Abstract

NetApp® Private Storage (NPS) for Amazon Web Services (AWS) enables enterprises to build an agile cloud infrastructure that balances private and cloud resources to best meet their business needs. This solution provides a low-initial-cost platform that can be rapidly deployed and scaled as required. Perforce Helix, one of the leading software configuration management tools in the market, can benefit from the application of NPS with AWS. Using Helix with NPS and AWS can offer control, security, compliance, and data mobility between premises while providing full NetApp clustered Data ONTAP® value (storage efficiency, multiprotocol support, backup and recovery, and so on). This technical report provides an overview of testing that NetApp conducted to validate that Helix can operate successfully with NPS for AWS.
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1 Introduction

The software development cycle involves designing, developing, source configuration management (SCM), software product builds, quality assurance, testing, release, maintenance, and archival. On-premises software development brings certain challenges for developers, including:

- Dependence on IT to set up test infrastructure
- Space and power constraints
- Constraints because of a fixed set of resources
- Limited hardware resources for mid- to large-scale testing
- The need to plan and justify infrastructure resources in advance
- Maintenance of allocated resources
- Keeping pace with current technologies and hardware

With the emergence of cloud solutions and offerings, these challenges can be addressed and software development processes can be streamlined to increase developers’ productivity and efficiency and, therefore, accelerate time to market.

One of the key components of the software development cycle is source configuration management (SCM), which manages and tracks software and information related to development. SCM is integral to developers’ ability to access their own and others’ work in progress. NetApp Private Storage (NPS) is proven and trusted enterprise storage that offers high availability and enhanced disaster recovery while providing numerous enterprise data management features.

Perforce Helix is one of the top SCMs in the market. One of the main concerns for deploying Helix in the cloud is security and protecting a company’s intellectual property. Using Helix with NetApp Private Storage and Amazon Web Services offers control, security, and compliance. It also offers data mobility between premises and full NetApp clustered Data ONTAP value (storage efficiency, multiprotocol support, backup and recovery, and so on). Using the additional Helix options provided by NetApp Private Storage and Amazon Web Services improves efficiency and reduces time to market.

Leveraging many years of partnership with Helix, NetApp conducted tests to understand the utility and performance of Helix applications in the cloud using NetApp Private Storage and Amazon Web Services. Optimizations were attempted to develop this best practices guide for deployment and implementation as well as showcase the benefits of using Helix with NetApp Private Storage for Amazon Web Services. This technical report describes the objectives, testing methodology, and inferred best practices when deploying Helix into an environment using NetApp NPS with AWS. For more information on Helix applications and benchmarks, see TR-4164: Deployment and Implementation Guide: Helix Software on NetApp Clustered Data ONTAP.

2 Executive Summary

NetApp Private Storage (NPS) for Amazon Web Services (AWS) enables enterprises to build an agile hybrid cloud infrastructure that balances private and cloud resources to best meet their business needs. This solution provides a low-initial-cost platform that can be rapidly deployed and scaled as required. Perforce Helix, one of the leading software configuration management (SCM) tools in the market, can benefit from the application of NPS with AWS. Using Helix with NPS and AWS can offer control, security, compliance, and data mobility between premises while providing full NetApp clustered Data ONTAP value (storage efficiency, multiprotocol support, backup and recovery, and so on). This process provides additional options for improving efficiency and reducing time to market.

Testing proved the use of a hybrid cloud-computing environment using AWS with NPS for Software Configuration Management is viable for organizations looking to leverage the scalable compute
capabilities of Amazon with a secure, privately managed storage. This environment provides many advantages over the classic internal lab approach, including lower startup costs. This technical report proves the use case for this hybrid cloud approach. It also identifies best practices derived from observations made while testing.

Results of Helix testing with NPS for AWS were generally the fastest when employing the iSCSI protocol between the P4 server and NPS. Modified mixed-mode results, whereby two directories are mounted through iSCSI and the rest with NFS, were the next fastest and approached the speed of iSCSI. Mixed modes offer the advantages of speed, while still allowing substantial NFS manageability. NFS offers the best volume manageability.

3 NPS with AWS Helix Solution Overview

3.1 Target Audience

The target audience for the solution includes the following groups:

- System administrators—Those who administer DevOps clusters; they will enjoy the ease of automatically provisioning AWS instances (servers), along with the ability to cost-effectively scale the Helix environment.
- Lab managers—Those who want to combine on-premises and cloud-based compute capabilities while maintaining full data security.
- Development personnel—Developers who find progress constrained by the physical hardware available in a data center.

3.2 Perforce Helix

Helix is an enterprise-version management system in which users connect to a shared file repository (depot). Helix applications transfer files between the file repository and individual users’ workstations. Helix applications enable you to check files in and out, manage conflicts, create development branches, track bugs, and change requests, as well as perform other important development-related items. A user never works directly with files contained in a Helix depot, but rather in a client workspace that is a specially designated part of the workstation. The client workspace can be used to pull and send information to the main depot. Figure 1 from Perforce illustrates this process.

Helix uses the native Linux or Windows operating system underneath and requires no special kernel, dedicated file system, or volume. For more information on Helix, see the Perforce documentation at https://www.perforce.com/perforce/r15.1/manuals/p4guide/index.html.

3.3 NetApp Private Storage for Amazon Web Services (NPS for AWS)

NPS for AWS allows enterprises to build an agile cloud infrastructure that balances private and cloud resources to best meet their business needs. The solution couples EC2 for on-demand computing with the performance, availability, and control of dedicated NetApp storage. Organizations can bidirectionally replicate data from on-premises NetApp virtualized infrastructure to NetApp storage in an AWS Direct Connect colocation facility. Doing so leverages cloud computing services while retaining full control and mobility of enterprise data.

AWS Direct Connect establishes a dedicated connection between a facility and an AWS Direct Connect location. The solution maintains data privacy while providing cloud benefits with proven enterprise storage, enhanced disaster recovery at lower cost than that of traditional approaches, and the agility to dynamically adjust private and cloud resources to optimize business outcomes.

A diagram of how data can be moved from an on-premises environment to NPS is shown in Figure 2.

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2 Source: https://www.perforce.com/perforce/r15.1/manuals/intro/index.html
Figure 2) NetApp Private Storage for AWS.

Secure, high-performance integration between NetApp and the cloud compute

Full clustered Data ONTAP value

Seamless data mobility between premises/private cloud and NetApp Private Storage
3.4 Objective

The objective of this study was to validate the viability of running Helix in a hybrid cloud environment and to develop best practices for using Perforce Helix with NPS for AWS. There are two ways in which to deploy Helix in the cloud with NetApp Private Storage:

1. All Helix components are in the cloud with Helix database and depots stored in NetApp Private Storage in a colocation facility (Figure 3).

2. Master Helix components (Commit Server) and main Helix database and depots are on premises in NetApp storage. A Helix Edge server in the cloud and replicated Helix database and depots are stored in NetApp Private Storage in a colocation facility (Figure 4).

Figure 3) Helix cloud deployment with NetApp Private Storage.
4 Testing Strategy

The testing strategy consisted of a series of different tests that exercised Helix in the cloud using NPS for AWS. The primary purpose of these tests was to understand the viability and characteristics of Helix runs over NPS for AWS. The tests enabled the development of best practices for running Helix in NPS for AWS. These best practices are described in this technical report. A list of the various tests, brief explanations of the tests, and the success criteria are described in the following sections.

For the purposes of this study, approach #1 (left pane, Figure 3) was undertaken. Therefore, all Helix components resided in AWS while the Helix depots, databases, logs, and journals were stored in NPS. Data replication between the on-premises environment and NPS was beyond the scope of this effort, but the general description of this process is documented in TR-4015: “SnapMirror Configuration and Best Practices Guide for Clustered Data ONTAP.”

4.1 Helix Validation Tests

Helix has several benchmarks to determine the performance of Perforce Helix deployments. These benchmarks were used in the cloud deployment of Helix with NetApp Private Storage to validate with appropriate benchmarking tools that the configuration worked as advertised while under load. The Helix benchmarks that were run included the following:

- **Browse benchmark**—This benchmark involves a single P4D server and multiple browse-child client machines. Each browse-child instance generates load on the server by executing commands that simulate the operational characteristics of the Helix P4V client. Each browse-child instance issues a series of commands that repeatedly drill down random paths through the repository without delaying between the browses. This test records the time in seconds to complete the browse operations.

- **Branchsubmit benchmark**—This benchmark exercises dm-CommitSubmit performance. Using the default configuration, 70,000 files are integrated into a new branch; a changelist list is created and then submitted. Statistics from these actions are extracted for the final report. P4D accesses the p4dbs where it locks the db* files that need to be accessed. P4D applies either the read locks if the Helix tasks involve read operations or it applies write locks if the Helix tasks involve write operations. This test records the number of files being accessed per second.
• **Branchsubmit-Edit.** This test is similar to the Branchsubmit test and records the number of files being accessed per second with the following exceptions:
  - The `integrate` command does not incorporate the `-v` (virtual) flag, resulting in the creation of a new branch involving the copy of the branched archive files to the client.
  - Edits are performed on the integrated depot files before submission.

• **Sync benchmark**—This test is similar to the browse benchmark test, which involves a single P4D server and multiple clients. The fundamental difference is that a sync operation and not a filelog operation is performed at the end of the random browse. The primary metric of interest is the completion time for a specific amount of synced data by a specified number of children.

• **Deltas benchmark**—This benchmark exercises the read capabilities of the storage environment. It does so with the `-n` option in conjunction with Helix `integrate` and `sync` commands. To void the operating system's file system cache, the file system that contains the Helix metadata tables is unmounted. Remounted Deltas are based on the delta benchmark script, which records the results in seconds.

These benchmarks exercised the data path between the Helix client and servers on Amazon Web Services and the Helix database and depots that are stored on NPS.

### 4.2 Validation Criteria

Functionality and an understanding of key setup procedures are considered critical factors in determining success. The numbers obtained from the performance studies of various protocols were used to determine the viability of the NPS for AWS run environment and to develop best practices. The main aims of this study were to evaluate the viability of running Helix with NPS for AWS and to determine which NetApp storage protocols are best suited in an NPS for AWS Helix cloud deployment. Another main aim was to develop best practices that can enhance cloud Helix performance.

### 5 Configuration

#### 5.1 NPS for AWS

The compute nodes used to deploy Helix servers are instances created in Amazon Web Services and the Helix database was stored in a NetApp Private Storage environment that was provided by the NetApp Proof of Concept Lab. Table 1 shows the specific servers and storage that were used for these tests.

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 P4 server (AWS EC2 Instance), 2 x Intel Xeon CPU E5-2676 v3 @ 2.40GHz (Haswell), 160GB RAM</td>
<td>• RHEL Linux 7.1</td>
</tr>
<tr>
<td>2 P4 clients (AWS EC2 Instances), 2 x Intel Xeon CPU E5-2676 v3 @ 2.40GHz (Haswell), 160GB RAM</td>
<td>• RHEL Linux 7.1 • Helix Versioning Management and Collaboration latest reported release</td>
</tr>
<tr>
<td>NetApp Private Storage (POC Lab), FAS8060 with SATA/SSD drives (all available), 64GB RAM, 16-core Intel E5-2658 <a href="mailto:CPU@2.1GHz">CPU@2.1GHz</a> 4TB drives, SATA drives 1.4TB SSD drives</td>
<td>Clustered Data ONTAP 8.3.1</td>
</tr>
</tbody>
</table>
The exact AWS instances chosen are shown in Table 2.

### Table 2) AWS instances chosen.

<table>
<thead>
<tr>
<th>EC2 Instances</th>
<th>EC2 Type</th>
<th>Number of Cores (vCPU)</th>
<th>Memory</th>
<th>Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x clients</td>
<td>m4.10xlarge</td>
<td>40</td>
<td>160GB</td>
<td>10Gbe</td>
</tr>
<tr>
<td>Perforce server</td>
<td>m4.10xlarge</td>
<td>40</td>
<td>160GB</td>
<td>10Gbe</td>
</tr>
</tbody>
</table>

10GigE was the chosen interconnect between all AWS instances and between the P4 server instance and NPS. These AWS instances communicated internally at a default MTU size of 9,000. Between AWS and NPS, there is not yet support for the 9,000 MTU size, and the NPS was left at the default 1,500 size. Further testing indicated that leaving the AWS instance MTU size at 9,000 yielded the best results because of the internal instance communication, including the configuration of the internal AWS switch(es).

The following volumes were created using the FAS8060 being employed for the NPS. A LUN was constructed out of each of the two iSCSI volumes shown in Table 3.

### Table 3) NPS test volumes.

<table>
<thead>
<tr>
<th>Volume Name</th>
<th>Drive Type</th>
<th>Size (MB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>p4db_SATA</td>
<td>SATA</td>
<td>700</td>
</tr>
<tr>
<td>p4depot_SATA</td>
<td>SATA</td>
<td>700</td>
</tr>
<tr>
<td>p4journal_SATA</td>
<td>SATA</td>
<td>700</td>
</tr>
<tr>
<td>p4logs_SATA</td>
<td>SATA</td>
<td>10</td>
</tr>
<tr>
<td>p4voliscsi_SATA</td>
<td>SATA</td>
<td>1228.8 (1.2TB)</td>
</tr>
<tr>
<td>p4db_SSD</td>
<td>SSD</td>
<td>700</td>
</tr>
<tr>
<td>p4depot_SSD</td>
<td>SSD</td>
<td>700</td>
</tr>
<tr>
<td>p4journal_SSD</td>
<td>SSD</td>
<td>700</td>
</tr>
<tr>
<td>p4logs_SSD</td>
<td>SSD</td>
<td>10</td>
</tr>
<tr>
<td>p4voliscsi_SSD</td>
<td>SSD</td>
<td>1228.8 (1.2TB)</td>
</tr>
</tbody>
</table>

Volumes were initially created for SATA drive types and then mirrored with NetApp SnapMirror® software to SSD to provide this functionality.

### 6 Benchmark Analysis

As stated in Section 4.1, the browse, sync, branchsubmit, branchsubmit-edit, and deltas benchmarks were run to validate the overall environment. All benchmarks successfully completed using AWS instances (as the Helix server, client servers) and NPS. During the execution of these benchmarks, observances were made and best practices were developed.
The benchmarking was performed using NFS, iSCSI, and mixed-mode protocols. Mixed mode is the case in which iSCSI is used for the database (db) only. All other directories are mounted using NFS. Modified (Mod) mixed mode is variable, and this mode is discussed per benchmark in sections 5.1 and 5.2. In all modified mixed-mode cases, two directories are mounted using iSCSI. The exact two directories vary per benchmark and are shown in Table 9.

As part of the best practices development, AWS placement groups were employed. Placement groups logically place AWS instances close to one another versus having them potentially scattered as in a regular AWS approach. Placement groups are advantageous for applications that benefit from low network latency, high network throughput, or both. Placement groups showed performance advantages to regular AWS instance deployment.

Although performance testing was not a primary objective of this exercise, we were able to develop some general guidelines around performance and manageability with regard to using NFS or iSCSI. Table 4 shows the advantages seen in testing using various transport protocols between AWS instances and NPS.

Table 4) Network protocol advantages and disadvantages.

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>iSCSI</td>
<td>• Fastest performance</td>
<td>• Backup and recovery are complex and require more steps compared to those with NAS.</td>
</tr>
<tr>
<td>NFS</td>
<td>• Simple to manage</td>
<td>• The I/O performance is slow compared with that of iSCSI.</td>
</tr>
<tr>
<td></td>
<td>• Offers ease of use and granularity in backup and recovery operations</td>
<td></td>
</tr>
<tr>
<td>Mixed mode (iSCSI only for db)</td>
<td>• Improves Helix database write performance</td>
<td>• Backup and recovery are complex because backups are performed by using two separate protocols while maintaining concurrency between them. (However, using NetApp SnapDrive® data management software alleviates this complexity.)</td>
</tr>
</tbody>
</table>

See Table 5 for the criteria for selecting the protocol.

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Table 5) Criteria for network protocol selection.

<table>
<thead>
<tr>
<th>Important Criterion</th>
<th>iSCSI</th>
<th>NFS</th>
<th>Mixed Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>Fastest</td>
<td>Fair</td>
<td>Midrange</td>
</tr>
<tr>
<td>Direct file access to heterogeneous clients</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Manageability</td>
<td>Fair</td>
<td>Excellent</td>
<td>Good</td>
</tr>
<tr>
<td>Cost</td>
<td>Low cost</td>
<td>Low cost</td>
<td>Low cost</td>
</tr>
<tr>
<td>Ease of backup and recovery</td>
<td>Fair</td>
<td>Excellent</td>
<td>Good</td>
</tr>
</tbody>
</table>

7 Steps to Deploy Perforce Helix with NPS for AWS

Before we provide best practices, here is a brief description of the general setup process for using Helix with NPS with AWS by component area. This process is almost identical to the one used to run Helix with NetApp storage in a data center, with AWS a new component.

7.1 Perforce Helix
- Download or use Helix media to install the software. Helix has Helix software available at https://www.perforce.com/downloads/helix.
- Helix server software is free to use for up to 20 users and 20 client workspaces with unlimited files or unlimited users but with only 1,000 files. However, most run cases will easily exceed this number. If you exceed these numbers, request a quote and obtain a license from Helix at https://www.perforce.com/purchase/pricing-licensing.
- This license will be used in the AWS P4 server instance.

7.2 NPS
NPS setup is identical to the process of setting up regular NetApp FAS storage, but a few key areas must be kept in mind.
- The network on which NPS sits must be reachable by the AWS instance(s) that you wish to work with. This means that either an open network for NPS (with the correct firewall rules) or a private AWS Direct Connect link (as specified by NPS for AWS) is made between a facility and AWS. Use 10GigE if possible for the network connection.
- Choose the drive types to be used for Helix benchmarking based on what is desired. SSDs offer superior uptime but at a higher cost. SATA drives are low cost. Performance variations were not considerably different from our testing.
- Build volumes for Helix testing with the networking protocol you want. NFS offers the best manageability but at lower run speeds compared to those of iSCSI. Mixed-mode configurations are useful to maintain speed while enabling NFS manageability. If using iSCSI, an igroup will need to be created and mapped to the initiator of the P4 server instance. The created LUN should be mapped to the igroup.
- Suggested volumes are a depot, db, logs, and journal. Use these for NFS and iSCSI with the desired drive type(s).

7.3 AWS Setup
- Create three or more AWS instances in a single placement group and on the same subnet as your NPS (with AWS Direct Connect, if possible). The AWS instances should use an AWS region close to the physical NPS location to minimize latency. Use the latest Red Hat Enterprise Linux version on the instances. EC2 virtual machines have various instance types that support the computing needs required, based on CPU, memory, and network bandwidth. The P4 server instance should be powerful; we suggest
an m4.10xlarge or similar type. The P4 client machines can be chosen as the same type to support 10GigE networking.

- Download the pem key to connect to your AWS instances. pem can be used to connect to the AWS instance from a Linux machine, but putty (for a Windows machine) requires a ppk key. Use PuTTyGen or another tool to convert the pem key to ppk if required.
- Ensure the EC2 instances are reachable from your location. Reaching them requires logging into the EC2 instances by using the public IP address of the instance. For AWS Direct Connect, this address might be the private IP address. You can find the information for each instance in the Description tab after clicking on instances in the left panel. Figure 5 shows the location of the public and private IP addresses for the instance.

Figure 5) Location in AWS to view instance IP address data.

- Using SCP (or another file transfer program) and then a putty or other terminal program, install the NetApp Linux unified_host_utilities on the P4 server. Doing so provides added features to work with NetApp NPS storage. This step must be completed as user ec2-user.
- Attempt ping communications from the P4 server to NPS. If successful, attempt a mount of an existing or a new volume from the P4 server to NPS. Note: iSCSI volumes require additional commands to see devices from your instance. Use the options of “nocto,local_lock,vers=3” for NFS mounts.
- It is possible to run as ec2-user, although during this benchmarking we ran as root. If desired, switch to root using the command sudo su root from the ec2-user login. Ensure that passwordless ssh is set up between your instances.
- Upload the Perforce Helix software to the P4 server instance. Also copy the P4D and P4 executable binaries to the Helix client instances. Set the paths on all instances so that P4D and P4 are globally accessible through the Linux command line.
- Upload to the P4 server instance the Helix tarballs containing the benchmarks you want. During this exercise, we ran all of branchsubmit, branchsubmit-edit, browse, sync, and deltas. Deltas must be obtained specially from Helix and it is not a common benchmark.
- Modify the extracted Helix benchmark data so that the configuration files reflect the correct Helix binaries, correct port that Helix will use, correct directories, correct client server IP addresses (if required), and the correct location of database and depot files (as required). The various benchmarks call out different items and are set up differently.
- Mount the db, depot, logs, and journal directories using the preferred networking protocol. iSCSI typically has the fastest speed, while NFS enables more manageability. iSCSI typically has the fastest speed, while NFS allows for more manageability. If using the iSCSI protocol, collect the instance initiator name with the cat /etc/iscsi/initiatorname.iscsi command. This is required on NPS.
- Run the Helix benchmarks desired from the P4 server. Helix launch information is available in the benchmark files as text documents.
8 Best Practices

The following practices resulted from the testing described in this technical report and should be observed when running Perforce Helix with AWS and NPS (located at Equinix or another facility):

1. For NFS mounts, NetApp recommends that nocto,local_lock,vers=3 be used as NFS mount options (see NetApp TR-4164):

   “For the testing that required NFS, the database, logs, journals, and/or depots were mounted with the nocto and local_lock=all. It is important to note that the nocto and local_lock=all mount options should only be used when the mounted data is exclusively accessed by one NFS v3 client machine, in this case, the machine in which the Helix server is running. Since these mount options affect attribute checking and file locking, respectively, misuse of these options could result in data corruption.”

   This is the manner in which volumes were mounted for NFS during this testing. iSCSI was taken as a single large ext4 volume with multiple subdirectories (for db, logs, depots, journals, and so on).

2. Create AWS instances to use the high-speed, low-latency 10GigE network. The NPS should also be connected through 10GigE. Data-intensive benchmark performance is affected.

3. This process works with lower-cost SATA drives, unless there are concerns such as uptime. SATA drives appeared to perform relatively closely to SSD drive performance using Helix in a NPS for AWS environment.

4. Take advantage of manageability while maintaining high performance by using mixed mode (iSCSI for database only) or modified mixed mode (for even better performance). From testing, a modified mixed-mode manner is presented to approximate pure iSCSI performance for the benchmarks run, while allowing for NFS manageability in the remaining NFS mounted volumes. Which directories should be iSCSI mounted are shown in Table 6 below.

   Table 6) Suggested modified mixed modes.

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>iSCSI Mounts</th>
<th>NFS Mounts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Branchsubmit</td>
<td>Database(db), journals</td>
<td>Logs</td>
</tr>
<tr>
<td>Branchsubmit-edit</td>
<td>Database(db), journals</td>
<td>Logs, depot</td>
</tr>
<tr>
<td>Sync</td>
<td>Database(db), journals</td>
<td>Logs, depot</td>
</tr>
<tr>
<td>Browse</td>
<td>Database(db), logs</td>
<td>Journal</td>
</tr>
</tbody>
</table>

   Testing must determine exactly which directories must be iSCSI mounted to obtain iSCSI-like performance in real-world use cases. Table 6 provides a guideline based on Helix benchmarks and therefore workloads.

5. Use AWS placement groups to run Helix benchmarks or tests requiring more than one server (instance). The effect is particularly notable with the iSCSI sync benchmark in which the run times are reduced by over half. The effect is there for browse as well.
9 Conclusions

This report shows that Helix can be run in AWS with NPS residing in a remote facility. Results were generally the fastest when employing the iSCSI protocol between the P4 server and NPS. Modified mixed-mode results were the next fastest and approached those of iSCSI. Mixed mode offers the advantages of speed while enabling substantial NFS manageability. The choice of SATA versus SSD drives did not make a significant difference because the primary determinant of performance appeared to be network latency.

The use of NPS for AWS along with Helix or other applications provides these advantages:

- No need for the IT department during deployment
- Rapid provisioning and bringing up of compute instances
- No space or power constraints
- Having current compute hardware always available at a click
- Massive scalability of compute resources

A cloud computing environment such as AWS with NPS is valid for use as a software configuration management environment and presents many advantages compared to the classic internal lab approach.

10 References

Helix System Administration Guide

Deployment and Implementation Guide: Perforce Software on NetApp Clustered Data ONTAP

"Is it dangerous to change the value of /proc/sys/net/ipv4/tcp_tw_reuse?"
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Jumbo Frame Support
https://forums.aws.amazon.com/thread.jspa?threadID=170086

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Placement Groups, Amazon Web Services

How Perforce Works

NetApp Private Storage for Amazon Web Services
http://solutionconnection.netapp.com/netapp-private-storage-for-amazon-web-services.aspx

AWS Direct Connect
http://aws.amazon.com/directconnect/

SnapMirror Configuration and Best Practices Guide for Clustered Data ONTAP

Helix 2012.1: Command Reference
## Version History

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<td>Version 1.0</td>
<td>February 2016</td>
<td>Narjit Chadha</td>
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