, HOSTING averages 55 Mibits/sec, and Amazon averages 59 Mibits/sec. However, the File Copy test in Windows shows HOSTING outperforming Amazon and Rackspace. While HOSTING may not be as stable as Amazon and Rackspace in the File Copy test, it makes up for it with higher overall performance.

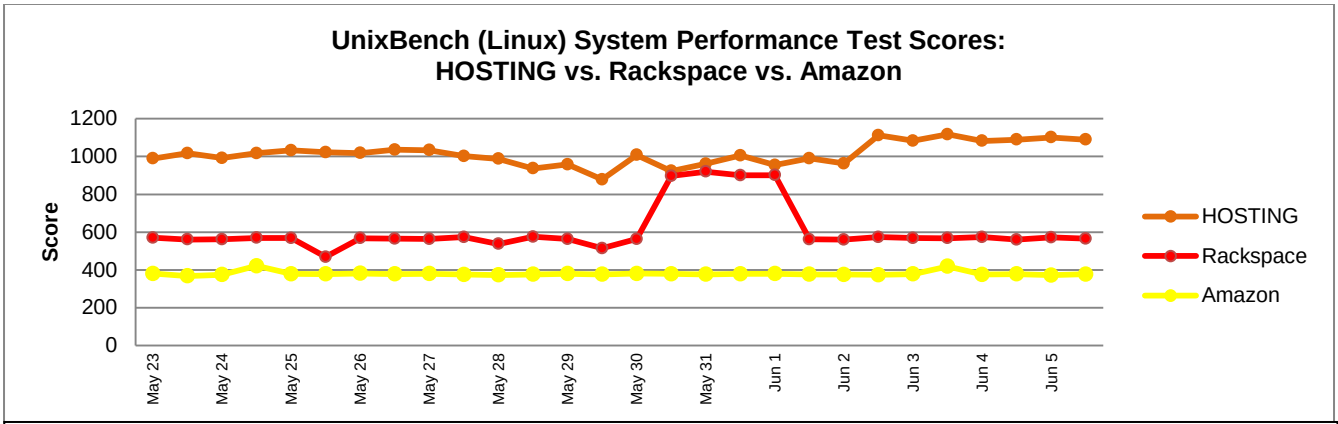
In the Dbench and File Copy tests in Linux, Rackspace is highest overall, but unstable. HOSTING performs at 90% of Rackspace's level in both tests, but offers greater stability. Amazon also performed with greater stability than Rackspace (but less than HOSTING).

The File System tests prove HOSTING performs well in disk write speed, but does not match Rackspace in disk read or overall disk performance. Similarly Amazon outperforms HOSTING in disk read, but not disk write speed.

System Performance

Results

HOSTING performs 67% greater than Rackspace, and 167% greater than Amazon in overall system performance. Amazon has the most predictable performance stability with a CV of 3.1%, followed by HOSTING at 5.9% and Rackspace at 20.5%. The overall higher performance of HOSTING downplays the significance of its minimal performance unpredictability compared to Amazon.



The graph above compares general server performance on a Linux server between HOSTING, Rackspace and Amazon. The graph shows the score of the UnixBench benchmark of each provider over a period of 14 days, with two data points shown for each day. As shown above, HOSTING consistently outperforms both Rackspace and Amazon over the entire test period.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-Day LOW
HOSTING	1014	60	5.9%	1118	879
Rackspace	609	125	20.5%	920	469
Amazon	380	12	3.1%	421	368

Test Description

See Appendix B

CPU Performance

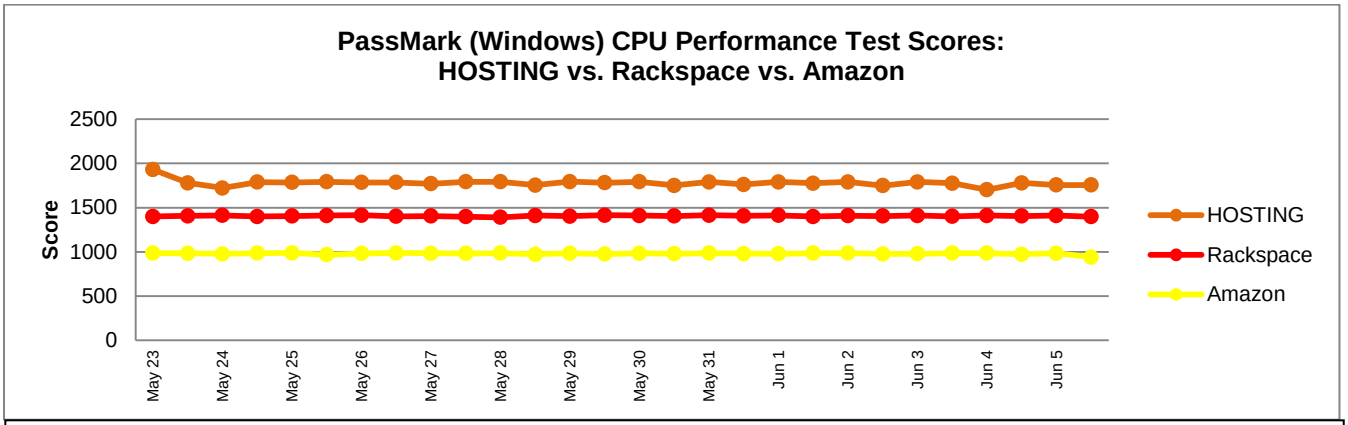
Why CPU Matters

The CPU is the most important component of overall system performance. The CPU is the brain of the system. It pulls data out of storage and fills the RAM. It determines how fast things can happen. Gaming, video editing, encryption, and graphics rendering are just a few actions that are reliant upon CPU performance. The increasing presence of HD video, high quality gaming, and other engaging content adds to the need for high CPU performance. Security concerns will lead to more complex encryption methods, which also rely on the CPU. The big data revolution we are seeing is possible because of the immense power of modern CPUs. In a big data scenario, superior CPU performance can significantly shrink the time it takes to crunch massive amounts of data to produce meaningful results. The amount of data being calculated, consumed, compressed and encrypted is growing fast. Massive processing power is more of a need now than ever.

CPU Results

Windows Server Results

The tests of CPU performance in Windows systems show HOSTING outperforming Rackspace and Amazon in the majority of benchmarks. The average overall PassMark CPU Score of HOSTING is 27% higher than Rackspace, and 82% higher than Amazon. The predictability of performance of the three providers does not present itself to be an issue since the CVs are all 2.1% or lower.



The graph above compares CPU performance on a Windows server between HOSTING, Rackspace and Amazon. The graph shows the scores from the PassMark benchmark test for each provider over a period of 14 days, with two data points shown for each day. As shown above, HOSTING consistently outperforms both Rackspace and Amazon over the entire test period.

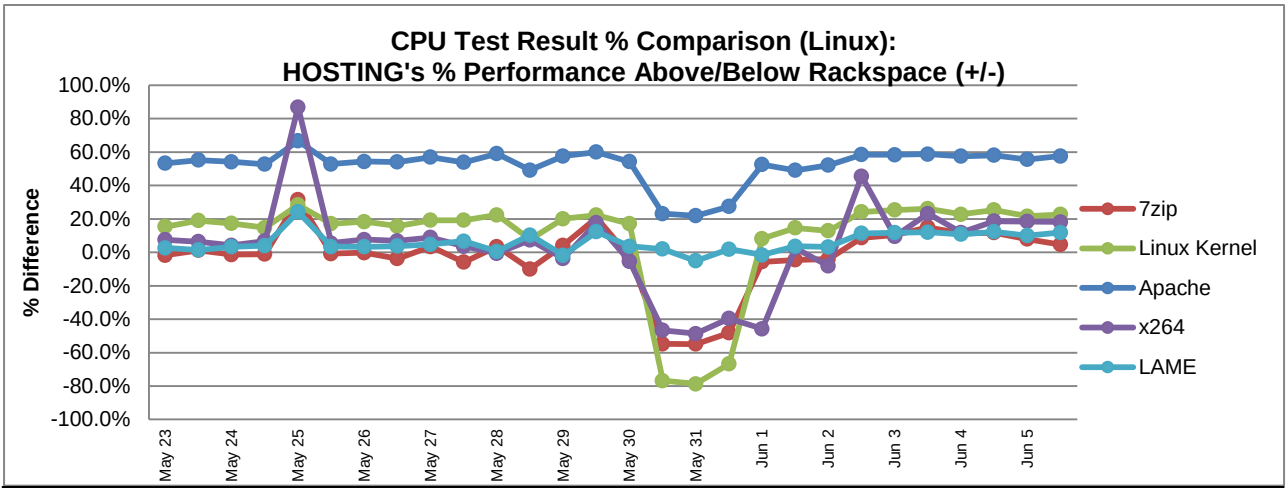
PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING	1779	37	2.1%	1930	1701
Rackspace	1406	6	0.4%	1414	1390
Amazon	979	9	0.9%	987	940

Linux Server Results

The aggregate performance differentials between the three providers for Linux systems show HOSTING CPUs outperforming Rackspace's CPUs by 10.1% and Amazon's by 49%. HOSTING also shows it provides the benefits of stable systems with low coefficients of variation (CVs) that are less than one-third that of Rackspace. However, Amazon is the most stable with an average CV of 3.1%, compared to HOSTING's CV of 6.8% and Rackspace's CV of 19.3%.

HOSTING's CPUs do exceptionally well in the Timed Apache Compilation tests, outperforming Rackspace and Amazon by 54% and 66%, respectively. HOSTING also shows superiority in the Timed Linux Kernel Compilation test by being 14% and 52% faster than Rackspace and Amazon, respectively.

Comparing only HOSTING and Rackspace, HOSTING outperforms Rackspace by a large margin in one of the benchmarks, the Timed Apache Compilation, while outperforming them by a smaller margin in the Timed Linux Kernel test. HOSTING slightly underperforms in the 7zip Compression, x264 and LAME tests, on average. However, HOSTING offers slightly greater performance for the majority of the test period, except for a brief period where Rackspace's servers perform at a high enough level to affect the averages for the entire test period.



The graph above compares CPU performance on a Linux server between HOSTING and Rackspace. The aggregate results of five separate benchmarks are shown using the different colored trend lines. Rackspace was used as the baseline (0% on the y-axis) for comparison against HOSTING. As shown above, HOSTING outperforms Rackspace on most tests for the majority of the testing period.

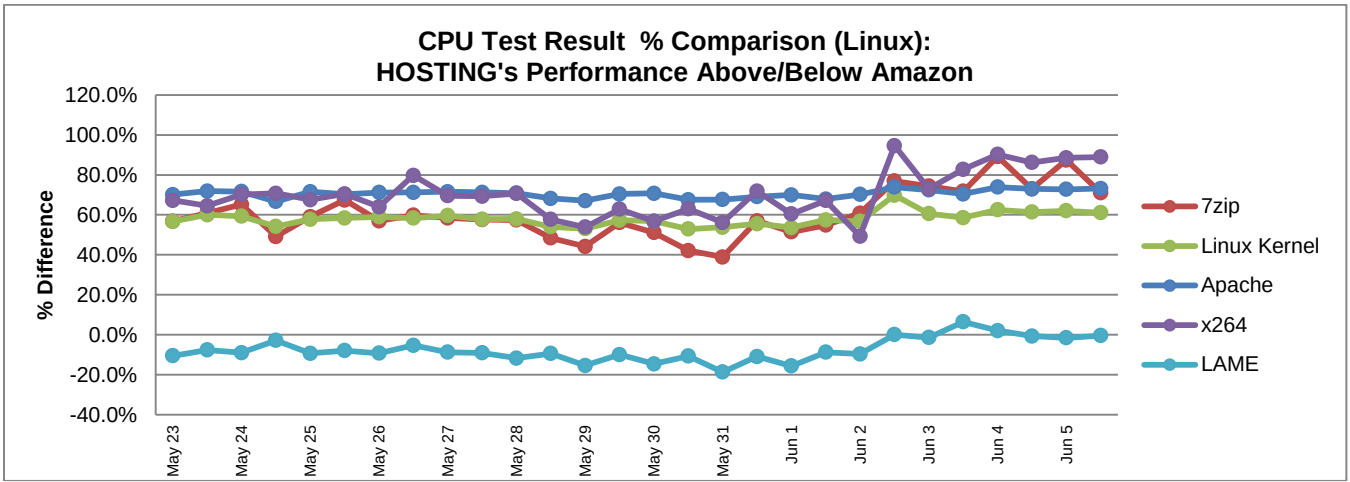
Performance

TEST	HOSTING AVG	RACKSPACE AVG	HOSTING VS RAX
7zip	3160 MIPS	3417 MIPS	-7.5%
Timed Linux Kernel	391 seconds	453 seconds	13.7%
Timed Apache	56 seconds	121 seconds	53.7%
X264	25 Fps	26 Fps	-3.8%
LAME MP3	33 seconds	35 seconds	-5.7%
AVERAGE			**10.1%**

Variability

TEST	HOSTING CV	RACKSPACE CV
7zip	6.8%	28.5%
Timed Linux Kernel	6.4%	17.0%
Timed Apache	6.4%	14.5%
X264	6.8%	31.1%
LAME MP3	4.7%	5.5%
AVERAGE	**6.2%**	**19.3%**

Comparing HOSTING and Amazon, HOSTING outperforms Amazon by a very large margin in four out of five Linux CPU benchmarks. HOSTING only underperforms in the LAME MP3 Encoding test by a small margin.



The graph above compares CPU performance on a Linux server between HOSTING and Amazon. The aggregate results of five separate benchmarks are shown using the different colored trend lines. Amazon was used as the baseline (0% on the y-axis) for comparison against HOSTING for each of the tests. As shown above, HOSTING outperforms Amazon on most tests, between 50-80% on average, except for the LAME test in which it is 10% slower.

Performance

TEST	HOSTING AVG	AMAZON AVG	HOSTING VS AMZN
7zip	3160 MIPS	1969 MIPS	60.5%
Timed Linux Kernel	391 seconds	935 seconds	58.2%
Timed Apache	56 seconds	191 seconds	70.7%
X264	25 Fps	15 Fps	66.7%
LAME MP3	33 seconds	30 seconds	-10.0%
AVERAGE			**49.2%**

Variability

TEST	HOSTING CV	AMAZON CV
7zip	6.8%	2.8%
Timed Linux Kernel	6.4%	5.5%
Timed Apache	6.4%	2.9%
X264	6.8%	2.2%
LAME MP3	4.7%	2.0%
AVERAGE	**6.2%**	**3.1%**

Test Descriptions

See Appendix C

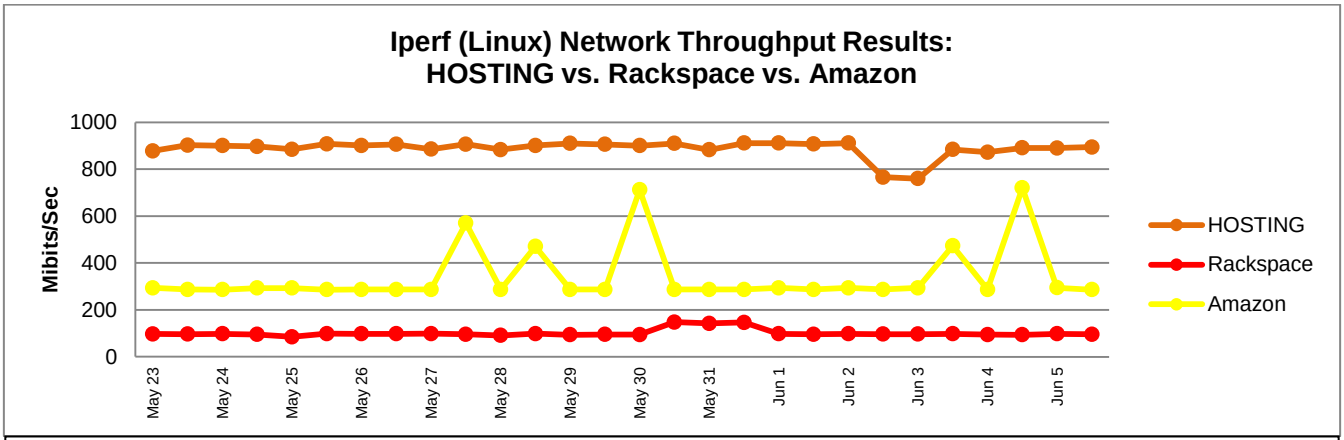
Internal Network Performance

Why internal network performance matters

The internal network is used to transmit data between different servers within a data center. In cloud computing, data is stored and processed in virtual environments spread across multiple physical servers. It is important that the data is accessible from anywhere within the data center, as quickly as possible. Applications that split their workload across multiple machines can be limited by bottlenecks in the internal network. When using a SAN, I/O capability can also be limited by a slow internal network. Even if a physical server is running top of the line hardware, and the virtualization environment is appropriately abstracted, a slow network negates the benefit of having high performance machines.

Results

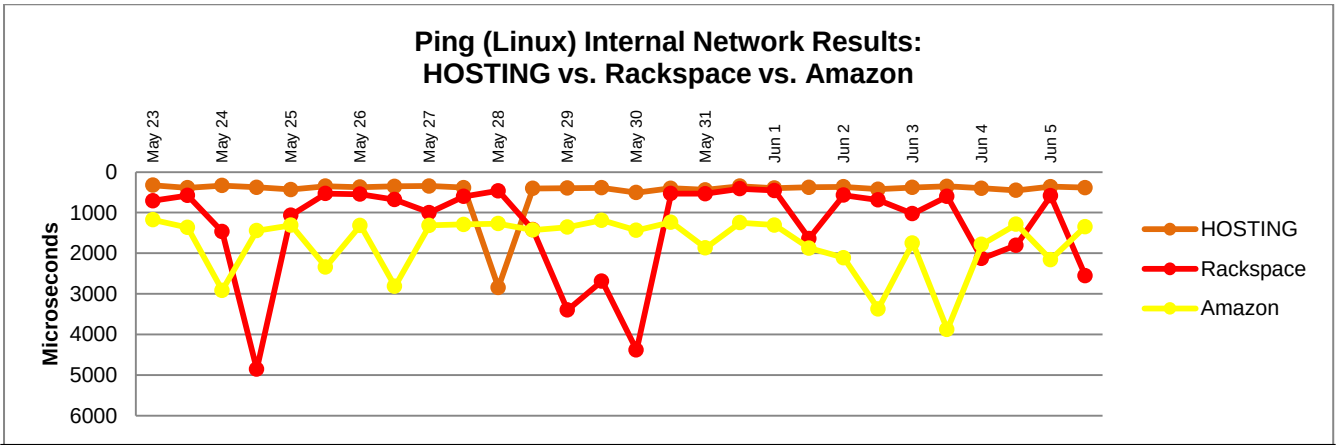
HOSTING's network throughput for Linux systems is on average 888 Mibits/sec, which is more than 2.5x that of Amazon and nearly 9x that of Rackspace. HOSTING also provides the most stable network throughput with a CV of 4.2%, compared to 15.9% for Rackspace and 37% for Amazon.



The graph above compares internal network performance between Linux servers for HOSTING, Rackspace and Amazon. The graph shows the network throughput results from the Iperf benchmark of each provider over a period of 14 days, with two data points shown for each day. As shown above, HOSTING outperforms Amazon by about 2.5x and Rackspace by 8.5x.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING	888 Mibits/sec	37 Mibits/sec	4.2%	912 Mibits/sec	760 Mibits/sec
Rackspace	101 Mibits/sec	16 Mibits/sec	15.7%	148 Mibits/sec	85 Mibits/sec
Amazon	343 Mibits/sec	126 Mibits/sec	37%	720 Mibits/sec	286 Mibits/sec

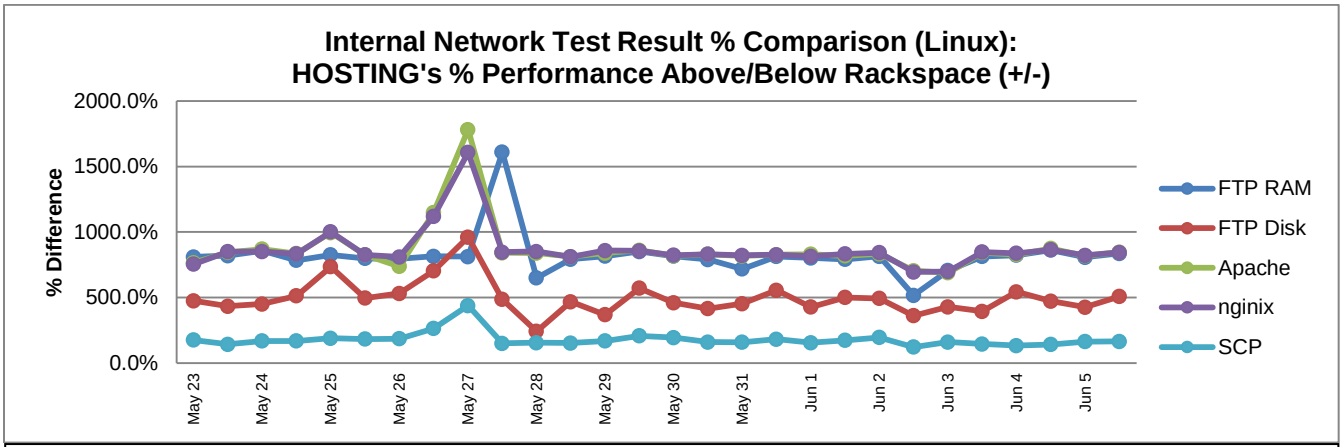
The results of the Ping benchmark show the stability of HOSTING throughout the twenty-day test period, while Rackspace's and Amazon's performance was erratic and unstable for this duration. HOSTING has the lowest average latency at 474 microseconds. Except for higher latency recorded on May 28th, HOSTING has the most stable throughout for most of the 14-day test period.



The graph above compares internal network performance between Linux servers for HOSTING, Rackspace and Amazon. The graph shows the network latency results from the Ping benchmark of each provider over a period of 14 days, with two data points shown for each day. As shown above, HOSTING has stable latency throughout most of the testing period, compared to Rackspace and Amazon whose latency is highly variable and elevated over several days.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING	474 µs	466 µs	98.3%	2844 µs	324 µs
Rackspace	1353 µs	1210 µs	89.4%	4858 µs	411 µs
Amazon	1757 µs	712 µs	40.5%	3880 µs	1178 µs

In the remaining five network tests, HOSTING outperformed Rackspace by an average of 633%. Against Amazon, HOSTING outperformed by 111% on average (*see chart on following page*). Comparing HOSTING to Rackspace, HOSTING dramatically outperforms Rackspace in a majority of the tests. In the Network FTP RAM, wget/Apache and wget/nginix tests, HOSTING is over 800% faster for each test. On the Network SCP test, HOSTING outperforms Rackspace by a significant 175%.



The graph above compares internal network performance on a Linux server between HOSTING and Rackspace. The aggregate results of five separate benchmarks are shown using the different colored trend lines. Rackspace was used as the baseline (0% on the y-axis) for comparison to HOSTING for each of the tests. As shown above, HOSTING outperforms Rackspace on each of the tests, up to a magnitude of 1,000% and higher.

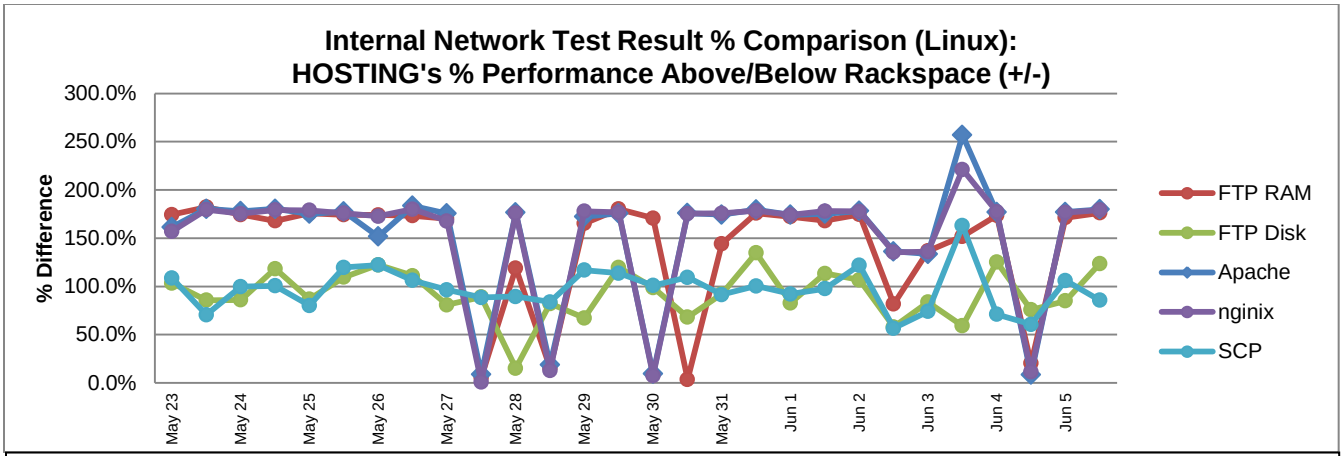
Performance

TEST	HOSTING AVG	RACKSPACE AVG	HOSTING VS RAX
Network FTP RAM	834 Mibits/sec	92 Mibits/sec	806%
Network FTP Disk	522 Mibits/sec	90 Mibits/sec	480%
wget/Apache	864 Mibits/sec	91 Mibits/sec	849%
wget/nginix	868 Mibits/sec	91 Mibits/sec	854%
Network SCP	239 Mibits/sec	87 Mibits/sec	175%
AVERAGE			**633%**

Variability

TEST	HOSTING CV	RACKSPACE CV
Network FTP RAM	7.8%	9.0%
Network FTP Disk	12.9%	12.8%
wget/Apache	4.5%	11.2%
wget/nginix	4.2%	10.4%
Network SCP	8.3%	10.7%
AVERAGE	**7.5%**	**10.8%**

Comparing HOSTING to Amazon, HOSTING outperforms Amazon at least 2x in 60% of the internal network tests. Performing best in the wget/Apache and wget/nginix tests, HOSTING's internal transfer speed between web servers is higher than Amazon by about 125%. Overall, HOSTING performs better than Amazon across all the internal network tests, and offers an average 74% greater stability.



The graph above compares internal network performance on a Linux server between HOSTING and Amazon. The aggregate results of five separate benchmarks are shown using the different colored trend lines. Amazon was used as the baseline (0% on the y-axis) for comparison to HOSTING for each of the tests. As shown above, HOSTING outperformed Amazon in each of the tests. HOSTING also has greater stability for most of the tests by comparison.

Performance

TEST	HOSTING AVG	AMAZON AVG	HOSTING VS AMZN
Network FTP RAM	834 Mibits/sec	380 Mibits/sec	119%
Network FTP Disk	522 Mibits/sec	272 Mibits/sec	92%
wget/Apache	864 Mibits/sec	382 Mibits/sec	126%
wget/nginix	868 Mibits/sec	387 Mibits/sec	124%
Network SCP	239 Mibits/sec	122 Mibits/sec	96%
AVERAGE			**111%**

Variability

TEST	HOSTING CV	AMAZON CV
Network FTP RAM	7.8%	43.0%
Network FTP Disk	12.9%	3.5%
wget/Apache	4.5%	44.6%
wget/nginix	4.2%	46.0%
Network SCP	8.3%	8.0%
AVERAGE	**7.5%**	**29.2%**

Test Descriptions

See Appendix D

Disk Performance

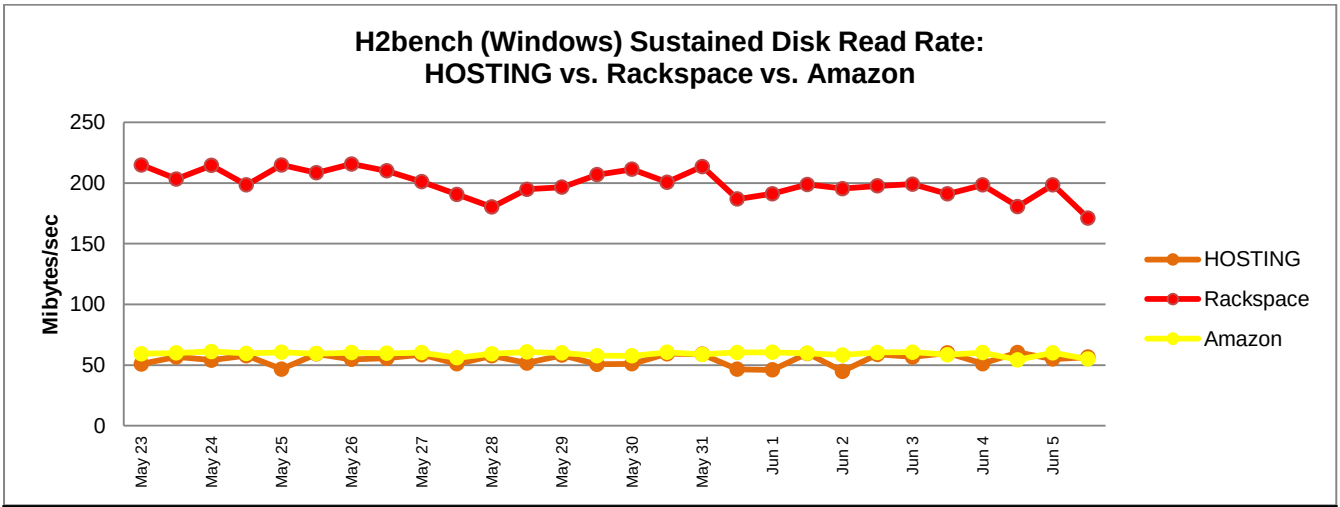
Why Disk performance matters

The disk is where it all starts. All the data has to go somewhere, and the disk is where it is stored. Whether they are using traditional spinning hard drives, or newer solid-state drives (SSD), service vendors need to provide customers with reliable and efficient means of storing their data. The disk needs to be able to quickly and reliably read/write the data it receives or that is requested from the other components of the server. The most common measurement for storage system performance is the input/output operations per second (IOPS) which measures how long the system has to wait as data is read from, or written to, the disk. As the quantity of data stored and analyzed scales upwards, every single IOPS a disk can handle will carry greater significance.

Results

Windows Server

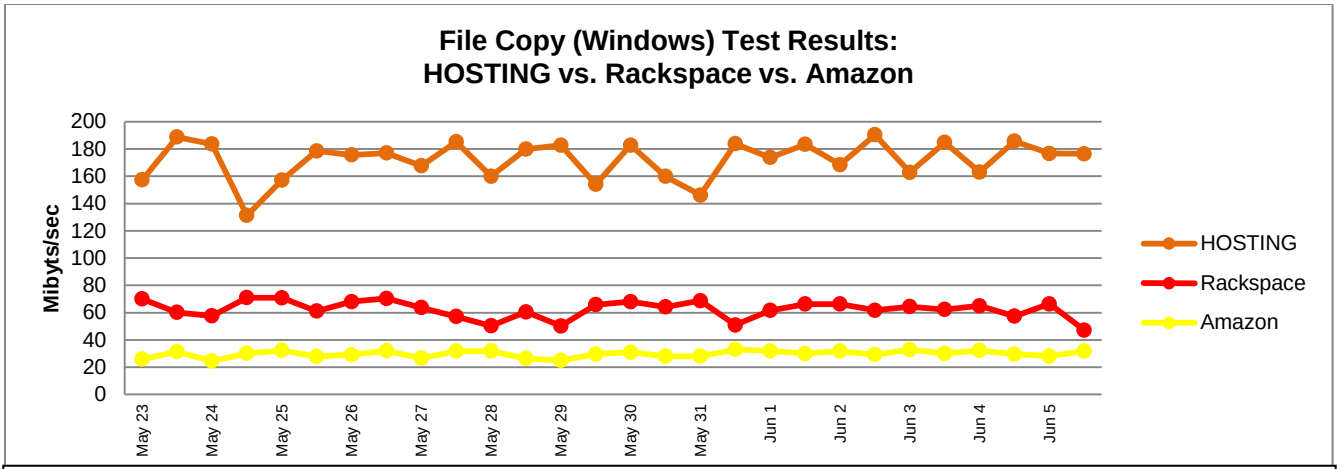
The results of the H2bench clearly show Rackspace with the highest sustained disk read rate out of the three providers. Rackspace averages 199 Mibytes/sec, compared to Amazon at 59 Mibytes/sec and HOSTING at a close 3rd place at 55 Mibytes/sec. Amazon leads in performance stability with a standard deviation of 2 Mibytes/sec and a CV of 3%. Rackspace is also relatively stable with only an 11 Mibytes/sec standard deviation and 6% CV. HOSTING is third, with a standard deviation of 5 Mibytes/sec and 9% CV.



The graph above compares disk performance on a Windows server between HOSTING, Rackspace and Amazon. The graph shows the sustained disk read rates from the H2bench benchmark results of each provider over a period of 14 days, with two data points shown for each day. As shown above, Rackspace outperforms both HOSTING and Amazon over the course of the testing period, where HOSTING and Amazon perform almost on par with each other.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING	55 MiBytes/sec	5 MiBytes/sec	8.6%	60 MiBytes/sec	45 MiBytes/sec
Rackspace	199 MiBytes/sec	12 MiBytes/sec	5.7%	216 MiBytes/sec	171 MiBytes/sec
Amazon	59 MiBytes/sec	2 MiBytes/sec	2.9%	61 MiBytes/sec	54 MiBytes/sec

The File Copy test measures the read/write ability of the disk by copying a large file. HOSTING's disk performs the copy an average of 3x faster than Rackspace and 6x faster than Amazon. In terms of performance reliability, Rackspace and Amazon offer a more consistent disk speed. However, the values for HOSTING at its lowest points are higher than the majority of the highest values for Rackspace and Amazon. When processing large amounts of data, slow and/or inconsistent read/write speeds can result in poor performance, affecting end users.

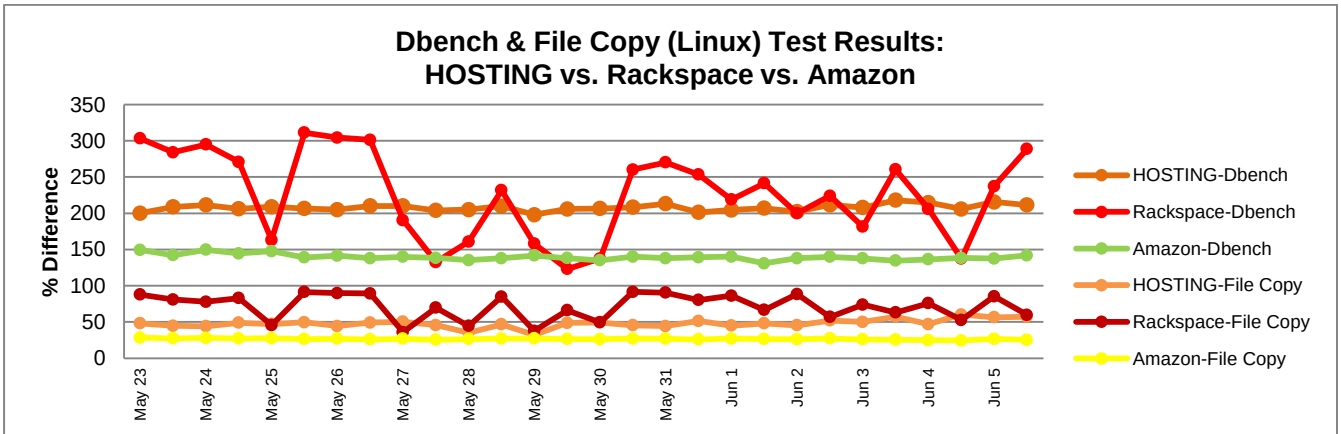


The graph above compares disk performance on a Windows server between HOSTING, Rackspace and Amazon. The graph shows the file copy speed from the File Copy benchmark results of each provider over a period of 14 days, with two data points shown for each day. As shown above, HOSTING outperforms Rackspace by nearly 3x and Amazon by nearly 6x throughout most of the testing period.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING	172 MiBytes/sec	14 MiBytes/sec	8.3%	190 MiBytes/sec	131 MiBytes/sec
Rackspace	62 MiBytes/sec	7 MiBytes/sec	10.6%	71 MiBytes/sec	47 MiBytes/sec
Amazon	30 MiBytes/sec	2 MiBytes/sec	8.2%	33 MiBytes/sec	25 MiBytes/sec

Linux Server

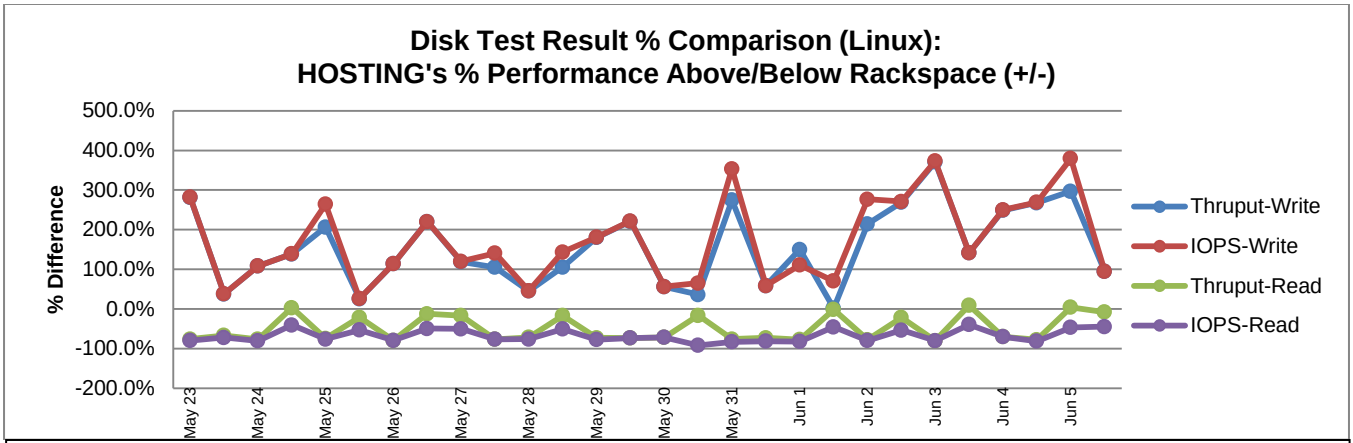
Rackspace outperforms both HOSTING and Amazon in the Dbench and File Copy tests. Rackspace recorded the highest average result of 227 Mibits/sec on Dbench, and 72 Mibits/sec on File Copy tests. HOSTING nearly matched Rackspace's performance with 208 Mibytes/sec on Dbench, and 48 Mibytes/sec on File Copy. HOSTING and Amazon match up in stability for the Dbench test, but Rackspace varies across the entire testing period. In the File Copy test, Rackspace again offers the least predictable performance with a CV of 24.7%.



The graph above compares disk performance on a Linux server between HOSTING, Rackspace and Amazon. The graph shows the aggregate results from the Dbench and File Copy benchmark tests of each provider over a period of 14 days, with two data points shown for each day. As shown above, Rackspace performs best on both tests, followed closely by HOSTING. Amazon performs around half as well as the other two providers.

PROVIDER	AVERAGE	STANDARD DEVIATION	CV	14-DAY HIGH	14-DAY LOW
HOSTING – Dbench	208 MiBytes/sec	5 MiBytes/sec	2.2%	218 MiBytes/sec	198 MiBytes/sec
Rackspace – Dbench	227 MiBytes/sec	60 MiBytes/sec	26.4%	311 MiBytes/sec	123 MiBytes/sec
Amazon – Dbench	140 MiBytes/sec	4 MiBytes/sec	3.0%	150 MiBytes/sec	131 MiBytes/sec
HOSTING – File Copy	48 MiBytes/sec	6 MiBytes/sec	12.3%	60 MiBytes/sec	32 MiBytes/sec
Rackspace – File Copy	72 MiBytes/sec	18 MiBytes/sec	24.7%	92 MiBytes/sec	36 MiBytes/sec
Amazon – File Copy	27 MiBytes/sec	1 MiBytes/sec	3.4%	28 MiBytes/sec	24 MiBytes/sec

HOSTING outperforms Rackspace by a large margin on file system write IOPS and throughput by 144% and 128% respectively. However, HOSTING performs 65% and 74% slower in file system read IOPS and throughput compared to Rackspace.



The graph above compares disk performance on a Linux server between HOSTING and Rackspace. The aggregate results of four separate benchmarks are shown using the different colored trend lines. Rackspace was used as the baseline (0% on the y-axis) for comparison to HOSTING for each of the tests. As shown above, HOSTING outperforms Rackspace in the disk write tests, and Rackspace outperforms HOSTING in the disk read tests.

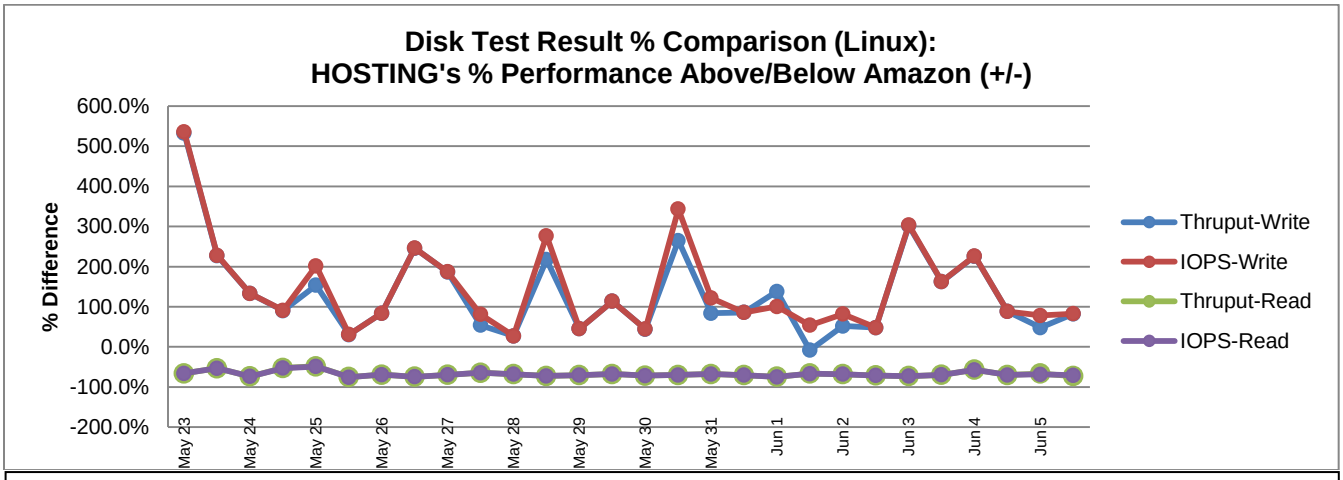
Performance

TEST	HOSTING AVG	RACKSPACE AVG	HOSTING VS RAX
FIO Throughput – Write	55791 Kb/sec	24461 Kb/sec	128%
FIO IOPS – Write	743 Ops/sec	305 Ops/sec	144%
FIO Throughput – Read	16376 Kb/sec	46960 Kb/sec	-65%
FIO IOPS – Read	204 Ops/sec	784 Ops/sec	-74%

Variability

TEST	HOSTING CV	RACKSPACE CV
FIO Throughput – Write	23.2%	39.0%
FIO IOPS – Write	25.8%	39.1%
FIO Throughput – Read	10.5%	52.2%
FIO IOPS – Read	10.5%	52.3%
AVERAGE	**17.5%**	**45.7%**

HOSTING outperforms Amazon by a respective 102% and 116% on throughput and IOPS file system write tests. However, Amazon outperforms HOSTING by a similar 66% and 66% for throughput and IOPS file system read.



The graph above compares disk performance on a Linux server between HOSTING and Amazon. The aggregate results of four separate benchmarks are shown using the different colored trend lines. Amazon was used as the baseline (0% on the y-axis) for comparison to HOSTING for each of the tests. As shown above, HOSTING outperforms Amazon in the disk write tests, and Amazon outperforms HOSTING in the disk read tests.

Performance

TEST	HOSTING AVG	Amazon AVG	HOSTING VS AWS
FIO Throughput – Write	55791 Kb/sec	27598 Kb/sec	102%
FIO IOPS – Write	743 Ops/sec	344 Ops/sec	116%
FIO Throughput – Read	16376 Kb/sec	51774 Kb/sec	-68%
FIO IOPS – Read	204 Ops/sec	646 Ops/sec	-68%

Variability

TEST	HOSTING CV	AMAZON CV
FIO Throughput – Write	23.2%	38.7%
FIO IOPS – Write	25.8%	38.8%
FIO Throughput – Read	10.5%	13.1%
FIO IOPS – Read	10.5%	13.1%
AVERAGE	**17.5%**	**25.9%**

Test Descriptions

See Appendix E

Appendix

Appendix A

Methodology

Server Setup:
Two servers are set up on each provider that match the following configurations as closely as possible. The Primary Server runs all tests specific to CPU and storage. The Secondary Server is used in conjunction with the Primary Server to test the internal network.

Primary Server
- 2 vCPU
- 4 GB RAM
- 50 GB Storage

Secondary Server
- 1 vCPU
- 1 GB RAM
- 50 GB Disk

The following server configurations were set up on each provider. The pre-configured VMs that characterize Amazon and Rackspace offerings make it impossible to match target configurations exactly.

Amazon AWS EC2
http://aws.amazon.com/ec2/instance-types/

Primary:
Availability zone East-1a
OS: Ubuntu 12.04 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 1 (with 2 ECU)
RAM: 3.75GB
Disk: 410GB

Secondary:
Availability zone East-1a
OS: Ubuntu 12.04 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 1 (with 2 ECU)
RAM: 3.75GB
Disk: 410GB

HOSTING Public Cloud (Cloud Enterprise)
http://www.hosting.com/managed-services/order-online

Primary:
Data center East-1
OS: Red Hat Enterprise Linux 5 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 2
RAM: 4GB
Disk: 50GB

Secondary:
Data center East-1
OS: Red Hat Enterprise Linux 5 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 2
RAM: 4GB
Disk: 50GB

Rackspace OpenStack Cloud
http://www.rackspace.com/cloud/servers/pricing/

Primary:
Data center Dallas Fort Worth (DFW)
OS: Ubuntu 12.04 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 2
RAM: 4GB
Disk: 160GB

Secondary:
Data center Dallas Fort Worth (DFW)
OS: Ubuntu 12.04 (Linux Test)
Windows Server 2008 R2 (Windows Test)
vCPUs: 2
RAM: 4GB
Disk: 50GB

Tests Used
The benchmarks used to test the providers listed in this report are derived from a number of sources. Many of the Linux tests use benchmarks from the Phoronix Test Suite, a compilation of varying types of open-source benchmarks. Most of the Windows tests use benchmarks from the CPU and disk tests of PassMark Software. For descriptions of test used, please see the Test Descriptions below.

System (Linux)
- UnixBench

CPU
Linux
- 7zip Compression
- Timed Linux Kernal Compilation
- Timed Apache Compilation
- X264
- LAME MP3 Encoding

Windows
- PassMark

Internal Network (Linux)
- Iperf
- Ping
- Network FTP RAM
- Network FTP Disk
- Wget/Apache
- Wget/Nginx
- Network SCP

Storage
Linux
- DBench
- File Copy
- FIO Throughput Write
- FIO Throughput Read
- FIO IOPS Write
- FIO IOPS Read

Windows
- H2Bench
- File Copy

Timeframe
The test period for Linux systems ranges from 5/23/2013 to 6/5/2013.
The test period for Windows systems ranges from 5/16/2013 to 5/29/2013.

Data Collection

Performance data for each test was collected three times per day, every day throughout the above testing periods. Data shown in the graphs and tables only take the highest and lowest point of each day into account. Rather than showing all the data points collected, only showing the highest and lowest points of the day let customers determine the range of best to worst performance they could expect from a virtual server from the providers.

Cloud Spectator obtains cloud servers by purchasing the server space directly from the providers as any user would. For certain providers, the client may reimburse Cloud Spectator for the sever space needed for data collection relevant to that active project. Cloud Spectator collects and compiles the data into the CloudSpecs database and translates it into a visual display.

Terms and Definitions

For the purpose of understanding the relational values of the data, all numbers within the tables below each graph are expressed as whole numbers except the percentages, which are expressed to the tenth decimal point. Percentages are expressed in that manner to account for instances when the coefficient of variation (CV), which is expressed as a percentage, falls below 1%, indicating a high degree of performance predictability.

Average

When describing averages, Cloud Spectator refers to the average numerical value over a period of x days from y until z (14 days; from 5/23/2013 to 6/5/2013 and 5/16/2013 to 5/29/2013). Average provider scores can be found inside the tables underneath each graph within this document. The average is used to summarize the data from the charts in a simplified overview.

Standard Deviation

The standard deviation is calculated over a period of x days from y until z (14 days; from 5/23/2013 to 6/5/2013 and 5/16/2013 to 5/29/2013). The standard deviation can be found inside the tables underneath each graph within this document. The standard deviation is used to understand the amount of variation from the average benchmark score of a provider; i.e., how predictable a provider's server performance is for that test. The standard deviation can only be used to understand the amount of variation within a certain provider, and cannot be used to compare among providers.

Coefficient of Variation (CV)

The coefficient of variation is expressed as a percentage. The CV can be found inside the tables underneath each graph within this document. The CV is a measure of precision. It normalizes the standard deviation as a percentage of the average, which can be compared across providers. A lower CV means more stable performance.

```
[(Standard Deviation) / (Average)] * 100
```

14-Day Highs and Lows

From the tested period between y until z (14 days; from 5/23/2013 to 6/5/2013 and 5/16/2013 to 5/29/2013), Cloud Spectator extracts and presents the highest and lowest achieved scores by each provider in the tables underneath the graphs within this document.

Appendix B

Test Descriptions

UnixBench

The purpose of UnixBench is to provide a basic indicator of the performance of a Unix-like system; hence, multiple tests are used to test various aspects of the system's performance. These test results are then compared to the scores from a baseline system to produce an index value, which is generally easier to handle than the raw scores. The entire set of index values is then combined to make an overall index for the system.

Appendix C

Test Descriptions

Passmark (Windows)

The Passmark suite is comprised of nine separate CPU tests that are all aggregated into a final score:

- Integer Math Test – measures how fast the CPU can perform mathematical operations with integers
- Compression Test – measures the speed at which the CPU can compress blocks of data into smaller blocks (kilobytes/sec)
- Prime Number Test – measures how fast the CPU can search for prime numbers (operations/sec)
- Encryption Test – encrypts blocks of random data with different encryption methods
- Floating Point Math Test – performs same operations as Integer Math Test, but with numbers with fractional parts (e.g. 5.927)
- Multimedia Instructions – measures SSE capabilities (instructions for processing data at higher speeds) of a CPU
- String Sorting Test – uses the qSort algorithm to see how fast the CPU can sort strings
- Physics Test – uses the Tokamak Physics Engine to measure how fast the CPU can calculate physics interactions of hundreds of objects colliding
- Single Core Test – an aggregate of the floating point, string sorting, and data compression tests

Source: cpubenchmark.net

7-zip Compression
A benchmark found within the Phoronix Test Suite. The test measures how many instructions a CPU can complete per second, expressed as millions of instructions per second (MIPS). The test consists of compressing a file with random data using the 7-zip program and then dividing the number of CPU instructions executed during the compression by the number of seconds. The result is then divided by one million to calculate the value in MIPS.

Timed Linux Kernel
A test to determine the amount of time needed to build the Linux kernel.

Timed Apache
A test to determine the amount of time needed to build the Apache HTTP server.

X264
A benchmark found within the Phoronix Test Suite. Tests the performance of the CPU by converting an uncompressed video to MPEG-4/H.264 format. Scoring is based upon the number of frames converted per second.

LAME MP3 Encoding
Measures the amount of time required to convert a WAV file to MP3 format.

Appendix D

Test Descriptions

Iperf
A frequently used network testing tool that can create TCP and UDP data streams to measure the throughput of a network that is carrying them. Cloud Spectator's test transfers as much data as possible through the local network for 120 seconds over TCP port 5001.

Ping
In contrast to throughput testing, ping commands can be used to measure the latency between nodes on a private network. Higher latency severely degrades application performance in a distributed computing environment, and can adversely impact user experience, especially with regard to time-sensitive applications.

Other Benchmarks:

Network FTP RAM
Transfer of a 1 GB file from ramdisk to ramdisk between two machines hosted by the same provider using the lftp client, vsftpd server.

Network FTP Disk
Transfer of a 5 GB file from disk to disk between two machines hosted by the same provider using the lftp client, vsftpd server.

wget/Apache
Transfer of a 1 GB file between two machines hosted by the same provider using the apache web server and wget client.

wget/nginix
Transfer of a 1 GB file between two machines hosted by the same provider using the nginx web server and wget client.

Network SCP
Transfer of a 5 GB file from disk to disk between two machines hosted by the same provider using scp.

Appendix E

Test Descriptions

H2bench (Windows)
Average sustained disk read rate

File Copy (Linux/Windows)
Copy of a 10 GB file to the same disk

Dbench
Dbench is a benchmark designed by the Samba project as a free alternative to Netbench, but Dbench contains only file-system calls for testing the disk performance.

FIO
Cloud Spectator used Fio to measure file system IO. Fio is a benchmark tool used to measure IO for hardware verification. For the purpose of this set of tests, Cloud Spectator runs a random pareto distribution with a size of 10GB for 1 thread and 8 concurrent threads to understand performance as the system is scaled. Data is calculated to return values of operations per second. File system IO is important in understanding and predicting the performance of production cloud servers such as a database.

About Cloud Spectator

Cloud Spectator is the premier, international cloud analyst group focused on infrastructure pricing and server performance. Since 2011, Cloud Spectator has monitored the cloud Infrastructure industry on a global scale and continues to produce research reports for businesses to make informed purchase decisions by leveraging its CloudSpecs utility, an application that automates live server performance tests 3 times a day, 365 days a year with use of open source benchmark tests. Currently, the CloudSpecs system actively tracks 20 of the top IaaS providers around the world.

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