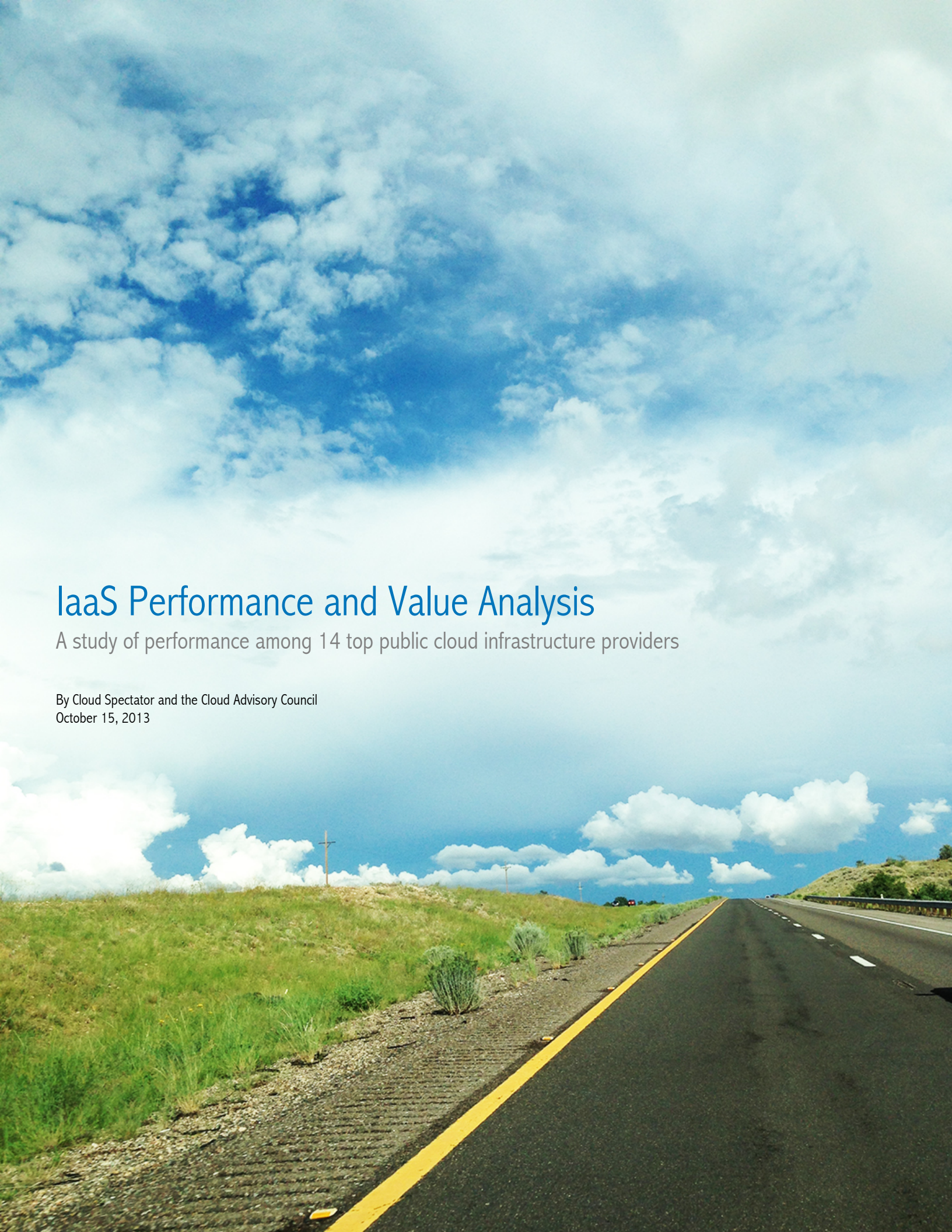

IaaS Performance and Value Analysis

A study of performance among 14 top public cloud infrastructure providers

By Cloud Spectator and the Cloud Advisory Council
October 15, 2013

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Executive Summary

Overview

Transparency in virtual server performance is a crucial component for vendor selection. As listed on Table 2.3 within the Experiment Information (Additional Server Information) section, hardware varies among providers; thus, performance is not standardized nor guaranteed. This document reports the performance information of 14 of the largest Infrastructure as a Service (IaaS) providers in the United States. While many of the providers serve clients globally with data centers worldwide, Cloud Spectator and the Cloud Advisory Council conducted this study exclusively in each provider's US data center. Running across a period of 10 consecutive days, the information in this report detail performance results on each provider's system, including component-level tests measuring CPU, disk, RAM, and internal network.

Performance data is related with cost of servers to acquire a price-performance value index, which is used to compare value among providers based on the results. This index is called the CloudSpecs Score. For more information on how the CloudSpecs Score is calculated, please see the section Experiment Information (Price-Performance Value: The CloudSpecs Score).

Findings

Table 1.1 lists an overview of the top providers from each comparison. Only the top 3 within each category are listed. The *Performance Leaders* category exclusively ranks IaaS providers from best to worst performance results. The *CloudSpecs Leaders* category ranks providers based on their CloudSpecs price-performance index, a relational integer from 1-100 (100 is the highest score) used to compare each provider's value.

For general system performance, Virtustream received the highest value score in the *CloudSpecs Leaders* segment. With performance exclusively, Tier 3 ranks first. The IaaS offerings of HP Cloud, SoftLayer, Tier 3, and Virtustream consistently rank as both *Performance Leaders* and *CloudSpecs Leaders* throughout the study. A combination of effective pricing and strong performance places those providers within the top tier of these categories.

Savvis is ranked on several of the *CloudSpecs Leaders* boards, and a *Performance Leader* of internal network performance. Microsoft Azure emerges as a *CloudSpecs Leader* in system performance; Dimension Data's offering ranks as a *CloudSpecs Leader* for disk performance.

	CloudSpecs Leaders	Performance Leaders
System	Virtustream HP Cloud Microsoft Azure	Tier 3 Virtustream HP Cloud

	CloudSpecs Leaders	Performance Leaders
CPU	Savvis Virtustream HP Cloud	SoftLayer Tier 3 Virtustream
Disk	HP Cloud Virtustream Dimension Data	Tier 3 HP Cloud Virtustream
RAM	HP Cloud Savvis Tier 3	Tier 3 HP Cloud SoftLayer
Internal Network	Savvis Virtustream Tier 3	Virtustream Tier 3 Savvis

Table 1.1

Experiment Information

Cloud Spectator monitors the CPU, RAM, storage, and internal network performance of over 20 of the world's most recognized IaaS services to understand important aspects of virtual server performance. Tests are run 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 a standard for VM performance comparison, giving consumers an indication of which services would be best for their application(s).

Time Frame Tests were run for ten (10) consecutive days on all providers from October 1, 2013 through October 10, 2013

Providers

Amazon AWS	Microsoft Azure
Dimension Data's OpSource	Rackspace
Fujitsu	Savvis
GoGrid	SoftLayer (Acquired by IBM)
HP Cloud	Tier 3
IBM SmartCloud Enterprise+	Verizon Terremark
Joyent	Virtustream

Tests Suites Unixbench Phoronix Test Suite

Price-Performance Value: The CloudSpecs Score

The CloudSpecs score calculates the relationship between the cost of a virtual server per hour and the performance average seen from each provider. The scores are relational to each other; e.g., if Provider A scores 50 and Provider B scores 100, then Provider B delivers 2x the performance value in terms of cost. The highest value provider will always receive a score of 100, and every additional provider is pegged in relation to that score. The calculation is:

- (Provider Average Performance Score) / (Provider Cost per Hour) = VALUE
- The largest VALUE is then taken as the denominator to peg other VALUES.
- [(Provider's VALUE) / (Largest VALUE)] * 100 = CloudSpecs Score (CS Score)

CLIENT Configurations and Costs

The CLIENT virtual machine is used in this study to run all benchmark tests.

General Information			Client Configuration				
Provider	Offering Name	Data Center	vCPU(s)	RAM (GB)	Disk (GB)	OS	Cost/Hour
Amazon AWS	EC2	US-east-1a	2	7.5	50	Ubuntu 12.04	$0.25
Dimension Data	OpSource Public Cloud	US East 2	2	4	60	Ubuntu 12.04	$0.19
Fujitsu	Cloud IaaS Trusted Public S5	Sunnyvale, CA	2	15	60	CentOS 6.4	$1.00
GoGrid	Cloud Hosting	US West 1	4*	4	200	Ubuntu 12.04	$0.32
HP	Public Cloud	US West AZ	2	4	120	Ubuntu 12.04	$0.14
IBM	SmartCloud Enterprise+	Raleigh, USA	2	4	60	Red Hat Ent 5.9	$0.19
Joyent	Compute Service	US-east-1	4*	4	150	Ubuntu 12.04	$0.29
Microsoft Azure	Infrastructure Services	West US	2	3.5	130	Ubuntu 12.04	$0.12
Rackspace	Cloud Servers	Dallas (DFW)	2	4	160	Ubuntu 12.04	$0.24
Savvis	SavvisDirect	Sterling, VA	2	4	50	Ubuntu 12.04	$0.12
SoftLayer	CloudLayer Compute	Dallas 5	2	4	100	Ubuntu 12.04	$0.22
Tier 3	Enterprise Cloud	US East (NYC)	2	4	50	Ubuntu 12.04	$0.35
Verizon Terremark	vCloud Express	Miami, FL	2	4	54	Ubuntu 10.04	$0.40
Virtustream	xStream	West Coast (San Francisco)	2	4	50	Ubuntu 12.04	$0.17

Table 2.1

*4 vCPU systems were throttled to 2 vCPUs by cutting the vCPUs from the kernel with cat /proc/cpuinfo -> sudo sh –c "echo 0 > /sys/devices/system/cpu/cpu**x**/online" where x are the third and fourth cores.

SERVER Configurations and Costs

The SERVER virtual machine is used in this study to transmit data across the internal network for network testing within the data center.

General Information			Server Configuration				
Provider	Offering Name	Data Center	vCPU(s)	RAM (GB)	Disk (GB)	OS	Cost/Hour
Amazon AWS	EC2	US-east-1a	1	1.7	50	Ubuntu 12.04	$0.07
Dimension Data	OpSource Public Cloud	US East 2	1	2	30	Ubuntu 12.04	$0.09
Fujitsu	Cloud IaaS Trusted Public S5	Sunnyvale, CA	0.25	1.7	60	CentOS 6.4	$0.13
GoGrid	Cloud Hosting	US West 1	2	2	100	Ubuntu 12.04	$0.16
HP	Public Cloud	US West AZ	2	2	60	Ubuntu 12.04	$0.07
IBM	SmartCloud Enterprise+	Raleigh, USA	1	2	60	Red Hat Ent 5.9	$0.12
Joyent	Compute Service	US-east-1	1	2	66	Ubuntu 12.04	$0.06
Microsoft Azure	Infrastructure Services	West US	1	1.75	139	Ubuntu 12.04	$0.06
Rackspace	Cloud Servers	Dallas (DFW)	2	4	160	Ubuntu 12.04	$0.24
Savvis	SavvisDirect	Sterling, VA	1	2	50	Ubuntu 12.04	$0.07
SoftLayer	CloudLayer Compute	Dallas 5	1	2	100	Ubuntu 12.04	$0.11
Tier 3	Enterprise Cloud	US East (NYC)	1	2	50	Ubuntu 12.04	$0.20
Verizon Terremark	vCloud Express	Miami, FL	1	2	29	Ubuntu 10.04	$0.21
Virtustream	xStream	West Coast (San Francisco)	1	4	50	Ubuntu 12.04	$0.17

Table 2.2

Additional Server Information

Additional server information details the processor, compiler, kernel, and filesystem type used for each virtual machine. Keep in mind that this information may change depending on the location of a virtual machine from data center to physical server.

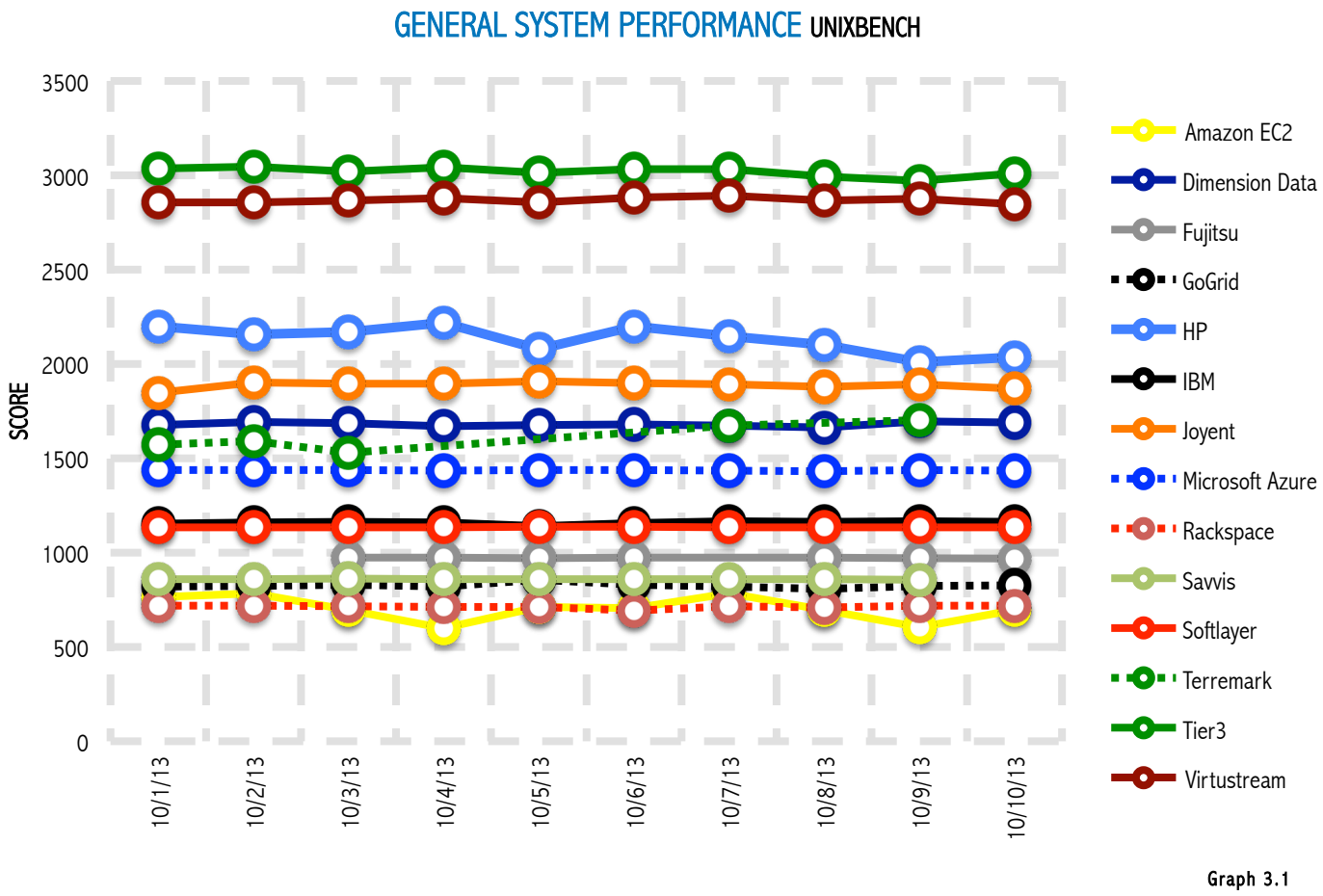
General Information		Additional Server Information			
Provider	OS	Processor	Compiler	Kernel	Filesystem
Amazon AWS	Ubuntu 12.04	Intel Xeon E5507	GCC 4.6	3.2.0-48-virtual (x86_64)	Ext2/ext3
Dimension Data	Ubuntu 12.04	Intel Xeon E5-4650	GCC 4.6	3.2.0-53-generic (x86_64)	Ext4
Fujitsu	CentOS 6.4	Intel Xeon X5570	GCC 4.4.7	2.6.32-358.18.1.el6.x86_64 (x86_64)	Ext3
GoGrid	Ubuntu 12.04	Intel Xeon X5650	GCC 4.6	3.2.0-31-virtual (x86_64)	Ext3
HP	Ubuntu 12.04	QEMU Virtual	GCC 4.6	3.2.0-40-virtual (x86_64)	Ext2/ext3
IBM	Red Hat Ent 5.9	QEMU Virtual	GCC 4.1.2	2.6.18-348.18.1el5 (x86_64)	Ext3
Joyent	Ubuntu 12.04	Intel Xeon E5645	GCC 4.6	3.8.6-joyent-ubuntu-12-opt (x86_64)	Ext2/ext3
Microsoft Azure	Ubuntu 12.04	AMD Opteron 4171 HE	GCC 4.6	3.2.0-40-virtual (x86_64)	Ext4
Rackspace	Ubuntu 12.04	AMD Opteron 4332 HE	GCC 4.6	3.2.0-24-virtual (x86_64)	Ext2/ext3
Savvis	Ubuntu 12.04	Intel Xeon X5650	GCC 4.6	3.0.0-12-server (x86_64)	Ext3
SoftLayer	Ubuntu 12.04	Intel Xeon E31270	GCC 4.6	3.2.0-41-virtual (x86_64)	Ext3
Tier 3	Ubuntu 12.04	Intel Xeon E5-2680	GCC 4.6	3.2.0-53-generic (x86_64)	Ext4
Verizon Terremark	Ubuntu 10.04	AMD Opteron 8389	GCC 4.4.3	2.6.32-51-server (x86_64)	Ext4
Virtustream	Ubuntu 12.04	Intel Xeon X5680	GCC 4.6	3.5.0-23-generic (x86_64)	Ext4

Table 2.3

Notes

- Out of the 14 providers tested, three did not offer Linux distribution Ubuntu 12.04. These are Fujitsu (using CentOS 6.4), IBM (using Red Hat Enterprise 5.9), and Verizon's Terremark (using Ubuntu 10.04).
    - Terremark's distribution of Linux Ubuntu ran into some problems with the CloudSpecs benchmark application; as a result, not all data points were collected on Terremark. The internal network test was not affected.
- Configuration of offerings varied. 5 providers could not match the suggested CLIENT configuration: Amazon AWS, Fujitsu, GoGrid, Joyent, and Microsoft Azure. Under those circumstances, providers were as closely matched as possible to a dual-core configuration. Cloud Spectator provisioned quad-core virtual machines on GoGrid and Joyent to match RAM, and sliced CPU from the kernel to behave as a dual-core system.
- Fujitsu's CLIENT system is unique; its RAM allocation for a dual-core system is above that of any other provider on the list, at 15GB for two cores. Cost of its servers is reflective of the resources at $1.00 per hour, also above the cost of any other provider on the list.
- Cloud Spectator attempted to include CSC in the performance analysis but could not create an account given the timeframe for this round of testing.

General System Performance



Graph 3.1

About the Test

UnixBench runs a set of individual benchmark tests, aggregates the scores, and creates a final, indexed score to gauge the performance of UNIX-like systems, which include Linux and its distributions (Ubuntu, CentOS, and Red Hat). From the Unixbench homepage:

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.

The UnixBench suite used for these tests ran tests that include: Dhrystone 2, Double-precision Whetstone, numerous File Copy tests, Pipe Throughput, Process Creation, Shell Scripts, System Call Overhead, and Pipe-based Context Switching.

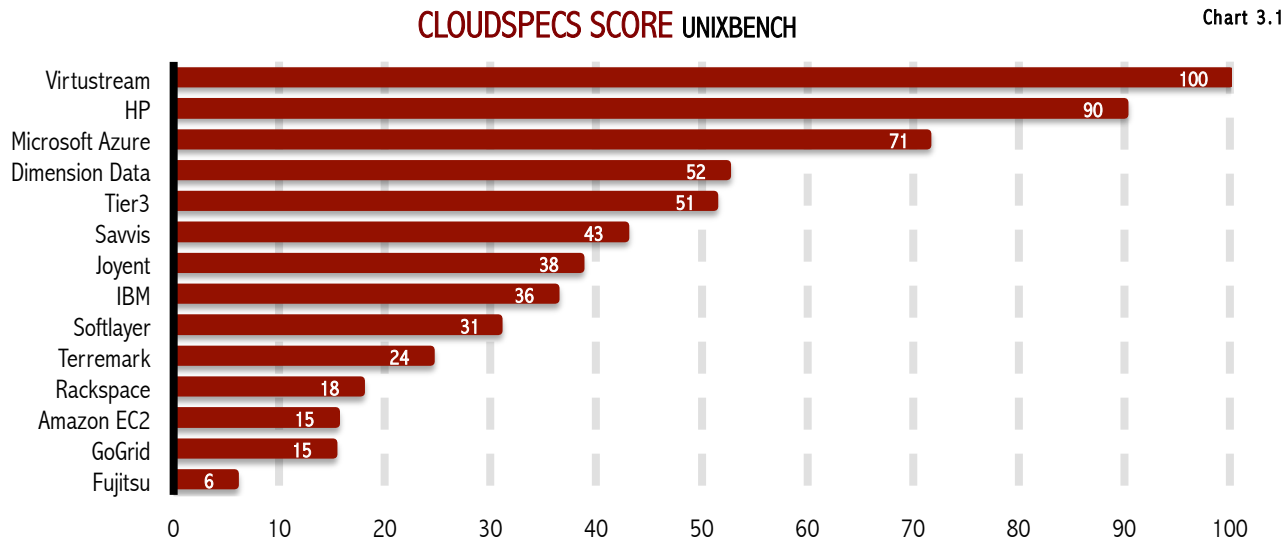
Results

UnixBench highlights the significant system performance difference among the top providers in the IaaS industry. The highest and lowest scorers show a difference of 4.7x in system performance; Tier 3's average UnixBench score is 2998, while Amazon EC2's is 642.

The average score over the period of ten days in the UnixBench comparison across the 14 providers is 1488. Chart 3.2 lists the average scores of each provider; 6 provider's IaaS offerings (Tier 3, Virtustream, HP, Joyent, Dimension Data's OpSource, and Terremark) scored above the average. The highest score

achieved across all iterations of tests and providers is 3046, which was received by Tier 3 on October 2, 2013. Virustream scored the next highest score, 2891, on October 7, 2013. Generally, scores are consistent and stable performance can be expected across most providers over time.

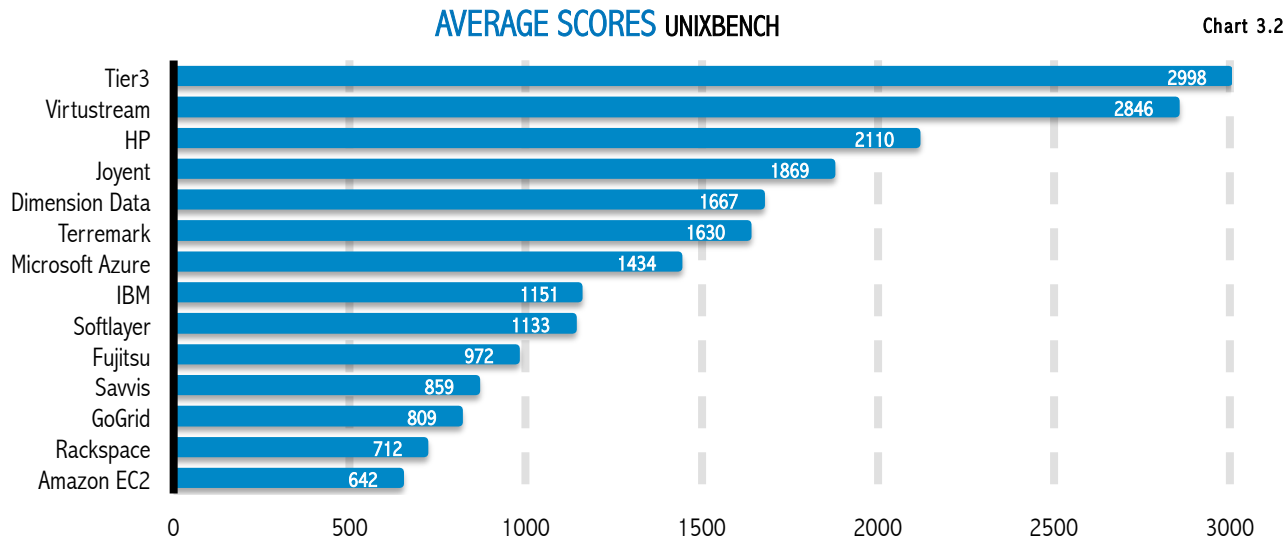
Using standard deviation as a measurement of performance fluctuation, the provider with the highest amount of variability in scores throughout the test period was Amazon EC2. Expressed as a percentage of the average (i.e., coefficient of variation or CV), Amazon EC2 experiences 10% fluctuation. 7 providers experienced a fluctuation of ≤1% (Fujitsu, Dimension Data's OpSource, Rackspace, Savvis, SoftLayer, Virustream, and Microsoft Azure).



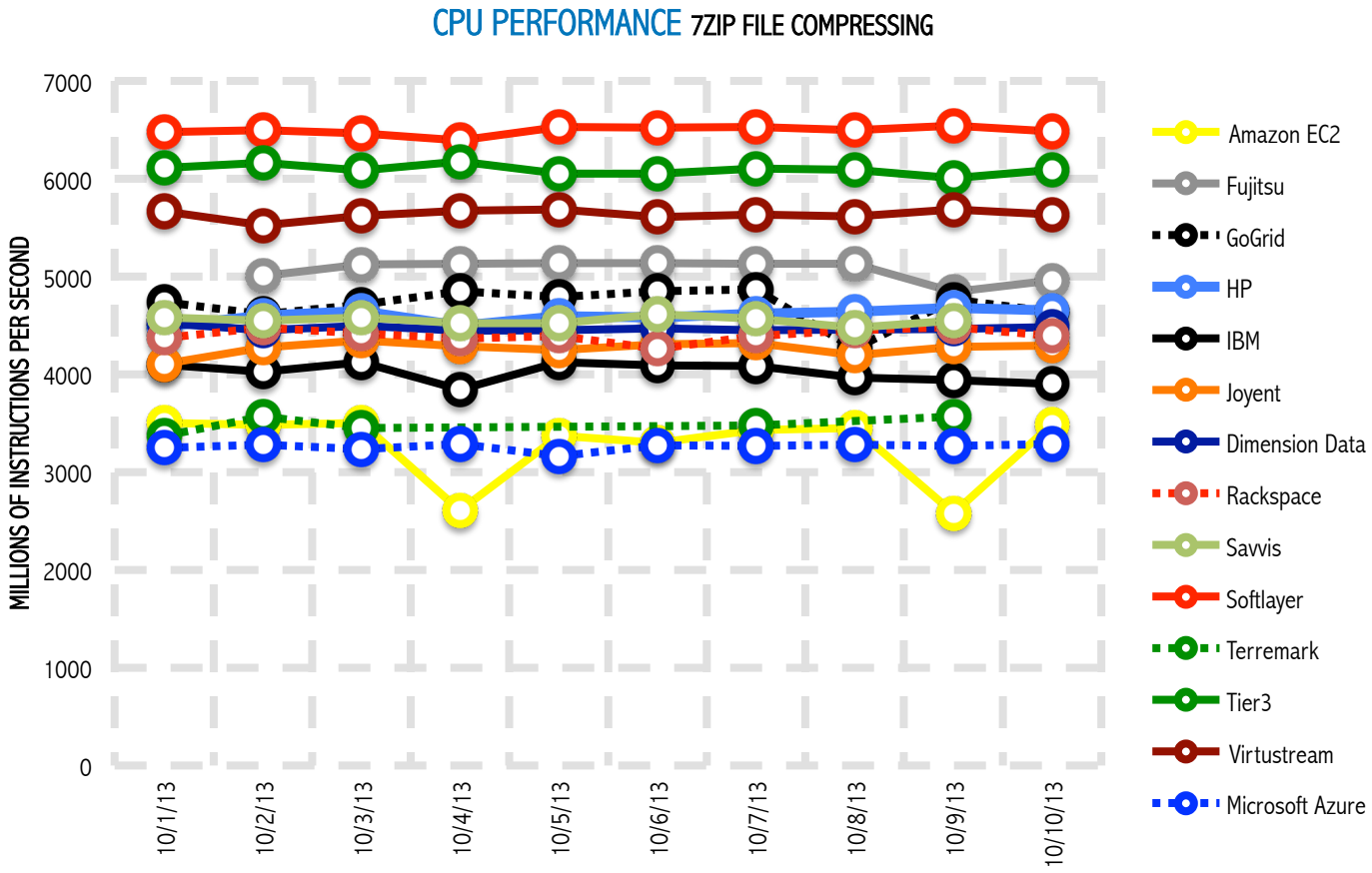
After applying the cost of each provider (costs can be found in Table 2.1 in Experiment Information – CLIENT Configurations and Costs), a new ranking emerges that compares value of price to performance (for more information on the CloudSpecs Score, see Experiment Information – Price-Performance Value: The CloudSpecs Score).

Due to its higher cost, Tier 3 drops to 5TH in value from 1ST in performance. Virtustream's combination of low cost and high performance results in its ranking as best value provider for system performance. HP Cloud and Microsoft Azure come in second and third, respectively, due to their pricing. While Microsoft Azure's average performance falls slightly below the overall average (see Chart 3.2), it offers one of the lowest prices for dual-core VMs, which translates to price-performance value in its service.

Because of its below-average performance and high price, Fujitsu ranks last in system performance in a CloudSpecs price-performance comparison; in fact, due to its high price of $1.00 per hour, Fujitsu falls in many CloudSpecs score rankings. The high cost is due to the unique configuration of its dual-core IaaS offering, which pairs the CPU with 15GB of RAM, a significantly higher amount of RAM than any other provider's dual-core offering in the test.



CPU Performance



Graph 4.1

About the Test

From the Phoronix Test Suite, the 7-zip File Compression benchmark runs p7zip's integrated benchmark feature to calculate the number of instructions a CPU can handle per second (measured in millions of instructions per second, or MIPS) when compressing a file.

Provider	Processor
Amazon AWS	Intel Xeon E5507
Dimension Data	Intel Xeon E5-4650
Fujitsu	Intel Xeon X5570
GoGrid	Intel Xeon X5650
HP	QEMU Virtual
IBM	QEMU Virtual
Joyent	Intel Xeon E5645
Microsoft Azure	AMD Opteron 4171 HE
Rackspace	AMD Opteron 4332 HE
Savvis	Intel Xeon X5650
SoftLayer	Intel Xeon E31270
Tier 3	Intel Xeon E5-2680
Verizon Terremark	AMD Opteron 8389
Virtustream	Intel Xeon X5680

Table 4.1

Results

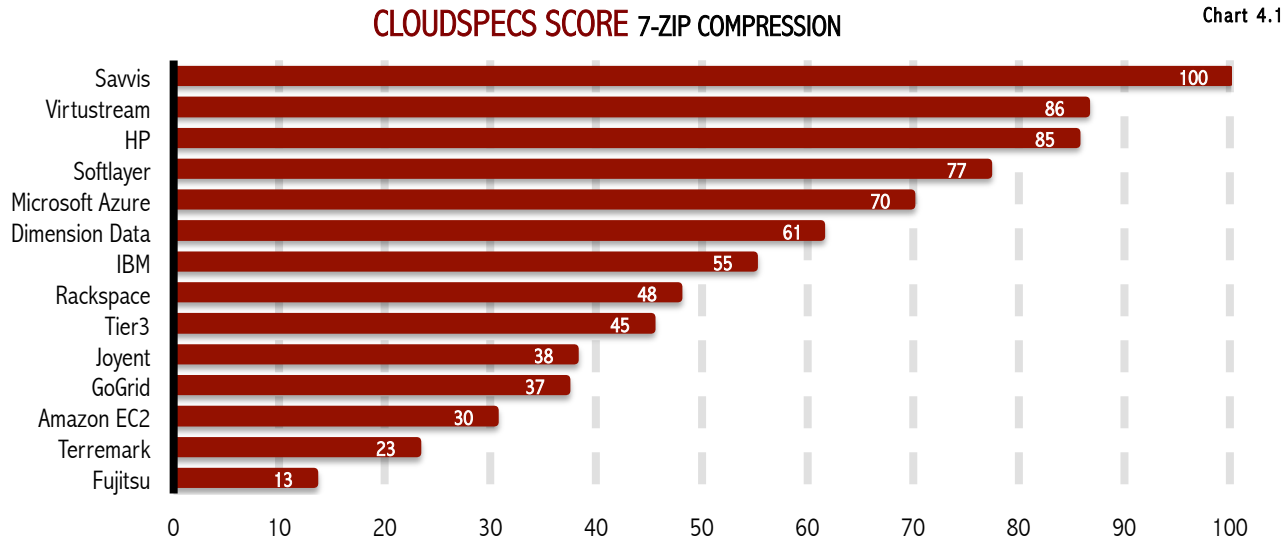
Similar to system performance, CPU performance also highlights the variability of expected performance across the top IaaS providers in the industry. Table 4.1 lists the processors behind each virtual machine used in the test; a majority of providers use Intel-based processors.

SoftLayer (Intel Xeon E31270), which scores the highest MIPS in this period of testing, achieved an average of 6445 MIPS, and Amazon EC2 (Intel Xeon E5507), which scored the lowest MIPS in this period of testing, achieved an average of 2887 MIPS. That is a difference of 2.2x in CPU performance.

The average MIPS across the 14 tested providers is 4517. Half of the providers (SoftLayer, Tier 3, Virtustream, Fujitsu, Savvis, HP Cloud, and GoGrid) scored, on average, above that threshold. All of those providers also ran the tested virtual machines on Intel processors.

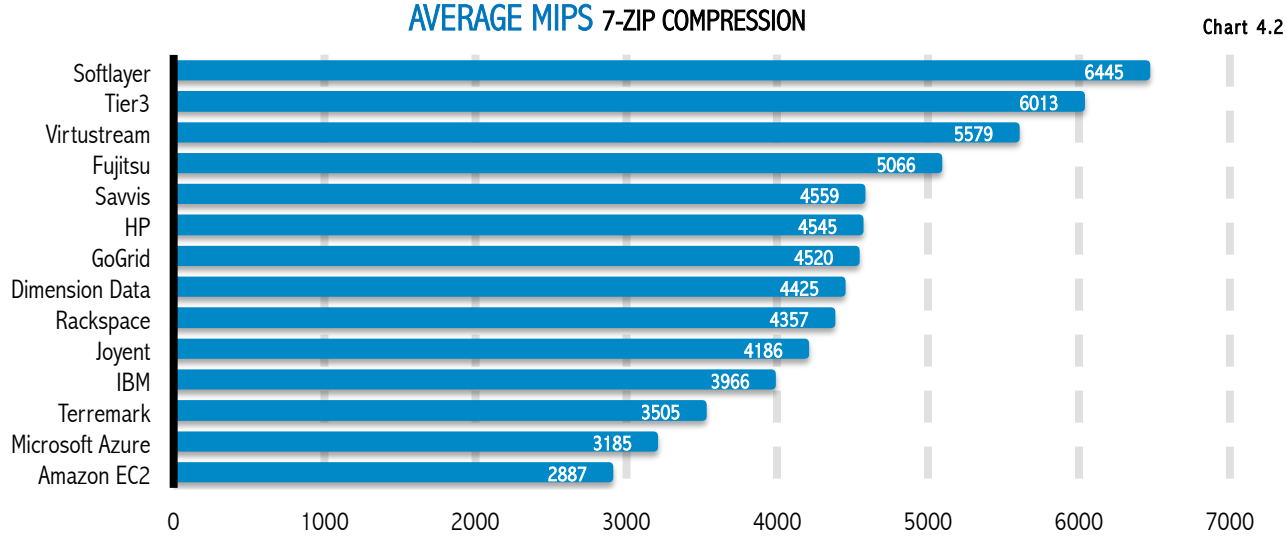
Performance fluctuation remained low for CPU performance as well; the highest percentage of fluctuation

occurred with Amazon EC2, which scored a CV of 14%. The steadiest performers (those with CV of <2%) were Savvis, SoftLayer, and Virtustream. No provider achieved a CV of less than 1%.

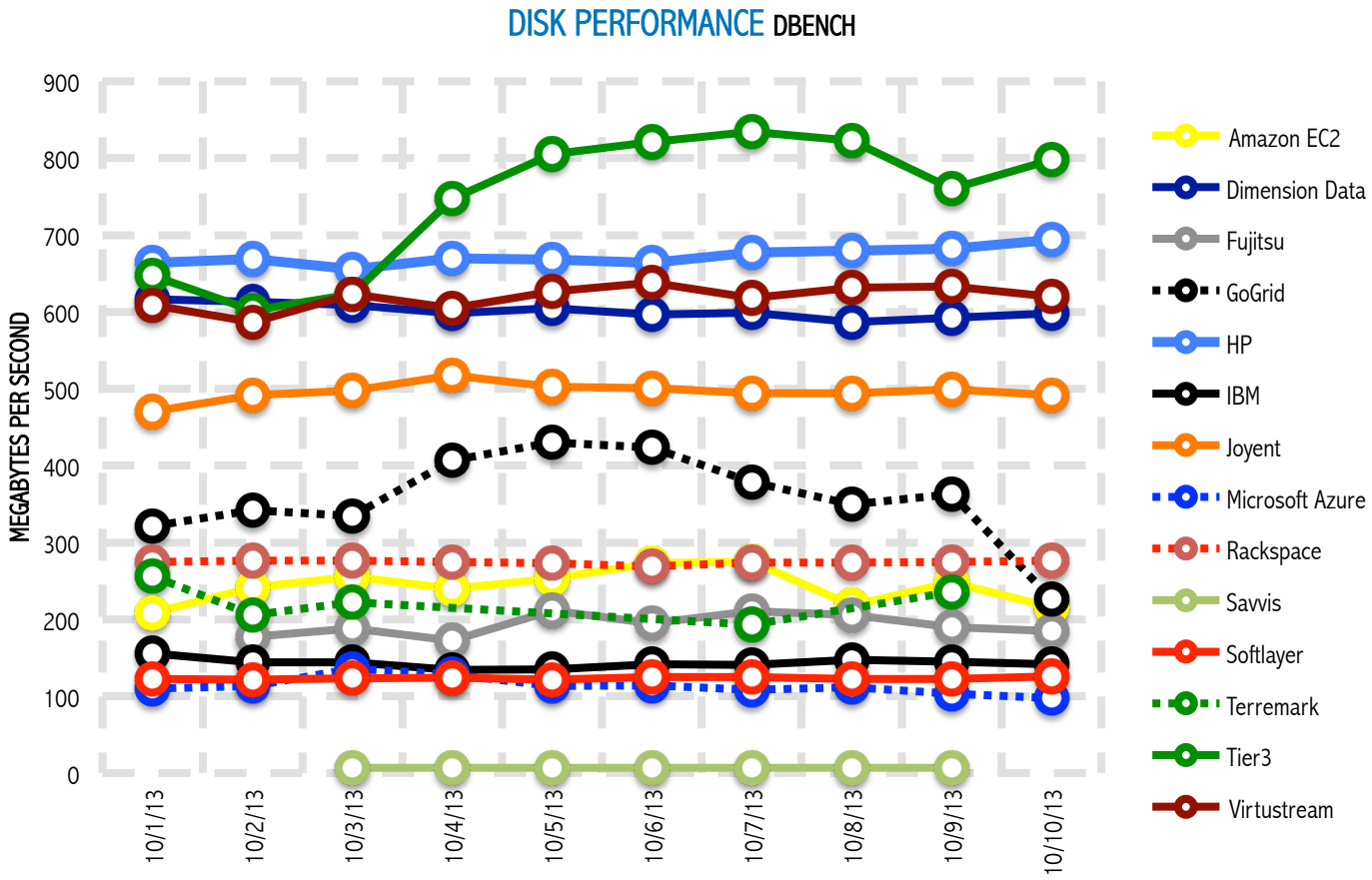


With respect to the CloudSpecs score, SoftLayer falls to 4TH below Savvis, Virtustream, and HP Cloud. Savvis ranked 4TH for average performance, but increased in ranking due to its competitive pricing, equating to a better value for users. Similarly, Virtustream and HP Cloud rose from 3RD and 6TH to 2ND and 3RD, respectively.

Once again, Fujitsu falls last due to its high price. When only factoring in performance, its virtual machine achieved a position in the top 5 highest scores.



Disk Performance



Graph 5.1

About the Test

Part of the Phoronix Test Suite, Dbench can be used to stress a filesystem or a server to see which workload it becomes saturated and can also be used for prediction analysis to determine "How many concurrent clients/applications performing this workload can my server handle before response starts to lag?" It is an open source benchmark that contains only file-system calls for testing the disk performance. For the purpose of comparing disk performance, write results are recorded.

Results

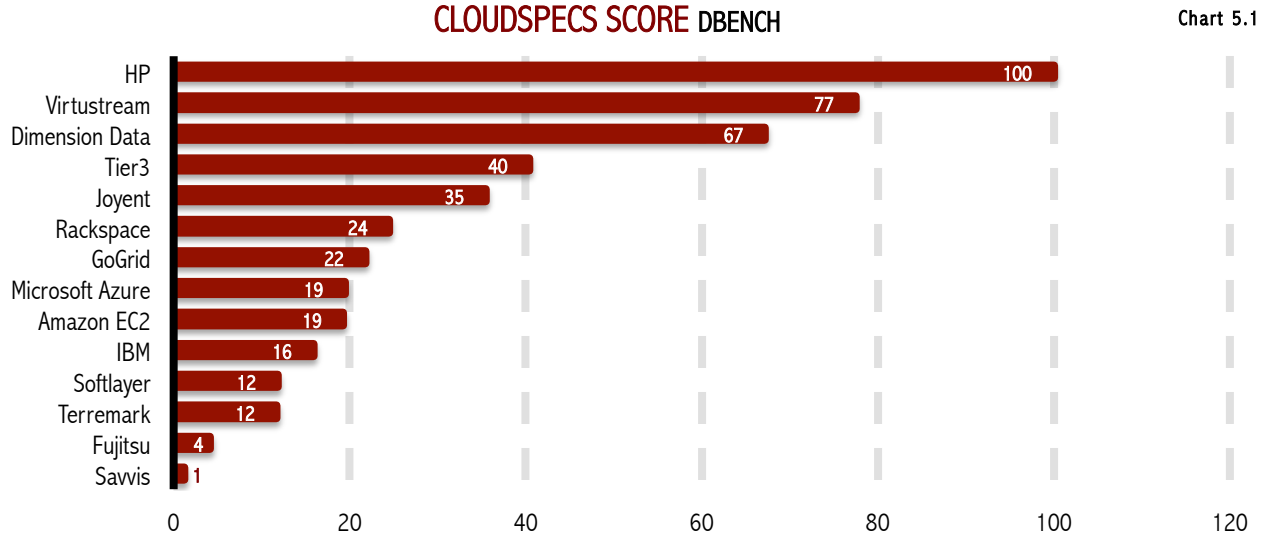
Average write speed across the list of tested providers is 328 Mbps. Tier 3, which ranks highest in average performance across the 10-day period, has a disk speed of 2x the average, at 657 Mbps.

Savvis's performance is unique for these results. Falling far below average, Savvis delivers 6 Mbps write speed for the period of the experiment. When first running the test, Cloud Spectator's development team re-entered Savvis's virtual machine to cross check the application. Two virtual disks were partitioned for the virtual machine; one for the operating system (xvda) and one for the tests (xvdb). Running manual checks using dd to confirm the results of dbench, xvda was achieving write speeds of 150 MB/s while xvdb was achieving write speeds of only 6 MB/s.

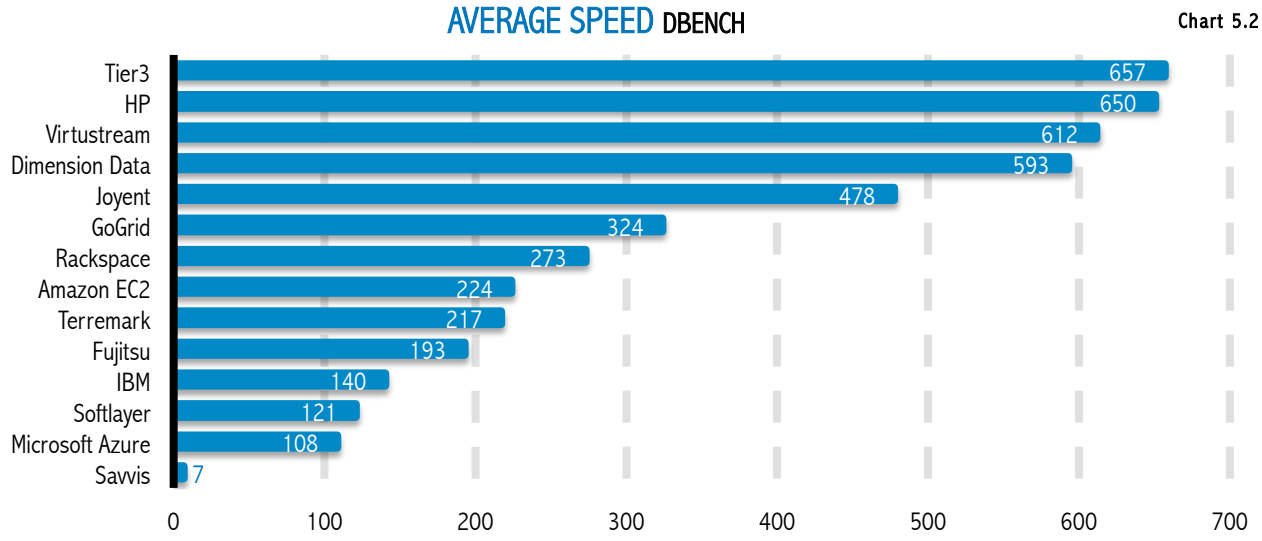
Cloud Spectator proceeded to format the filesystem in the case of a possibility that the performance is related to filesystem fragmentation, but the results remained the same after formatting. Following conclusion of this study, the development team continued its investigation on Savvis's write speed by cloning the

CLIENT server and performing write tests again. The new results showed up significantly higher, around 125 Mb/s. Unfortunately, as the low results were not a result of errors in the experiment, the results are valid and used in this experiment.

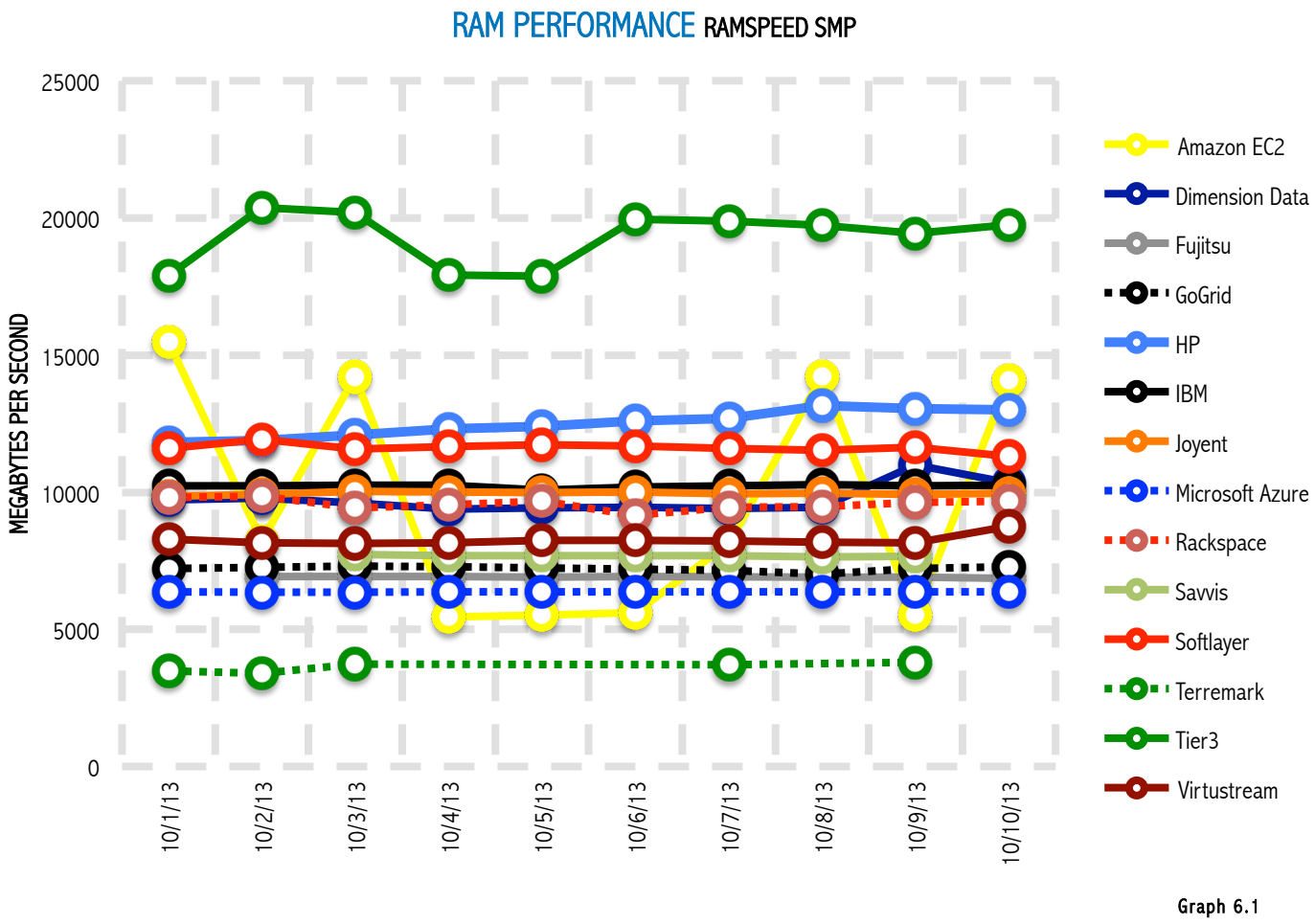
For stability, 3 providers (Dimension Data, Rackspace, and Savvis) scored a CV of <1%. For this test, the least-stable provider is GoGrid at 27% CV. Tier 3 comes in at a close second with a CV of 25%, despite being the highest-performing provider.



Considering pricing in this instance lowers Tier 3 from top performance provider to 4TH in rank for value. HP, which showed the second best performance, moves quickly to first in value with its competitive pricing. Virtustream also moves up to second due to its low cost.



RAM Performance



Graph 6.1

About the Test

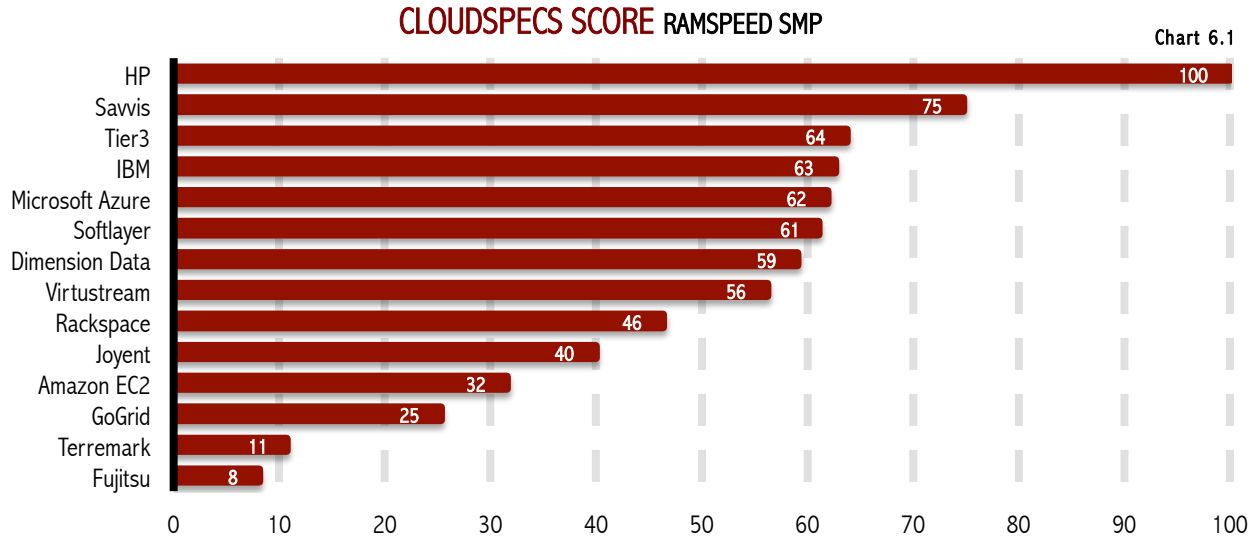
RAMspeed/SMP is a memory performance benchmark for multi-processor machines running UNIX-like operating systems, which include Linux and its distributions (Ubuntu, CentOS, and Red Hat). Within the RAMspeed/SMP suite, the Phoronix Test Suite conducts benchmarks using a set of Copy, Scale, Add, and Triad tests from the *mem benchmarks (INTmem, FLOATmem, MMXmem, and SSEmem) in BatchRun mode to enable high-precision memory performance measurement through multiple passes with averages calculated per pass and per run.

Results

The average RAM performance result across the 10-day study is 9163 mbps. Half of the providers (Tier 3, HP Cloud, SoftLayer, IBM SmartCloud, Joyent, Dimension Data, and Rackspace) score above the average, while the other half fall below. Tier 3's RAM performs significantly higher than any other provider, with an average of 19 Gbps.

HP Cloud and SoftLayer come in 2ND and 3RD, respectively, though their performance scores are far behind at 11 Gbps. Terremark, with the lowest performance results, averages 3.7 Gbps. The difference in performance ranges by 5x between the lowest and highest results.

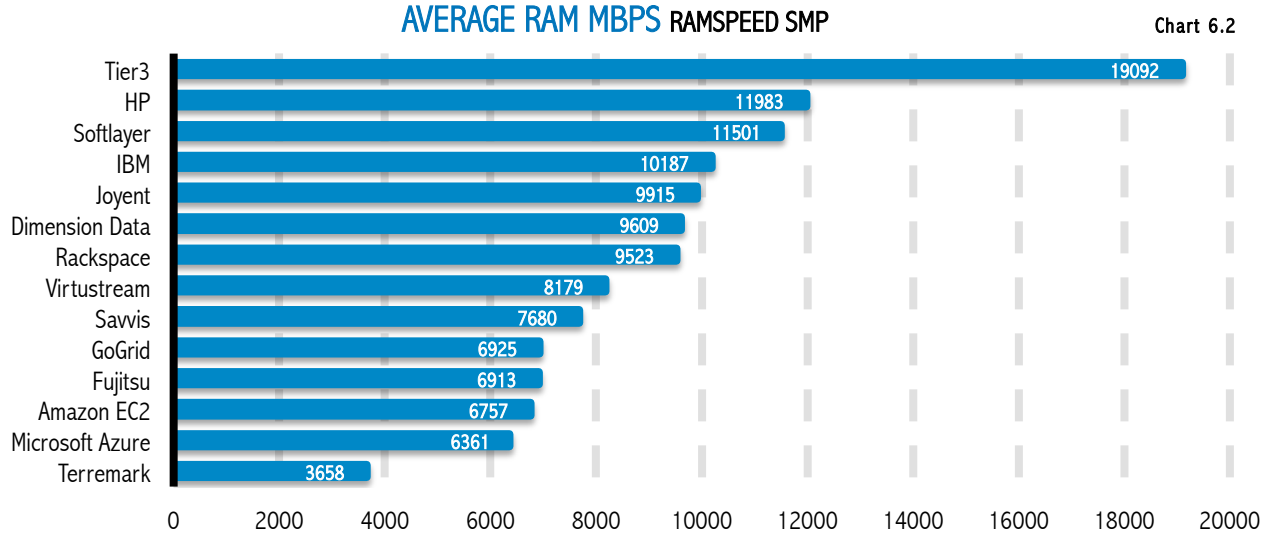
Regarding performance stability, all providers have a CV of <7% except Amazon EC2. Graph 6.1 illustrates the RAM performance fluctuation of Amazon EC2. Its results jump between a low of 5.5 Gbps and a high of15.5 Gbps. Amazon EC2 scores a CV of 51%. The 5 most stable RAM performance providers scored <1% CV (Fujitsu, IBM SmartCloud, Joyent, Savvis, and Microsoft Azure).



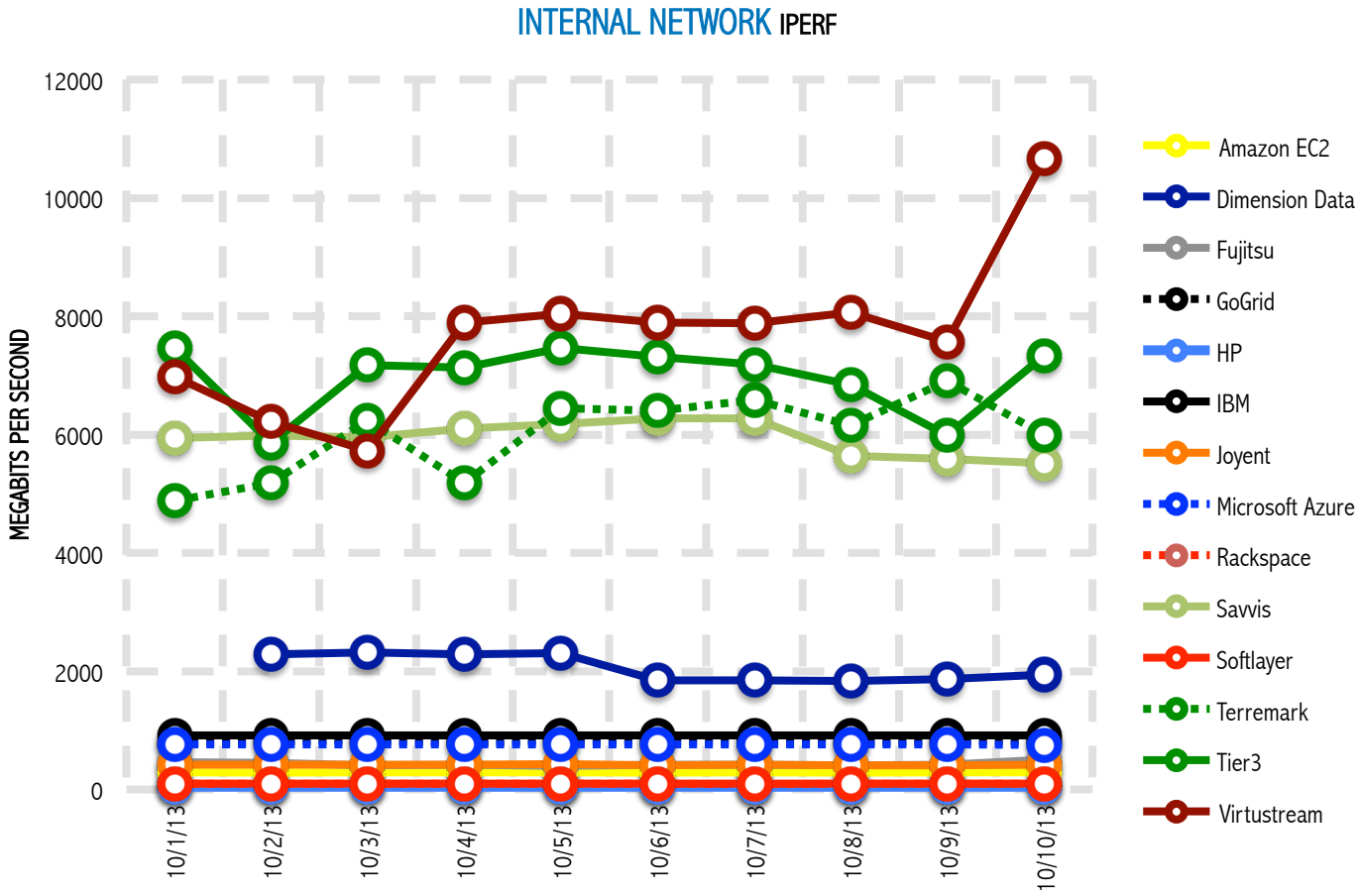
While Tier 3's RAM performance scores 1.6x and 1.7x higher than HP and Savvis, respectively, the latter two providers score higher with the CloudSpecs score. HP and Savvis have one of the lowest costs per hour across providers, giving them a strong advantage in value ranking when comparing price with performance.

Tier 3's cost is more than double that of HP and Savvis. The cost actually drops Tier 3's value (CloudSpecs Score of 64) to a score comparable with Microsoft Azure, (CloudSpecs Score of 62) though when considering performance only, Tier 3 still performs 3x better than Microsoft Azure on average across the study.

Terremark and Fujitsu's combination of low performance and high cost works against them from a value angle, lowering their ranking for the CloudSpecs score. Microsoft Azure, which scores the second lowest performance value for RAM performance at 6361 Mbps, ranks as top 5 for value due to its competitive cost; in fact, it is one of the least expensive providers tested, tied with Savvis's SavvisDirect offering at $0.12 per hour.



Internal Network Performance



Graph 7.1

About the Test

Iperf is a benchmark tool used to measure bandwidth performance. For the purpose of this benchmark, Cloud Spectator set up 2 virtual machines within the same availability zone/data center to measure internal network throughput.

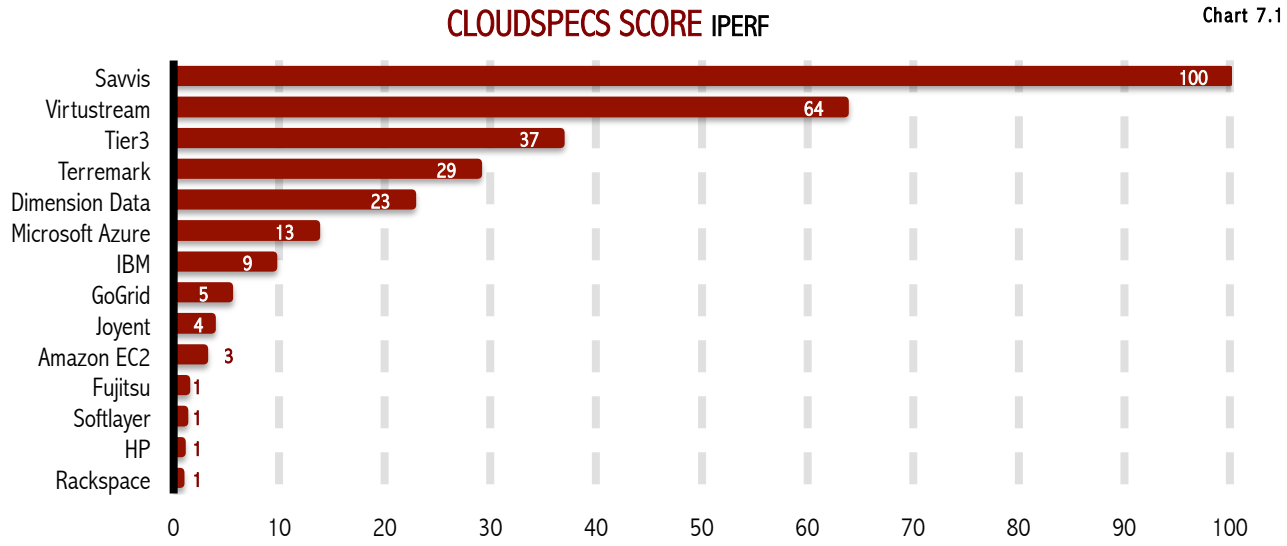
Results

As illustrated by Graph 7.1, the type of connection between servers marks a significant difference in throughput of the virtual cloud environments. Providers Virtustream, Tier 3, Terremark, and Savvis deliver a larger bandwidth in their offerings, resulting in higher throughput for the user. Between those providers and the others emerges a large gap in throughput.

The average throughput across the 14 tested providers is 2165 Mbit/s. Only 4 providers (Virtustream, Tier 3, Savvis, and Terremark) achieve higher throughput than that average. Virtustream and Tier 3 achieve throughput of more than 6 Gbit/s on average. The significance in internal network throughput variation across providers can be viewed on Chart 7.2. Virtustream, with an average of 6763 Mbit/s, provides over 138x internal network throughput than HP Cloud, which has an average of 49 Mbit/s.

The performance stability of internal network fluctuates as well; the highest fluctuation is seen in Virtustream with a CV of 21%. Virtustream's CV equates to a performance variability with a low of 5.7 Gbit/s to a high of 10.7 Gbit/s. The 10.7 Gbit/s throughput contributes to the high average Virtustream receives. Microsoft Azure, SoftLayer, IBM SmartCloud, and HP Cloud's network are the most stable, with a CV of less than 1%.

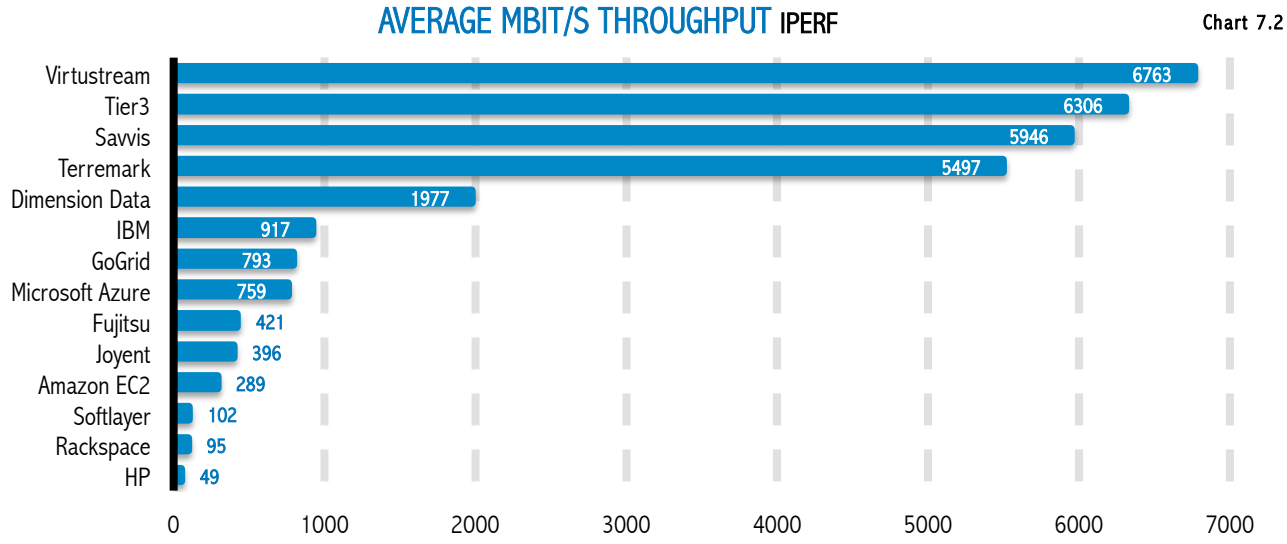
9 Providers (IBM, GoGrid, Microsoft Azure, Fujitsu, Joyent, Amazon EC2, SoftLayer, Rackspace, and HP Cloud) have an average throughput of less than 1 Gbit/s.



With respect to value, Savvis receives the highest CloudSpecs score for internal network throughput. Virtustream comes in second. The top 4 performing providers also achieve the Top 4 CloudSpecs scores. Even with the variance in pricing, the significant gap between the throughput results of the Top 4 and the other providers outweighs the effect cost may have on the value.

A gap emerges in the CloudSpecs score as well, due to the factored in price; all scores are pegged relatively to the highest-scoring provider (Savvis, in this case), but no provider receives a score between 40 and 60, and only Virtustream receives a score higher than 60.

SoftLayer and Rackspace's low performance combined with expensive cost results in a CloudSpecs score of only 1. Fujitsu receives a score of 1 as well, despite its significantly higher performance, due to the expensive cost of its virtual machines. HP, though one of the lowest-priced providers in this experiment, also received a score of 1 because of its low throughput.



Conclusion

With a lack of standardized hardware and virtualization platforms, measuring performance and value of cloud providers is an important step in selecting an IaaS provider. Results in this document have shown the variability in performance from similar dual-core offerings. Cross-provider comparison variability can be expected in different-sized offerings as well. By applying cost to the performance results, a comparison can be made that further exposes the value of each provider's offering.

High price and high performance are not correlated. For example, Fujitsu, which costs $1.00 per hour, offers a lower performance in general than Tier 3, which costs $0.35 per hour; even $0.35 per hour is considered high for the dual-core systems. A provider like Virtustream finds a balance between low cost ($0.17 per hour) and high performance, earning high CloudSpecs scores on most tests. Some providers, like HP Cloud, do not necessarily perform best in any tests, but their competitive pricing preserves their value, making up for the lost performance.

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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About the Cloud Advisory Council

The Cloud Advisory Council is a not-for-profit organization with a mission to develop the next generation cloud architecture, to provide cloud designers and IT managers with the tools needed to enable computing in the cloud, to strengthen the qualification and integration of cloud solutions and to provide best practices. The Cloud Advisory Council is led by a broad coalition of industry practitioners and corporations.

Cloud Advisory Council Objectives:

- Definition of the next generation of cloud architecture
- Providing open specification for cloud infrastructures
- Publications of best practices for optimizing cloud efficiency and utilization
- Enable ease-of-use with comprehensive cloud management and tools

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