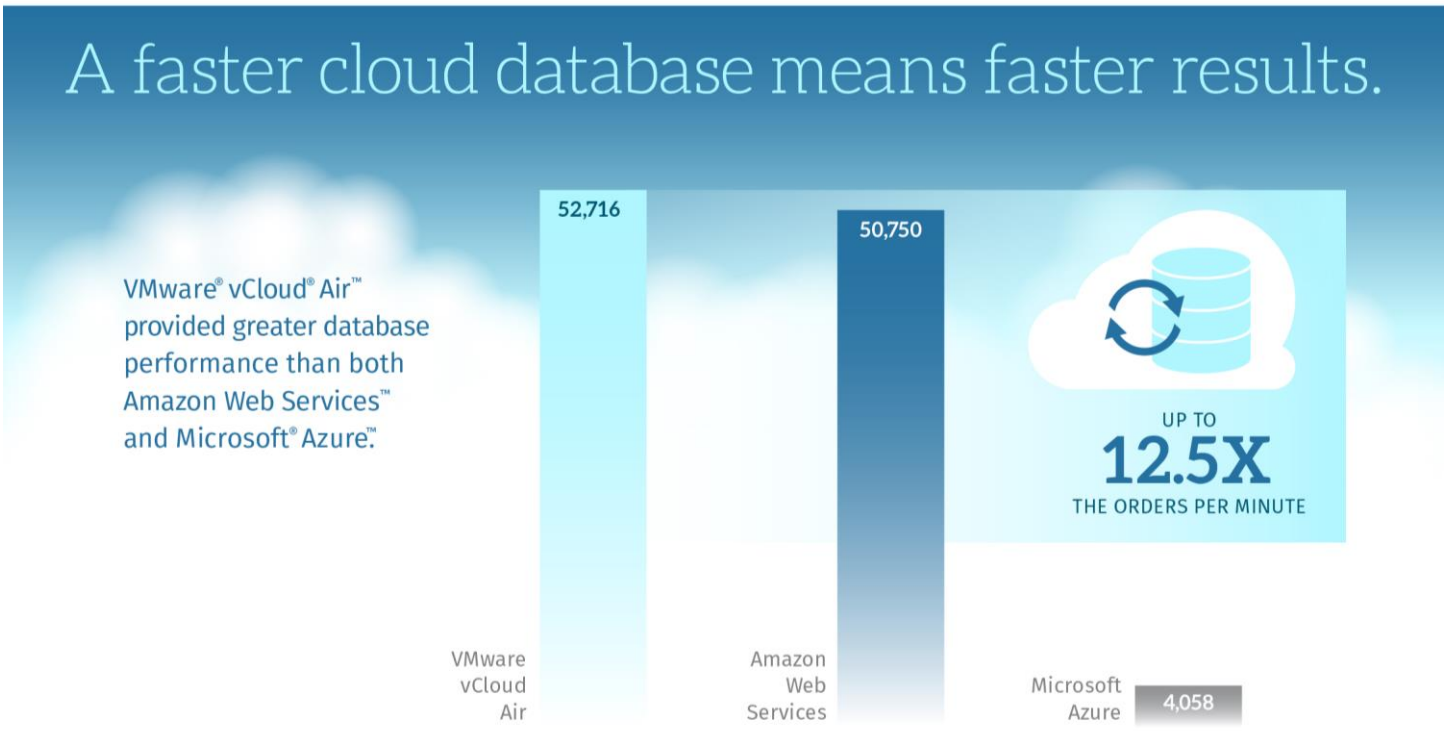
DATABASE PERFORMANCE COMPARISON OF VMWARE VCLOUD AIR, AMAZON WEB SERVICES, AND MICROSOFT AZURE



Businesses are rapidly transitioning to the public cloud to take advantage of on-demand resources and potential cost savings. Compared to the traditional datacenter model, where a business purchases and maintains its own physical servers on-site, running your virtualized applications off-premises and on infrastructure-as-a-service (IaaS) platforms offers enormous flexibility, enhances disaster recovery planning, and can save companies in a variety of ways, including management and capital expenditures.

Many public cloud services are available, and the performance that each delivers can vary considerably. From the Principled Technologies labs, we tested the database performance of three public cloud solutions: VMware vCloud Air, Amazon Web Services (AWS), and Microsoft Azure.

We found that the database performance of our vCloud Air instance was more than 12 times that of our Azure instance and 3.9 percent greater than our AWS instance. This kind of advantage can translate to cost savings in your public cloud architecture.

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A PRINCIPLED TECHNOLOGIES REPORT
Prepared for VMware, Inc.

THE POWER OF THE CLOUD

Businesses moving their computing to the cloud gain efficiency, cut up-front expenses, and enjoy a number of other advantages. It is the rare business in which computing needs remain constant—demand on servers can fluctuate seasonally, as companies grow, in response to special events, and due to countless other factors. Regardless of the reason, IaaS allows a company to immediately expand and contract their compute and storage resources to meet the needs of any particular moment. This responsiveness means that the company saves money by expanding server resources only when demand requires, not weeks or months or years before. More importantly, this responsiveness means employees, customers, and other users are taken care of right away. The company is able to respond to business needs more quickly and deliver resources more nimbly.

The public cloud is an ideal destination for multi-tier web stacks where spinning up additional VMs can help scale out the load and immediately increase capacity. For web servers and other lightweight server functions that are not as performance-bound, the performance of a few VMs might not be critical. However, the scale, agility, and cost model provided by public cloud computing can also be beneficial to performance-sensitive workloads such as the database tier; database servers tend to tax storage, memory, and compute resources, and are fundamental building blocks to most applications.

COMPARING DATABASE PERFORMANCE

We used a benchmarking tool to compare the performance of a SQL Server® database configuration on the three cloud services we tested—VMware vCloud Air, Amazon Web Services, and Microsoft Azure.[1]

We began by subscribing to the three services and then setting up comparable configurations. To make sure we were comparing apples to apples, on all three vendors we selected an instance with SQL Server included. We used instances with eight vCPUs and amounts of memory that were as similar as possible. (For detailed system configuration information and test methodology, see Appendix A.)

For testing, we attached a second disk to the instance to hold the database. Both vCloud Air and AWS allowed us to attach an SSD volume as the second disk, but Azure did not at the time of testing. Azure does offer an SSD volume with the instance, but it is temporary storage that is cleared during a reboot. We didn't use this temporary storage because we believe that typical users would not put their databases on temporary storage.

[1] Note: We performed the testing in March 2015.

The tool we used, DVD Store Version 2.1, reports database performance using a metric of orders per minute (OPM). As Figure 1 shows, the number of OPM the vCloud Air solution performed exceeded that of the other two cloud solutions. It delivered 1,966 more OPM than AWS, an increase of 3.9 percent. It outperformed the Microsoft Azure solution by a whopping 48,658 OPM, achieving more than 12 times the performance.

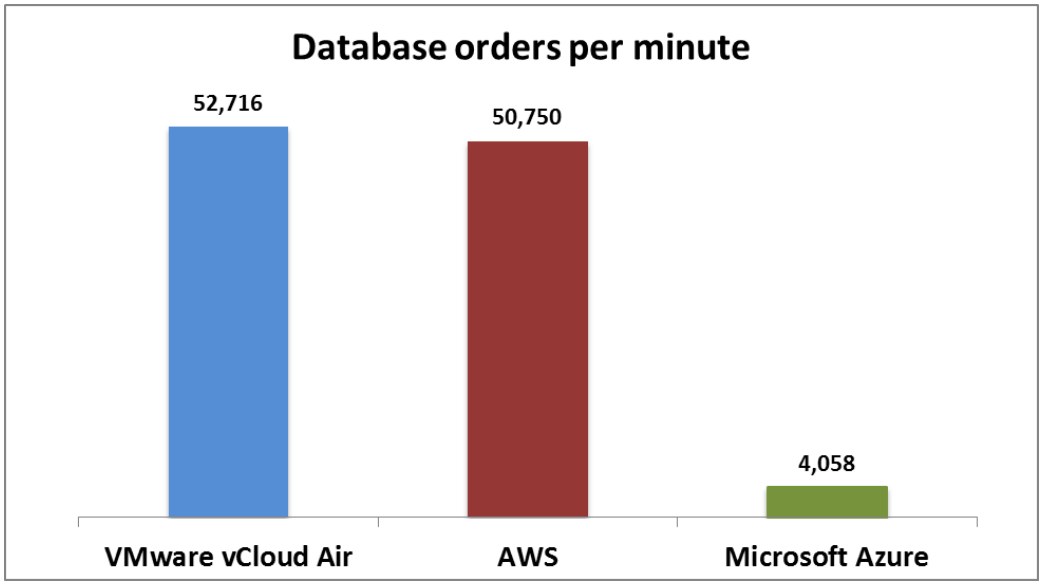

Figure 1: The VMware vCloud Air solution delivered database performance better than that of the AWS solution and dramatically better than that of the Microsoft Azure solution.

With a solution that handles more orders per minute, the applications and users that rely on databases get their needs met more quickly, and spend less time waiting. You can support more database operations with fewer database instances, which can add up to savings.

WHAT WE TESTED

About VMware vCloud Air

According to VMware, "vCloud Air, built on VMware vSphere®, quickly and seamlessly extends your data center into the cloud using the tools and processes you already have." It is available in three service offerings: OnDemand, Dedicated Cloud, and the Virtual Private Cloud, and it offers two tiers of block-level storage: Standard and SSD-Accelerated. We tested a Dedicated Cloud with SSD-Accelerated storage.

For more information about VMware vCloud Air, see www.vmware.com/products/vcloud-hybrid-service/.

About Amazon Web Services

According to Amazon, "Amazon Web Services provides a variety of cloud-based computing services including a wide selection of compute instances which can scale up and down automatically to meet the needs of your application, a managed load balancing service as well as fully managed desktops in the cloud."

AWS offers persistent block-level storage through EBS. There are actually three different configurations for EBS: EBS General Purpose (SSD) volumes, EBS Provisioned IOPS (SSD) volumes, and EBS magnetic volumes. We conducted testing against the EBS General Purpose (SSD) volumes across three virtual machine sizes and used "EBS-Optimized" instances on the ones that supported it.

For more information about Amazon Web Services, see aws.amazon.com.

About Microsoft Azure

According to Microsoft, "Azure is an open and flexible cloud platform that enables you to quickly build, deploy and manage applications across a global network of Microsoft-managed datacenters. You can build applications using any language, tool or framework. And you can integrate your public cloud applications with your existing IT environment."

For more information about Microsoft Azure, see azure.microsoft.com.

About our test tool, DVD Store Version 2.1

To create our real-world ecommerce workload, we used the DVD Store Version 2.1 benchmarking tool. DS2 models an online DVD store, where customers log in, search for movies, and make purchases. DS2 reports these actions in orders per minute that the system could handle, to show what kind of performance you could expect for your customers. The DS2 workload also performs other actions, such as adding new customers, to exercise the wide range of database functions you would need to run your ecommerce environment.

For more details about the DS2 tool, see www.delltechcenter.com/page/DVD+Store.

IN CONCLUSION

Business computing is making its way to the cloud in a dramatic fashion. Selecting the correct cloud service provider is a pivotal decision that could have a significant effect on how much your company benefits from this move.

In our database testing, we found that our VMware vCloud Air instance performed dramatically better than the Azure instance, delivering more than 12 times as many orders per minute. The vCloud Air solution also delivered 3.9 percent greater performance than the AWS solution.

Choosing a cloud service that can deliver better database performance can allow you to make the most of your investment in the cloud platform.

APPENDIX A – DETAILED TEST METHODOLOGY

For testing, we selected three of the default Microsoft Server 2012 R2 with SQL Server 2012 instances from AWS and then configured similar instances with the same virtual processors and memory from VMware vCloud Air and Microsoft Azure. Note that Azure did not offer an instance with 30 GB of memory, so we used the closest available amount, 28 GB. For all three vendors, we used a 30GB root virtual disk and connected a second 120GB virtual disk against which to run the database. Figure 2 shows the configurations we used.

Compute instance	Virtual CPU	Memory (GB)	Attached storage (GB)
vCloud Air	8	30	120
AWS m3.2xlarge	8	30	120
Azure D4	8	28	120

Figure 2: The three instance configurations we tested.

Configuring the database

We generated the data using the Install.pl script included with DVD Store Version 2.1 (DS2), providing the parameters for our 40GB database size and the database platform we used. We ran the Install.pl script on a utility system running Linux® to generate the database schema.

After processing the data generation, we transferred the data files and schema creation files to a Windows-based system running SQL Server. We built the 40GB database in SQL Server, and then performed a full backup, storing the backup file remotely for quick access. We used that backup file to restore the database when necessary.

The only modification we made to the schema creation scripts were the specified file sizes for our database. We explicitly set the file sizes higher than necessary to ensure that no file-growth activity would affect the outputs of the test. Other than this file size modification, we created and loaded the database in accordance to the DVD Store documentation. Specifically, we followed these steps:

1. We generated the data, and created the database and file structure using database creation scripts in the DS2 download. We made size modifications specific to our 40GB database, and made the appropriate changes to drive letters.
2. We transferred the files from our Linux data generation system to a Windows system running SQL Server.
3. We created database tables, stored procedures, and objects using the provided DVD Store scripts.
4. We set the database recovery model to bulk-logged to prevent excess logging.
5. We loaded the data we generated into the database. For data loading, we used the import wizard in SQL Server Management Studio. Where necessary, we retained options from the original scripts, such as Enable Identity Insert.
6. We created indices, full-text catalogs, primary keys, and foreign keys using the database-creation scripts.
7. We updated statistics on each table according to database-creation scripts, which sample 18 percent of the table data.
8. On the SQL Server instance, we created a ds2user SQL Server login using the following Transact SQL (TSQL) script:

```
USE [master]
GO
```

```
CREATE LOGIN [ds2user] WITH PASSWORD=N'',
        DEFAULT_DATABASE=[master],
        DEFAULT_LANGUAGE=[us_english],
        CHECK_EXPIRATION=OFF,
        CHECK_POLICY=OFF
GO
```

9. We set the database recovery model back to full.
10. We created the necessary full text index using SQL Server Management Studio.
11. We created a database user, and mapped this user to the SQL Server login.
12. We then performed a full backup of the database. This backup allowed us to restore the databases to a pristine state.

Running the DVD Store Version 2.1 tests

For the clients, we used a Microsoft Server 2012 R2 instance for each vendor and made sure it was in the same datacenter. We created a series of batch files, SQL scripts, and shell scripts to automate the complete test cycle. DVD Store outputs an orders-per-minute metric, which is a running average calculated through the test. In this report, we report the last OPM reported by each client/target pair.

We used the following DVD Store parameters for testing:

```
ds2sqlserverdriver.exe --target=<target_IP> --ramp_rate=10 --run_time=60 --
n_threads=32 --db_size=40GB --think_time=0 --detailed_view=Y --warmup_time=5
--csv_output=<drive path>
```

ABOUT PRINCIPLED TECHNOLOGIES

Principled Technologies, Inc.
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We provide industry-leading technology assessment and fact-based marketing services. We bring to every assignment extensive experience with and expertise in all aspects of technology testing and analysis, from researching new technologies, to developing new methodologies, to testing with existing and new tools.

When the assessment is complete, we know how to present the results to a broad range of target audiences. We provide our clients with the materials they need, from market-focused data to use in their own collateral to custom sales aids, such as test reports, performance assessments, and white papers. Every document reflects the results of our trusted independent analysis.

We provide customized services that focus on our clients' individual requirements. Whether the technology involves hardware, software, Web sites, or services, we offer the experience, expertise, and tools to help our clients assess how it will fare against its competition, its performance, its market readiness, and its quality and reliability.

Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.