



# **HPE REFERENCE ARCHITECTURE FOR SAS 9.4 ON HPE SUPERDOME FLEX 280 AND HPE PRIMERA STORAGE**

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## EXECUTIVE SUMMARY

In today's digital transformation world, Enterprises are deploying Analytical and Data Visualization solutions to gain a competitive edge and make real-time decisions from the huge amount of data that's generated. A large amount of data that needs to be addressed and handled to make these complex decisions that give the business a competitive edge is compute intensive and consumes large amounts of storage. These solutions need compute and storage platforms that are highly scalable and reliable.

This Reference Architecture highlights the key findings and demonstrated scalability when running SAS® 9.4 using the Mixed Analytics Workload running on HPE Superdome Flex 280 Server and HPE Primera Storage. These results demonstrate that the combination of the HPE Superdome Flex 280 Server and HPE Primera Storage with SAS 9.4 delivers up to 20GB/s of sustained throughput, up to a 2x performance improvement from the previous server and storage generation testing<sup>1</sup>.

SAS 9.4 customers require a hardware and software configuration that can deliver data analysis results quickly and accurately. As a result, enterprises demand reliable and fast storage that can scale to meet their business analytics requirements. This report details a proof point for SAS 9.4 that demonstrates the performance available with HPE Superdome Flex 280 Server and HPE Primera Storage can bring to the SAS workload.

The HPE Superdome Flex is ideal for managing workloads that need to process the exponentially growing data sets and scalability while ensuring flexibility for all transaction, analytical, and data management workloads. HPE Superdome Flex coupled with HPE Primera storage is an ideal combination to meet the needs of any scale-up environment. Designed for small and medium enterprise environments, HPE Superdome Flex 280 Server is your system to power digital transformation. This solution can start at two (2) sockets and scales up to eight (8) sockets, using powerful 3rd generation Intel® Xeon® Scalable Processors and also provides large memory capacity, thus meeting the need for the most demanding workloads. The expansive and configurable memory and processor options available within HPE Superdome Flex can speed up queries by orders of magnitude, while simultaneously processing transactions and serving the clinicians requests.

HPE Primera Storage is the world's most intelligent storage for mission-critical apps that delivers extreme resiliency and performance with the agility of the cloud. HPE Primera Storage delivers instant access to data with storage that sets up in minutes, upgrades transparently, and can be delivered as a service. With mission-critical reliability built-in, HPE Primera Storage is architected for high availability with multi-node design, transparent business continuity with HPE Peer Persistence, and data replication. Unlike traditional storage that stops here, HPE Primera Storage also uses artificial intelligence (AI) and machine learning (ML) powered by HPE InfoSight for analytics and prediction. This end-to-end, app-aware approach for resiliency maximizes uptime for mission-critical apps.

Some of the salient features of HPE Primera Storage:

- It is the only enterprise storage array with 100% guaranteed availability
- Uses HPE InfoSight to analyze and predict disruptions across the infrastructure stack
- Has mission-critical resiliency without sacrificing agility

**Target audience:** The target audience for this Reference Architecture is Chief Information Officers (CIOs), Chief Technology Officers (CTOs), data center managers, enterprise architects, deployment/implementation engineers and others who are interested in implementing a SAS solution may find this report useful for a sample SAS configuration and a demonstration of the HPE Superdome Flex 280 Server and HPE Primera Storage.

**Document purpose:** The purpose of this document is to describe a Reference Architecture, highlighting the recognizable benefits of running SAS 9.4 on HPE Superdome Flex 280 Server with HPE Primera Storage to technical audiences.

This Reference Architecture describes solution testing performed in October-November 2020.

<sup>1</sup> Source: HPE Reference Architecture for SAS 9.4 on HPE Synergy and HPE 3PAR 8400, April 2018.



## INTRODUCTION

SAS is the leader in advanced and predictive analytics with industry specific product sets for banking, government, retail, telecommunications, and aerospace and for marketing optimization or high-performance computing. The SAS 9.4 platform streamlines data access and preparation, enhances data quality, and ensures optimal processes to increase the productivity of your analytics projects.

The SAS Mixed Analytics Workload uses real-world data volumes and structures of a typical SAS customer. The scenario simulates the types of jobs received from various SAS clients such as SAS Display Manager, batch, SAS Data Integration Studio, SAS Enterprise Miner, SAS Add-In for Microsoft® Office, SAS Enterprise Guide®, and SASStudio. Many customer environments have a large number of ad hoc SAS users or jobs that utilize analytics in support of their company's day-to-day business activities.

The scenario consists of typical analytic jobs designed to replicate light to heavy workload. These jobs were launched via a script that includes time delays to simulate scheduled jobs and interactive users launching at different times.

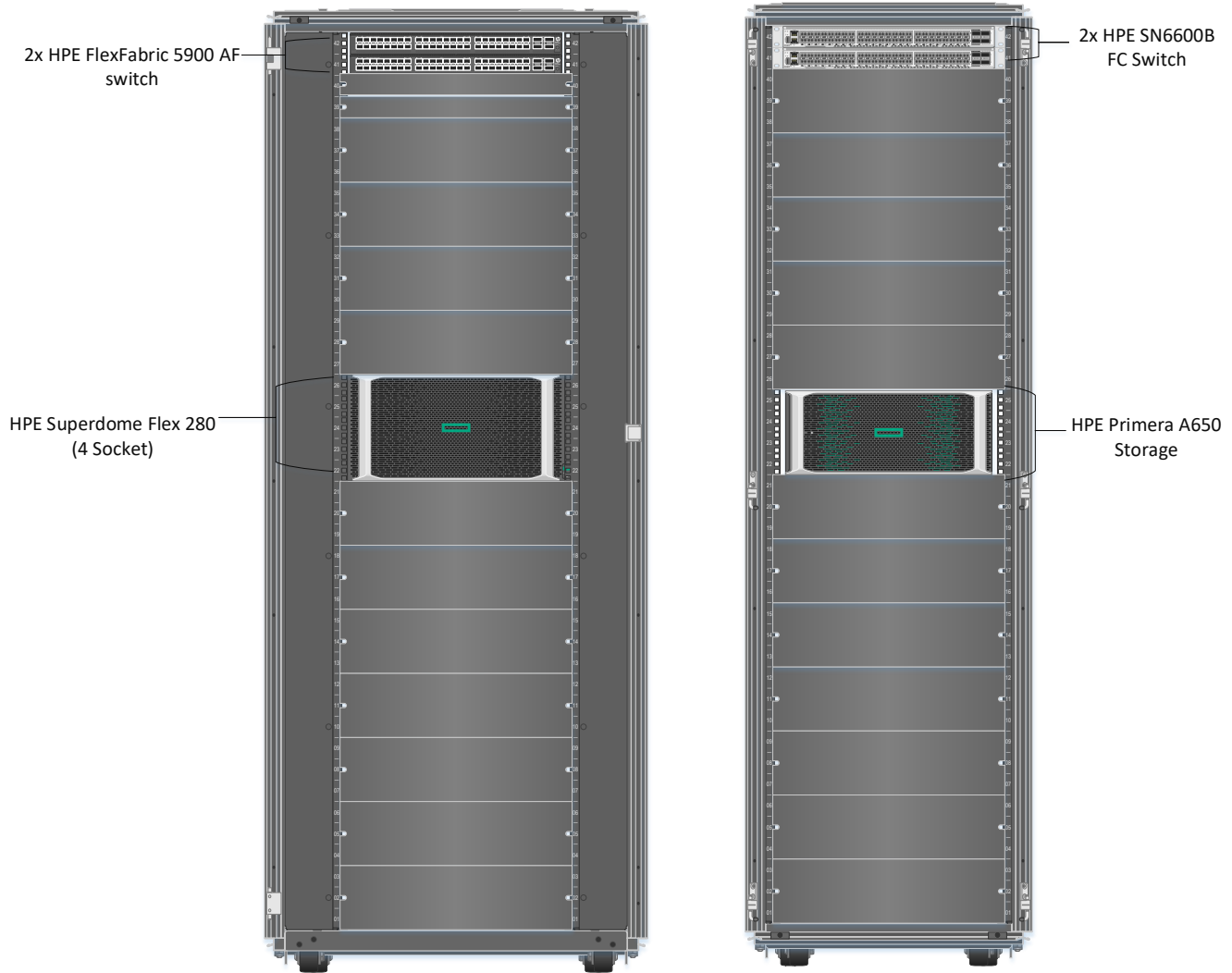
The purpose of these particular set of tests was to characterize HPE Superdome Flex 280 Server and HPE Primera Storage array, so that users will understand how to configure HPE Superdome Flex 280 Server along with HPE Primera Storage to utilize the ideal combination of storage and compute, and also get a feel for the level of performance this combination can deliver in a SAS 9.4 environment.

## SOLUTION OVERVIEW

This solution is based on HPE Superdome Flex 280 Server combined with HPE Primera A650 Storage on Red Hat® Enterprise Linux® 7.



The diagram of the hardware components that form the solution is shown in Figure 1.



**FIGURE 1.** Front view of the solution featuring HPE Superdome Flex 280 Server and HPE Primera storage

## SOLUTION COMPONENTS

### HPE Superdome Flex 280 Server

The HPE Superdome Flex 280 Server is a new model in the HPE Superdome Flex family of servers. It is a highly scalable, reliable, and secure server that starts at two (2) sockets and scales up to eight (8) sockets, utilizing powerful 3rd generation Intel® Xeon® Scalable Processors. Its modular architecture scales cost-efficiently to meet future growth.



Figure 2 shows the HPE Superdome Flex 280 Server.



**FIGURE 2.** HPE Superdome Flex 280 Server – Single chassis

HPE Superdome Flex 280 Server offers:

- Support for 2 to 8 sockets of Intel Xeon Scalable Processors in a single system with up to 28-cores per socket for a maximum of 224 cores
- 6 UPI links per socket providing unparalleled bandwidth and performance
- 48 DIMM slots of DDR4 memory per chassis
- 64GB - 24TB of shared memory (12TB at first release)
- 16 half-height IO slots, or 8 full-height + 4 half-height IO slots, per four-socket chassis
- Base IO includes support for 8 SATA drives via VROC, two 1GbE NIC ports, four USB ports, and Management LAN
- Internal storage up to 10 drive bays, or 8 drives and an optional DVD
- HPE Superdome Flex 280 Server Error Analysis Engine for better diagnostics and mission-critical reliability

#### **Platform Management:**

The HPE Superdome Flex 280 Server is configured with an embedded rack management controller (eRMC) for hardware management. By integrating the management into the server platform, Hewlett Packard Enterprise ensures that every HPE Superdome Flex 280 Server comes with the full set of management features, which simplifies the task of integrating HPE Superdome Flex 280 Server into the data center. The eRMC is included with the base chassis and allows you to perform the following:

- Web GUI for eRMC – Redfish driven covers:
  - System inventory, health, and configuration
  - Launch vMedia, vKVM (HTML5)
  - Configure UEFI reboot and power
  - eRMC security settings
  - eRMC LAN settings
- Command-line interface (CLI) for easy access to all eRMC functions, providing potential scripting to ease setup and provide consistency across HPE Superdome Flex 280 Server installations within the data center.
- Console, and console logs



- Built-in Error Analysis Engine constantly monitors all system hardware, analyzes log and telemetry data, and determines corrective actions for highest system uptime (often performing corrective actions automatically).
- HPE Superdome Flex 280 eRMC will interface directly with the HPE Remote Support software for data center wide fault management visibility and tie-in to HPE support services, such as the Insight Online portal.

For more details, refer to [HPE Superdome Flex 280 Server QuickSpecs](#).

HPE Superdome Flex 280 was used for testing and its configuration is as below:

- 4 x Intel Xeon-Platinum 8380HL (2.9GHz/28-core/250W) Processor<sup>2</sup>
- 48 x HPE 128GB DDR4-3200 LRDIMM
- 4 x HPE 800 GB SAS 12G MU SFF SSD
- 4 x HPE SN1610Q 32Gb Fibre Channel Host Bus Adapter
- 2 x HPE Ethernet 10Gb 2 Port 562T Adapter

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## NOTE

For two (2) socket testing, two (2) CPUs were disabled at eRMC level.

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## HPE Primera Storage

HPE Primera Storage is a Tier-0 enterprise storage solution designed for simplicity, resiliency, and performance when running mission-critical applications and workloads. Built upon proven resiliency and powered by the intelligence of HPE InfoSight, HPE Primera Storage delivers instant access to data with storage that sets up in minutes, upgrades transparently, and is delivered as a service. It ensures always fast and always on storage for all mission-critical applications. HPE Primera Storage is a parallel, multi-node, all-active platform that achieves predictably high-performance at extremely low latency.

HPE Primera storage systems include the HPE Primera 630, HPE Primera 650, and HPE Primera 670. Each model is available in an all-flash-drive configuration or a converged-drive configuration. The converged-drive configuration supports a mix of flash and no flash physical drives. All models come with factory-installed HPE Primera OS and HPE Primera UI.

The following summarizes the basic configurations. It does not include additional feature options. For more information on the number of host ports and maximum storage capacities, see the [HPE Primera Storage QuickSpecs](#).

**HPE Primera A630 and C630:** The HPE Primera A630 is an all-flash-drive configuration and the HPE Primera C630 is a converged-drive configuration. The 630 includes a 2U base enclosure that contains 2 storage controllers. The 2U base enclosure can hold up to 24 small form factor physical drives. The HPE Primera A630 can provide 5 add-on drive enclosures and for HPE Primera C630 can provide 9 add-on drive enclosures.

**HPE Primera A650 and C650:** The HPE Primera A650 is an all-flash-drive configuration and the HPE Primera C650 is a converged-drive configuration. The 650 is available with the 2U or 4U base enclosure that contains either two (2) or four (4) storage controllers. The 2U and 4U base enclosure can hold up to 24 or 48 small form factor physical drives. The HPE Primera A650 can provide 14 add-on drive enclosures and for HPE Primera C650 can provide 22 add-on drive enclosures.

**HPE Primera A670 and C670:** The HPE Primera A670 is an all-flash-drive configuration and the HPE Primera C670 is a converged-drive configuration. The 670 is available with the 2U or 4U base enclosure that contains either two (2) or four (4) storage controllers. The 2U and 4U base enclosures can hold up to 24 or 48 small form factor physical drives. The HPE Primera A670 can provide 22 add-on drive enclosures and for HPE Primera C670 can provide 38 add-on drive enclosures.

<sup>2</sup> An Intel Xeon Platinum 8380HL processor supports up to 4.5TB of memory per processor. In this Reference Architecture, only 1536GB memory was installed per processor.



Figure 3 shows the series of HPE Primera Storage.



**FIGURE 3.** HPE Primera Storage Series

#### Management interfaces for HPE Primera:

- **HPE Primera UI:** The HPE Primera UI is a graphical user interface for managing a single HPE Primera Storage system. HPE Primera UI software is included in each HPE Primera Storage system and does not require installation on a server.
- **HPE Primera CLI:** HPE Primera CLI is a text-based command-line interface for managing one HPE Primera Storage system at a time. The functionality is included in the HPE Primera OS on HPE Primera Storage systems. HPE Primera CLI client software can be installed on hosts (servers) running various computer operating systems.
- **HPE 3PAR SSMC (StoreServ Management Console):** HPE 3PAR SSMC is a graphical user interface for managing multiple HPE Primera Storage systems and/or HPE 3PAR StoreServ Storage systems at a time. The software is available as a virtual appliance and can be downloaded from the HPE Software Depot. The software can be deployed in several supported virtual machine environments.

HPE 3PAR SSMC provides additional features and capabilities compared to HPE Primera UI version 1.1.

The HPE Primera A650 was used for testing and its configuration is as below:

- 4-node Primera A650 Running OS 4.2.1.6
- 56 x 1.92 TB SAS SSD
- 16 x 1.92 TB NVMe SSD
- 8 x 32 Gb 4 port FC HBA

#### Software

The software components used for this Reference Architecture are:

- Red Hat® Enterprise Linux® 7.9
- HPE Foundation Software

#### Application software

##### SAS 9.4

SAS 9.4 is a highly flexible and extensible fourth-generation programming language (4GL) for data access, data transformation, analysis, and reporting. It is included with the SAS Foundation. SAS 9.4 is designed for data manipulation, information storage and retrieval, descriptive statistics, and report writing. It also includes a powerful macro facility that reduces programming time and maintenance headaches.

SAS 9.4 software optimizes all hardware resources and scales across different infrastructure components. Numerous layered applications are available for additional functionality, including direct access to standardized data sources and advanced statistical analysis.





Prewritten SAS procedures handle many common tasks, including data manipulation and management, information storage and retrieval, and report writing. They encapsulate and deliver significant functionality that can be executed with just a few simple commands, so programmers can be more efficient and productive.<sup>3</sup>

### **SAS Mixed Analytics Workload description**

The SAS Mixed Analytics Workload used for this test had the following characteristics:

- 50% CPU intensive and 50% IO intensive jobs
- Utilized SAS DATA step and procedures including:
  - PROC RISK, PROC LOGISTIC, PROC GLM (general linear model), PROC REQ, PROC SQL, PROC MEANS, PROC SUMMARY, PROC FREQ, and PROC SORT
- SAS program input sizes up to 50GB per job
- Input data types are text, SAS data set, and SAS transport files
- Memory use per job is up to 1GB
- Job runtimes were varied (short and long-running tasks)

## **BEST PRACTICES AND CONFIGURATION GUIDANCE FOR THE SOLUTION**

### **HPE Foundation Software**

The HPE Foundation Software should be installed on the server after installing the OS. This software consists of packages designed to ensure the smooth operation of the server. It includes Data Collection Daemon (DCD) for Linux, an agentless service that proactively monitors the health of hardware components in the server.

### **HPE Primera Storage**

HPE Primera Storage is configured as per the [HPE Primera Red Hat Enterprise Linux Implementation Guide](#). The Primera Volumes are provisioned to the HPE Superdome Flex 280 Server using HPE 3PAR/Primera SSMC (StoreServ Management Console).

Multipathing configuration for the HPE Primera can be found in [Appendix B](#).

Hewlett Packard Enterprise has found, that it is optimal to have multiple virtual volumes (LUNs), typically 8, exported from the array to the server(s). On the server end, those LUNs are then aggregated into a volume group, from which logical volumes are created for each of the storage areas needed for SAS.

The SAS Mixed Analytics Workload deploys in groups of 30 users and each 30 user grouping is self-contained. This means that for each 30 user grouping, we created a separate area on the disk. We create that area on disk from the same volume group as all the other groupings are created from. In this way, we are able to emulate any number of users, because they all share the same server and they all use the same LUNs.

For each of the 30 user runs, Hewlett Packard Enterprise created logical volumes for SAS Data, SAS Work and UTILLOC. Each of the logical volumes were striped across all 8 LUNs with a stripe size of 2MB. The Logical Volume Manager (LVM) read ahead was then also set to 2MB, via the lvchange command. Hewlett Packard Enterprise has also found that the best performing file system for SAS is XFS.

Scripts for the creation of the volume group, the logical volumes, and the file systems can be found in [Appendix C](#) through [Appendix F](#).

## **CAPACITY AND SIZING**

With SAS 9.4 running the Mixed Analytics Workload, we rate a server based on the amount of time it takes to complete the entire test, IO throughput, and the amount of time an average job takes to execute. A SAS 9.4 job will demand a certain amount of processing power and IO during its execution. We tend to find that the ability to read and write data is just as important to the execution of a SAS 9.4 job

<sup>3</sup> Reprinted from Base SAS Software Fact Sheet: [https://www.sas.com/content/dam/SAS/en\\_us/doc/factsheet/base-sas-101198.pdf](https://www.sas.com/content/dam/SAS/en_us/doc/factsheet/base-sas-101198.pdf).



as the ability of the CPU to process the data. The inability to effectively and rapidly move data to and from the processor means that the cores will have idle time even though there are SAS 9.4 jobs that are ready to run. We ran a series of tests; each SAS test bundle was representative of 30 concurrent SAS 9.4 users. Each test bundle ran a total of 102 SAS jobs on behalf of those 30 representative users.

The environment was queried every 5 seconds during the tests. The results were then aggregated for the best 10 intervals (50 seconds), 24 intervals (2 minutes), 60 intervals (5 minutes), 120 intervals (10 minutes), and 240 intervals (20 minutes). This was done because the IO demand starts high and tails steadily off during the duration of the tests. In fact, for a number of intervals during the later stages of the tests, only CPU intensive jobs remained active and no IO was being performed.

Figure 4 shows the amount of throughput for each of the job counts along with the total number of jobs for HPE Superdome Flex 280 (4 Socket Server).

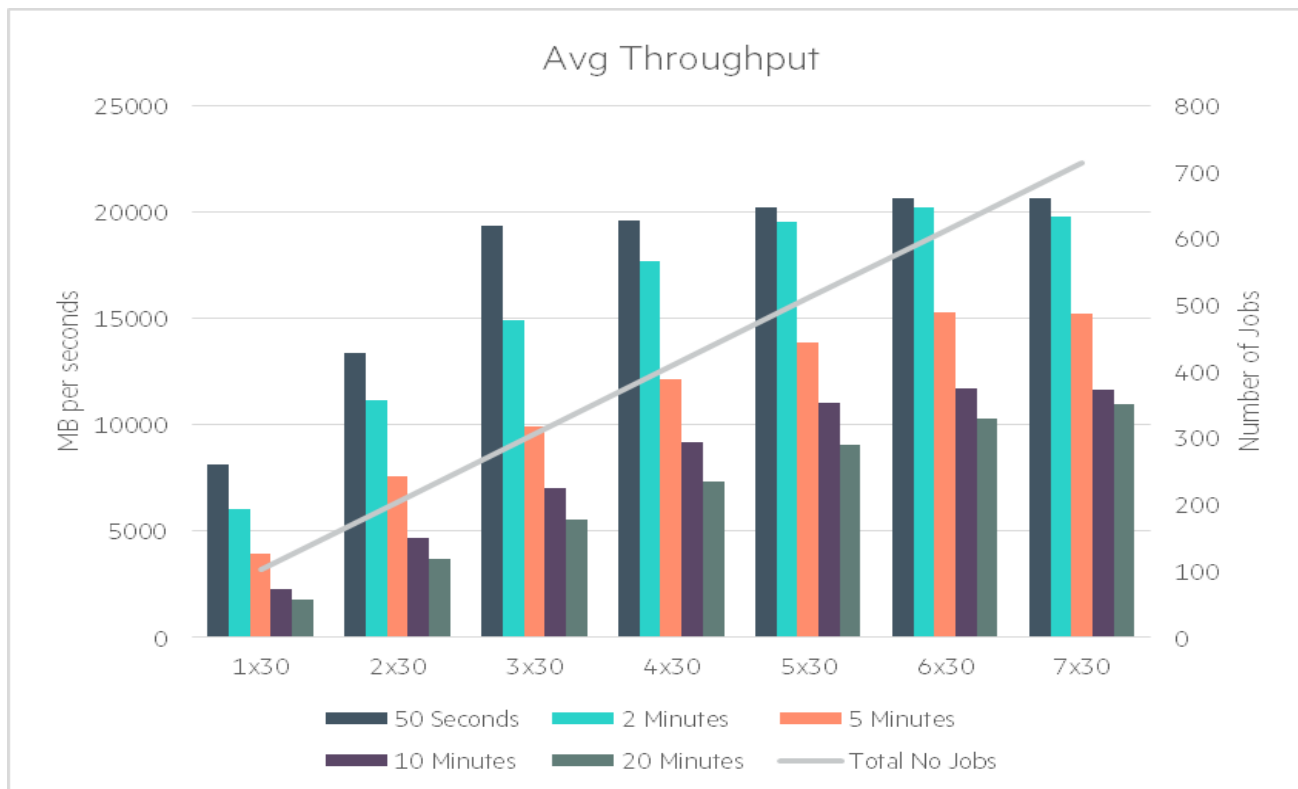
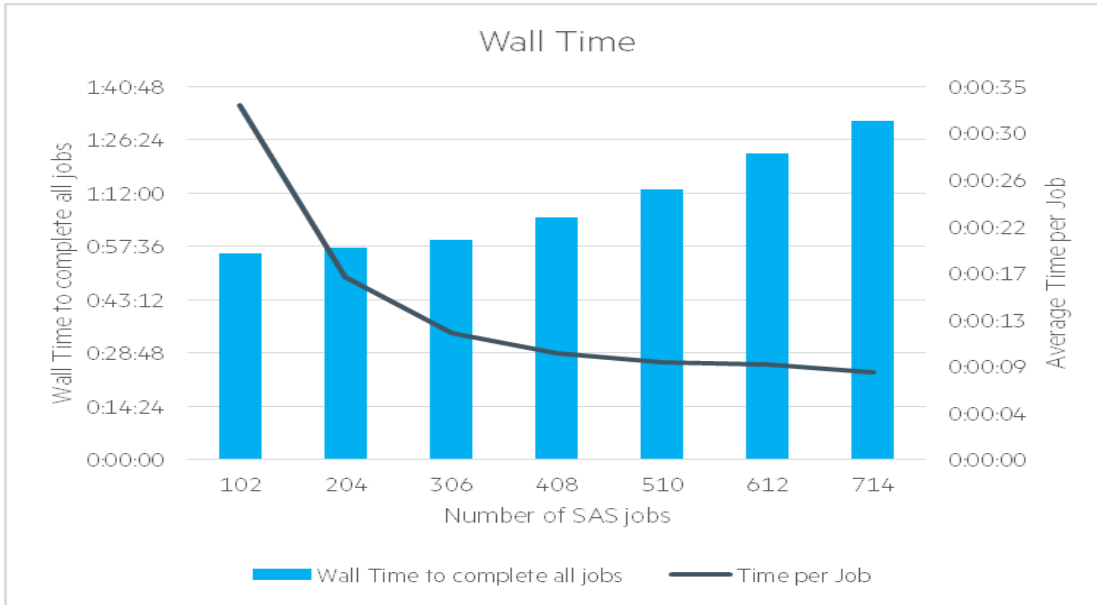


FIGURE 4. IO throughput at various Time intervals and the total number of SAS jobs for HPE Superdome Flex 280 (4 Socket server)

The legend tells the number of 30 user runs being executed on HPE Superdome Flex 280 Server. A legend of 7x30 means that seven sets of 30 users were executed on the HPE Superdome Flex 280 (Intel Xeon-Platinum 8380HL (2.9GHz/28-core/250W) Processor) consisted of a total of 714 SAS jobs.

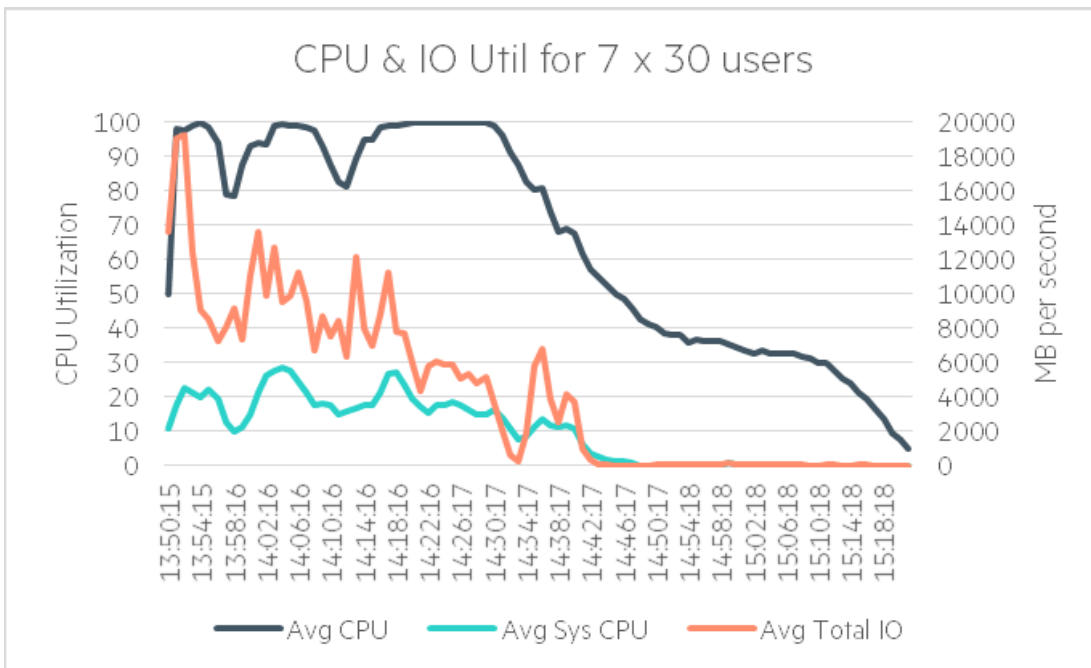


Another important aspect of SAS 9.4 software is the amount of time that it takes for a series of SAS jobs to complete in total and also the time it takes for a single SAS job to complete. The following, Figure 5, shows the times for all jobs, along with the average time it took a single SAS job to run during the scenario for HPE Superdome Flex 280 (4 Socket Server).



**FIGURE 5.** Average time recorded for the 30-user scenario to complete all jobs along with Average time per job on HPE Superdome Flex 280 (4 Socket server)

The next graph shows the amount of IO and CPU utilized during the test period. Figure 6, shows the amount of CPU hitting the mid to high 100 percent range using the 7 by 30 user test sequence. Look also at the amount of IO demanded during the test. As you can see, it starts high, but soon lessens after the start of the test.



**FIGURE 6.** Amount of CPU consumed during 7 x 30 user test scenario along with the total amount of IO for HPE Superdome Flex 280 (4 Socket)



Next, let's take a look at the HPE Superdome Flex 280 (2 Socket Server) results. This server was also used for 2 socket testing. Two CPUs were disabled at eRMC level using deconfig command. So, the memory, in this case, is only ~ 3TB. Figure 7 shows the amount of throughput for each of the job counts along with the total number of jobs for HPE Superdome Flex 280 (2 Socket Server).

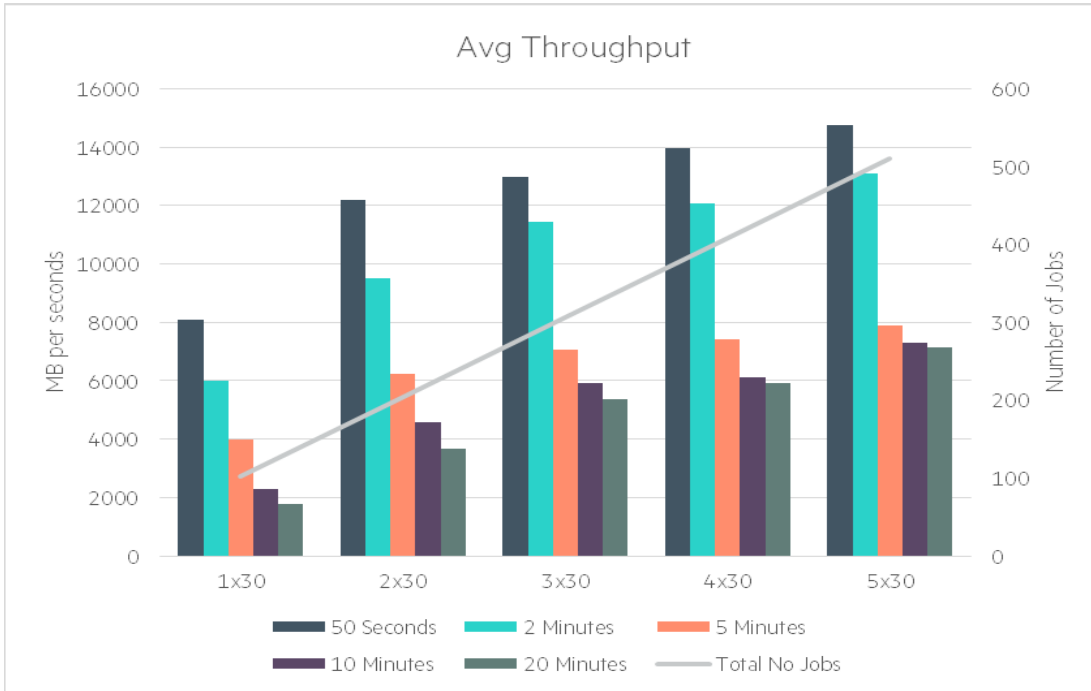


FIGURE 7. IO throughput at various Time intervals and the total number of SAS jobs for HPE Superdome Flex 280 (2 Socket server)

The following, Figure 8, shows the wall time per job, the total time it took to complete the entire test bundle of jobs for HPE Superdome Flex 280 (2 Socket Server).

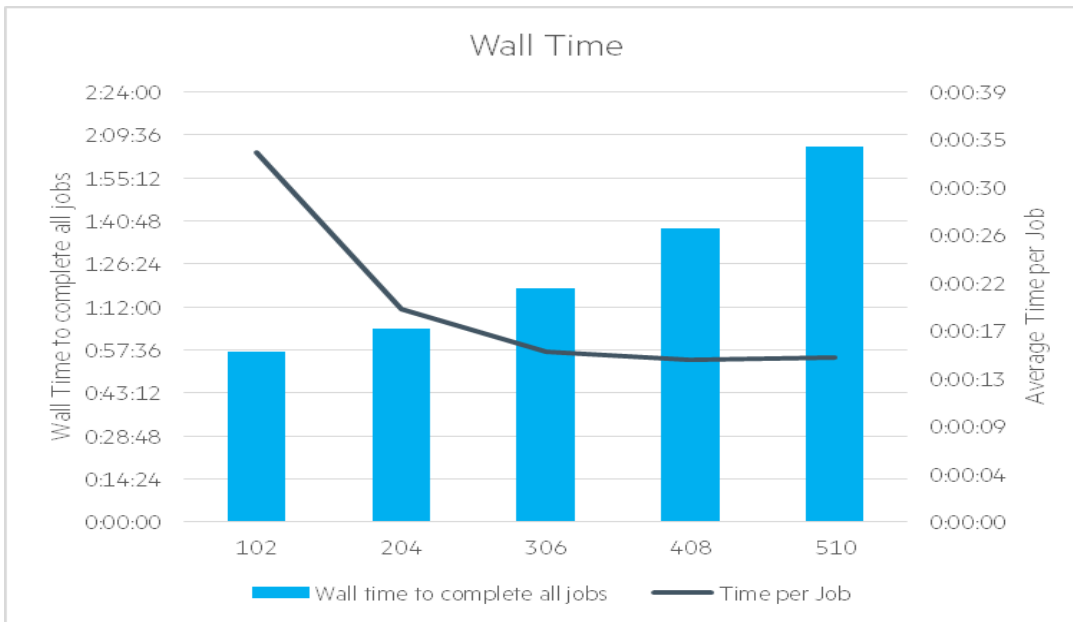
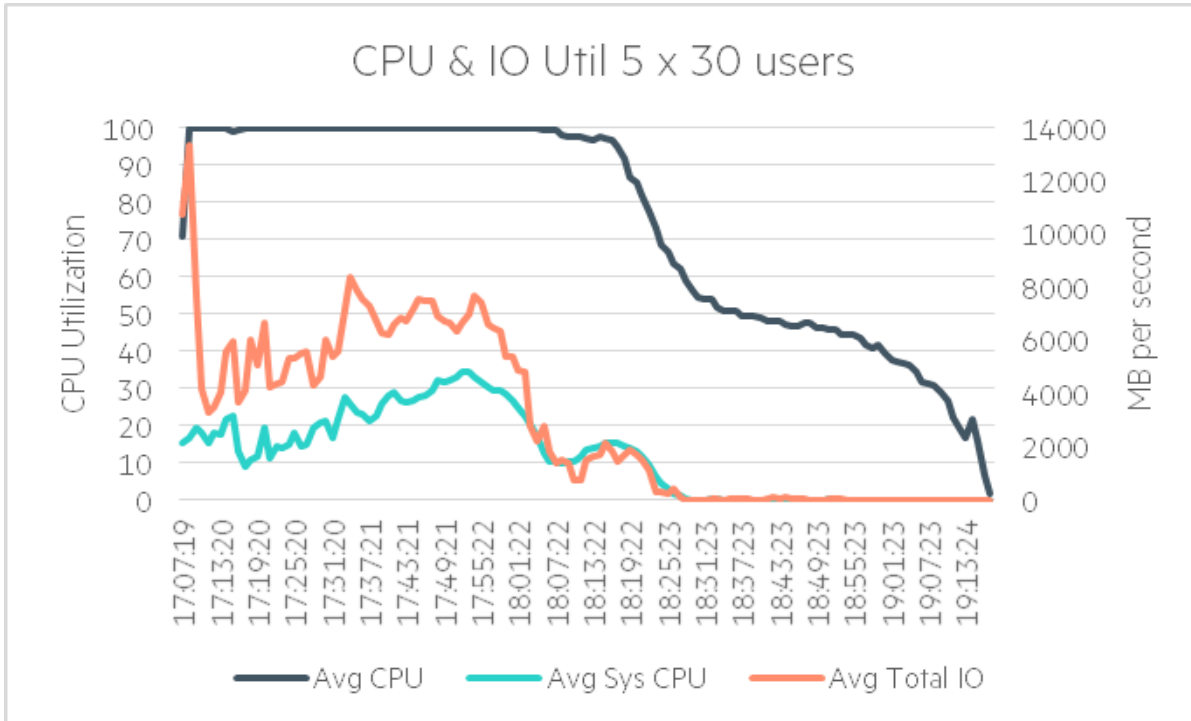


FIGURE 8. Average time recorded for the 30-user scenario to complete all jobs along with Average time per job on HPE Superdome Flex 280 (2 Socket server)



The following, Figure 9, shows the CPU and IO Utilization for 5 x 30 users test scenario for HPE Superdome Flex 280 (2 Socket Server).



**FIGURE 9.** Amount of CPU consumed during 5 x 30 user test scenario along with the total amount of IO for HPE Superdome Flex 280 (2 Socket)

## SUMMARY

With up to 2x performance improvement from previous server and storage generation testing, the combination of HPE Superdome Flex 280 Server and HPE Primera Storage coupled with SAS 9.4 delivers a robust business analytics solution with compelling performance, scalability and reliability.

The HPE Superdome Flex 280 Server is designed to power data-intensive applications and provides support for 2 to 8-sockets of Intel Xeon Scalable Processors in a single system. With the 3rd generation Intel® Xeon® Scalable Processors, the HPE Superdome Flex 280 Server provides significant performance and scalability with a linear performance improvement. By provisioning HPE Primera Storage array with HPE Superdome Flex 280 Server we can create a simple, consumer-grade user experience for mission-critical and IO-intensive workload solution.

HPE Superdome Flex 280 Server is designed for small or medium-size enterprise environments, to handle analytical workloads.

HPE Superdome Flex 280 Server has a large memory capacity which can also be utilized for the memory intensive workload such as SAS Visual Analytics and SAS Viya solutions.

## IMPLEMENTING A PROOF-OF-CONCEPT

As a matter of best practice for all deployments, Hewlett Packard Enterprise recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact a Hewlett Packard Enterprise services representative ([hpe.com/us/en/services/consulting.html](http://hpe.com/us/en/services/consulting.html)) or your Hewlett Packard Enterprise partner.



## APPENDIX A: BILL OF MATERIALS

The following BOMs contain electronic license to use (E-LTU) parts. Electronic software license delivery is now available in most countries. Hewlett Packard Enterprise recommends purchasing electronic products over physical products (when available) for faster delivery and for the convenience of not tracking and managing confidential paper licenses. For more information, please contact your reseller or a Hewlett Packard Enterprise representative.

### NOTE

Part numbers are at the time of publication/testing and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your Hewlett Packard Enterprise Reseller or Hewlett Packard Enterprise Sales Representative for more details. [hpe.com/us/en/services/consulting.html](http://hpe.com/us/en/services/consulting.html)

**TABLE A1.** Bill of materials

Part number	Quantity	Description
<b>Rack and Switches</b>		
P9K16A	1	HPE 42U 800x1200mm Advanced Shock Rack
P9K38A	1	HPE 42U 600mmx1075mm G2 Enterprise Shock Rack
P9K16A 001	1	HPE Factory Express Base Racking Service
P9K38A-001	1	HPE Factory Express Base Racking Service
JC772A	2	HPE FlexFabric 5900AF 48XG 4QSFP+ Switch
QOU54B	2	HPE SN6600B 32Gb 48/24 Fibre Channel Switch
<b>HPE Superdome Flex 280 (4-Socket server)</b>		
R4R03A	1	HPE Superdome Flex 280 4-socket Base Chassis
R4R14A4	4	Intel Xeon-Platinum 8380HL (2.9GHz/28-core/250W) Processor Kit for HPE Superdome Flex 280
R4S37A	1	HPE Superdome Flex 280 PCIe Low Profile 16-slot Bulkhead with 1x 4-slot Riser Kit
R4S12A	1	HPE Superdome Flex 280 4-slot 2x8/2x16 PCIe Left Riser
R4S39A	2	HPE Superdome Flex 280 4-slot 2x8/2x16 PCIe Right Riser
R4S34A	1	HPE Superdome Flex 280 9.5mm SATA Internal DVD-RW Optical Drive
R4R08A	1	HPE Superdome Flex 280 2-4 Sockets UPI Internal Enablement Kit
R4S14A	1	HPE Superdome Flex 280 2x 1600W Platinum Hot Plug Power Supply
R4S15A	1	HPE Superdome Flex 280 2x 1600W Platinum Hot Plug Additional Power Supply
R4S22A	1	HPE Superdome Flex 280 8SFF Premium Storage Backplane Kit
R4R47A	1	HPE Superdome Flex 280 SmartRAID 3154-16i 16-port Internal 4GB Cache SAS 12G PCIe3 x8 Controller
R4R43A	2	SLIM SAS 8i PLUG TO MINI SAS 4i PLUG CABLE ASSY (320mm)
R4R44A	2	SLIM SAS 8i PLUG TO MINI SAS 4i PLUG CABLE ASSY (490mm)
R4S29A	48	HPE Superdome Flex 280 128GB (1x128GB) Quad Rank x4 DDR4-3200 Load Reduced Standard Memory Kit
R4S18A	2	HPE Superdome Flex 280 2x C14 250V 10Amp Power Cord
R4R07A	1	HPE Superdome Flex 280 Chassis Bezel
R4S20A	1	HPE Superdome Flex 280 Chassis Intrusion Detection Kit
817738-B21	2	HPE Ethernet 10Gb 2-port BASE-T X550-AT2 Adapter



Part number	Quantity	Description
R2E09A	4	HPE SN1610Q 32Gb 2p FC HBA
R6A27A	4	HPE 800GB SAS 12G MU SFF BC SSD
<b>HPE Primera A650 Storage</b>		
N9Z47A	1	HPE Primera 600 4-way Storage Base
N9Z61A	1	HPE Primera A650 4N Controller
R3B24A	16	HPE Primera 600 1.92TB NVMe SFF (2.5in) SSD
ROP95A	56	HPE Primera 600 1.92TB SAS SFF (2.5in) SSD
N9Z50A	2	HPE Primera 600 2U 24d SFF Drv Enc
N9Z39A	8	HPE Primera 600 32Gb 4p FC HBA
R1P32A	1	HPE Primera 600 w/o Installation SVC

## APPENDIX B: CONFIGURATION FOR THE HPE PRIMERA STORAGE SYSTEM

Parameter used in the /etc/multipath.conf for HPE Primera Storage specific device configurations:

```
defaults {
    polling_interval 10
    max_fds 8192
    user_friendly_names yes
}
devices {
    device {
        vendor "3PARdata"
        product "VV"
        path_grouping_policy "group_by_prio"
        path_selector "round-robin 0"
        path_checker tur
        features "0"
        hardware_handler "1 alua"
        prio "alua"
        failback immediate
        rr_weight "uniform"
        no_path_retry 18
        rr_min_io_rq 1
        detect_prio yes
        fast_io_fail_tmo 10
        dev_loss_tmo "infinity"
    }
}
```

## APPENDIX C: SCRIPT FOR CREATING VOLUME GROUP

Script used to create the volume group:

```
#!/bin/bash
#Volume group creation#
vgcreate vgsas /dev/mapper/mpatha \
/dev/mapper/mpathb \
/dev/mapper/mpathc \
/dev/mapper/mpathd \
/dev/mapper/mpathe \
/dev/mapper/mpathf \
```



```
/dev/mapper/mpathg \  
/dev/mapper/mpathh
```

## APPENDIX D: SCRIPT FOR CREATING LOGICAL VOLUME

Script used to create the logical volumes:

```
#!/bin/bash  
#logical volume creations#  
lvcreate -y -L 50G -i 8 -I 2M -n sas vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork1 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc1 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite1 vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork2 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc2 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite2 vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork3 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc3 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite3 vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork4 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc4 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite4 vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork5 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc5 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite5 vgsas  
lvcreate -y -L 2000G -i 8 -I 2M -n saswork6 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n utilloc6 vgsas  
lvcreate -y -L 1000G -i 8 -I 2M -n asuite6 vgsas  
lvchange --readahead 2097152 /dev/vgsas/utilloc1  
lvchange --readahead 2097152 /dev/vgsas/sas  
lvchange --readahead 2097152 /dev/vgsas/asuite1  
lvchange --readahead 2097152 /dev/vgsas/saswork1  
lvchange --readahead 2097152 /dev/vgsas/utilloc2  
lvchange --readahead 2097152 /dev/vgsas/asuite2  
lvchange --readahead 2097152 /dev/vgsas/saswork2  
lvchange --readahead 2097152 /dev/vgsas/utilloc3  
lvchange --readahead 2097152 /dev/vgsas/asuite3  
lvchange --readahead 2097152 /dev/vgsas/saswork3  
lvchange --readahead 2097152 /dev/vgsas/utilloc4  
lvchange --readahead 2097152 /dev/vgsas/asuite4  
lvchange --readahead 2097152 /dev/vgsas/saswork4  
lvchange --readahead 2097152 /dev/vgsas/utilloc5  
lvchange --readahead 2097152 /dev/vgsas/asuite5  
lvchange --readahead 2097152 /dev/vgsas/saswork5  
lvchange --readahead 2097152 /dev/vgsas/utilloc6  
lvchange --readahead 2097152 /dev/vgsas/asuite6  
lvchange --readahead 2097152 /dev/vgsas/saswork6
```

## APPENDIX E: SCRIPT FOR CREATING FILE SYSTEMS

Script used to create the file systems

```
#!/bin/bash  
#file system creations#  
mkfs.xfs /dev/vgsas/sas  
mkfs.xfs /dev/vgsas/asuite1  
mkfs.xfs /dev/vgsas/utilloc1  
mkfs.xfs /dev/vgsas/saswork1  
mkfs.xfs /dev/vgsas/asuite2
```





```
mkfs.xfs /dev/vgsas/uttilloc2
mkfs.xfs /dev/vgsas/saswork2
mkfs.xfs /dev/vgsas/asuite3
mkfs.xfs /dev/vgsas/uttilloc3
mkfs.xfs /dev/vgsas/saswork3
mkfs.xfs /dev/vgsas/asuite4
mkfs.xfs /dev/vgsas/uttilloc4
mkfs.xfs /dev/vgsas/saswork4
mkfs.xfs /dev/vgsas/asuite5
mkfs.xfs /dev/vgsas/uttilloc5
mkfs.xfs /dev/vgsas/saswork5
mkfs.xfs /dev/vgsas/asuite6
mkfs.xfs /dev/vgsas/uttilloc6
mkfs.xfs /dev/vgsas/saswork6
```

## APPENDIX F: SCRIPT FOR CREATING MOUNT POINTS

Script used to create the mount points

```
#!/bin/bash
# Mountpoint creations #
mkdir /opt/sas9.4
mount /dev/vgsas/sas /opt/sas9.4/
mkdir /sasdata
mkdir /sasdata/asuite1
mount /dev/vgsas/asuite1 /sasdata/asuite1/
mkdir /sasdata/asuite1/saswork
mount /dev/vgsas/saswork1 /sasdata/asuite1/saswork/
mkdir /sasdata/asuite1/saswork/uttilloc/
mount /dev/vgsas/uttilloc1 /sasdata/asuite1/saswork/uttilloc/
mkdir /sasdata/asuite2/
mount /dev/vgsas/asuite2 /sasdata/asuite2/
mkdir /sasdata/asuite2/saswork
mount /dev/vgsas/saswork2 /sasdata/asuite2/saswork/
mkdir /sasdata/asuite2/saswork/uttilloc
mount /dev/vgsas/uttilloc2 /sasdata/asuite2/saswork/uttilloc/
mkdir /sasdata/asuite3/
mount /dev/vgsas/asuite3 /sasdata/asuite3/
mkdir /sasdata/asuite3/saswork
mount /dev/vgsas/saswork3 /sasdata/asuite3/saswork/
mkdir /sasdata/asuite3/saswork/uttilloc
mount /dev/vgsas/uttilloc3 /sasdata/asuite3/saswork/uttilloc/
mkdir /sasdata/asuite4/
mount /dev/vgsas/asuite4 /sasdata/asuite4/
mkdir /sasdata/asuite4/saswork
mount /dev/vgsas/saswork4 /sasdata/asuite4/saswork/
mkdir /sasdata/asuite4/saswork/uttilloc
mount /dev/vgsas/uttilloc4 /sasdata/asuite4/saswork/uttilloc/
mkdir /sasdata/asuite5/
mount /dev/vgsas/asuite5 /sasdata/asuite5/
mkdir /sasdata/asuite5/saswork
mount /dev/vgsas/saswork5 /sasdata/asuite5/saswork/
mkdir /sasdata/asuite5/saswork/uttilloc
mount /dev/vgsas/uttilloc5 /sasdata/asuite5/saswork/uttilloc/
mkdir /sasdata/asuite6/
mount /dev/vgsas/asuite6 /sasdata/asuite6/
mkdir /sasdata/asuite6/saswork
mount /dev/vgsas/saswork6 /sasdata/asuite6/saswork/
mkdir /sasdata/asuite6/saswork/uttilloc
```



```

mount /dev/vgsas/uttilloc6 /sasdata/asuite6/saswork/uttilloc/
chmod -R 775 /sasdata
chmod 755 /opt/sas
chown sas:sas /opt/sas9.4
chown -R sas:sas /sasdata

```

## APPENDIX G: /ETC/FSTAB SCRIPT FOR REMOUNTING THE FILE SYSTEMS AFTER A SYSTEM BOOT

The following is what the /etc/fstab file looks like on the HPE Superdome Flex 280 Server after all the logical volumes, file systems and mount points have been created. This allows the logical volumes to automatically mount after the system is rebooted.

```

#
# /etc/fstab
# created by anaconda
#
# Accessible filesystems, by reference, are maintained under '/dev/disk'
# See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info
/dev/mapper/rhel-root / xfs defaults 0 0
UUID=211d0774-f5ff-4bca-8ca5-279e12ed262c /boot xfs defaults 0 0
UUID=CAB7-56B0 /boot/efi vfat umask=0077,shortname=winnt 0 0
/dev/mapper/rhel-home /home xfs defaults 0 0
/dev/mapper/rhel-swap swap defaults 0 0
/dev/mapper/vgsas/asuite1 /sasdata/asuite1 xfs defaults 0 0
/dev/mapper/vgsas/asuite2 /sasdata/asuite2 xfs defaults 0 0
/dev/mapper/vgsas/saswork1 /sasdata/asuite1/saswork xfs defaults 0 0
/dev/mapper/vgsas/saswork2 /sasdata/asuite2/saswork xfs defaults 0 0
/dev/mapper/vgsas/uttilloc1 /sasdata/asuite1/saswork/uttilloc xfs defaults 0 0
/dev/mapper/vgsas/uttilloc2 /sasdata/asuite2/saswork/uttilloc xfs defaults 0 0
/dev/mapper/vgsas/sas /opt/sas9.4 xfs defaults 0 0
/dev/mapper/vgsas/asuite3 /sasdata/asuite3 xfs defaults 0 0
/dev/mapper/vgsas/saswork3 /sasdata/asuite3/saswork xfs defaults 0 0
/dev/mapper/vgsas/uttilloc3 /sasdata/asuite3/saswork/uttilloc xfs defaults 0 0
/dev/mapper/vgsas/asuite4 /sasdata/asuite4 xfs defaults 0 0
/dev/mapper/vgsas/saswork4 /sasdata/asuite4/saswork xfs defaults 0 0
/dev/mapper/vgsas/uttilloc4 /sasdata/asuite4/saswork/uttilloc xfs defaults 0 0
/dev/mapper/vgsas/asuite5 /sasdata/asuite5 xfs defaults 0 0
/dev/mapper/vgsas/saswork5 /sasdata/asuite5/saswork xfs defaults 0 0
/dev/mapper/vgsas/uttilloc5 /sasdata/asuite5/saswork/uttilloc xfs defaults 0 0
/dev/mapper/vgsas/asuite6 /sasdata/asuite6 xfs defaults 0 0
/dev/mapper/vgsas/saswork6 /sasdata/asuite6/saswork xfs defaults 0 0
/dev/mapper/vgsas/uttilloc6 /sasdata/asuite6/saswork/uttilloc xfs defaults 0 0

```



### RESOURCES AND ADDITIONAL LINKS

HPE Reference Architectures, [hpe.com/info/ra](https://hpe.com/info/ra)

HPE Servers, [hpe.com/servers](https://hpe.com/servers)

HPE Storage, [hpe.com/storage](https://hpe.com/storage)

HPE Networking, [hpe.com/networking](https://hpe.com/networking)

HPE Technology Consulting Services, [hpe.com/us/en/services/consulting.html](https://hpe.com/us/en/services/consulting.html)

SAS 9.4, [https://www.sas.com/en\\_us/software/sas9.html](https://www.sas.com/en_us/software/sas9.html)

What's New in SAS 9.4, <https://documentation.sas.com/?docsetId=whatsnew&docsetTarget=whatsnew.pdf&docsetVersion=9.4&locale=en>

HPE Superdome Flex 280 Server QuickSpecs, <https://h20195.www2.hpe.com/v2/GetDocument.aspx?docname=a00059763enw#>

HPE Superdome Flex 280 Server - Product documentation, <https://h20195.www2.hpe.com/v2/default.aspx?cc=us&lc=en&oid=1012865453>

HPE Primera, <https://www.hpe.com/us/en/storage/hpe-primera.html>

HPE Primera Red Hat Enterprise Linux Implementation Guide,  
[https://support.hpe.com/hpesc/public/docDisplay?docLocale=en\\_US&docId=emr\\_na-a00088902en\\_us](https://support.hpe.com/hpesc/public/docDisplay?docLocale=en_US&docId=emr_na-a00088902en_us)

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