Hewlett Packard Enterprise

HPE Reference Architecture for SAP HANA on HPE Synergy D3940 Storage Module

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Executive summary

SAP HANA® is a modern technology that offers an in-memory database, enables a radically different application architecture, and provides a new philosophy with regards to data model simplicity. SAP HANA offers a new way of solving current and future challenges with enterprise applications, such as real time data analysis of large amounts of data. More customers are transitioning to SAP HANA and are accelerating its use as a mission-critical platform.

HPE Synergy is the first infrastructure that allows composability, the ability to manipulate hardware in the same manner as we manipulate software today. HPE Synergy is a certified platform for SAP HANA, offering resource pools which can be customized at provisioning time for specific database needs.

SAP HANA requires memory for processing data in real time, as well as persistent storage to hold the data on media. In the context of a SAP HANA tailored data center integration (TDI) approach either shared storage or local disks can be leveraged. While shared or external storage based on Fibre Channel or NFS is required to get certified as SAP HANA Enterprise Storage it is not required for certifying local disk connectivity with SAP. Instead, a vendor verification for implementing the SAP HANA persistence layer on local disks has to be completed. This vendor verification is required as proof that the SAP HANA TDI KPIs are met, as outlined in the SAP HANA TDI Frequently Asked Questions document.

With the HPE Synergy D3940 Storage Module, SAP HANA persistent data storage is regarded as local storage in a Synergy environment. With the concept of the composable infrastructure, adding more storage to a Synergy environment can be handled quickly and easily.

In addition, the HPE Synergy Image Streamer specific benefits of automated SAP HANA deployments and workload switches can also be used with the HPE Synergy D3940 Storage Module.

This Reference Architecture (RA) provides SAP HANA TDI reference information in terms of storage performance. Additionally, this RA outlines the advantages of HPE Synergy Image Streamer, details best practices, and gives Image Streamer artifact information for deploying SAP HANA on an HPE Synergy D3940 Storage Module.

Testing for this Reference Architecture showed that SAP HANA TDI KPIs are fully met with SAP HANA on HPE Synergy Compute Modules and the HPE Synergy D3940 Storage Module. The testing also showed that more than one SAP HANA production and development system can be hosted on HPE Synergy Composable Infrastructure with the HPE Synergy D3940 Storage Module. All HPE Synergy Compute Modules tested in this RA, configured with a minimum of three SSDs, meet the SAP HANA TDI KPIs, and even the stricter KPIs for the SAP HANA appliance can be fulfilled for up to two systems. Testing multi node configurations with the Hardware Configuration Check Tool (HWCCT) showed that up to four productive systems can fulfill the TDI KPIs.

Having Synergy compute modules configured with a more affordable storage configuration of HDDs in combination with SSDs allows as well to run more than one SAP HANA production system. Up to three systems have been tested and the results fulfill the SAP HANA TDI KPIs. But the more systems are tested at one point in time the more the IO latency is growing and the bandwidth gets reduced even though the KPIs are still met.

HPE Synergy provides a flexible, simple and efficient option for SAP HANA TDI environments:

- Flexible: Customers can chose the best storage option for their environment, either shared storage (HPE 3PAR) or local disks (HPE Synergy D3940) can be leveraged with composable infrastructure capabilities
- Simple: Reduce complexity by using common composable infrastructure and manage it with HPE OneView
- Efficient: Consolidate and standardize infrastructure for mixed workloads, while still meeting high performance requirements

Target audience: This Hewlett Packard Enterprise white paper is designed for IT professionals who use, program, manage, or administer large databases that require high availability and high performance. Specifically, this information is intended for those who evaluate, recommend, or design new IT high-performance architectures.

Document purpose: The purpose of this document is to describe a fully tested Reference Architecture, highlighting the sizing for SAP HANA on HPE Synergy D3940 Storage Module.

This Reference Architecture describes testing performed in January 2019.

Solution overview

HPE Synergy enables IT organizations to accelerate application and service delivery through a single interface that composes physical and virtual compute, storage, and fabric pools into any configuration for any application. Composable resources are provisioned together with their state (determined by variables such as BIOS settings, firmware, drivers, and protocols) and their OS and application image using repeatable templates. This is useful for applications such as SAP HANA because it eliminates time-consuming provisioning processes and offers flexibility in resource usage.

The key components of the deployment of this solution are HPE Synergy Composer, HPE Synergy Image Streamer, and the HPE Synergy D3940 Storage Module. For setting up a new server, the HPE Synergy Image Streamer is not mandatory. However this Reference Architecture uses the advantages of the herein described artifact bundles for the HPE Synergy Image Streamer for an automated and standardized provisioning of servers for SAP HANA.

The combination of the HPE Synergy Composer and Image Streamer allows for automating the customization of an OS image and deployment of the SAP HANA software to quickly and repeatedly provision one or several servers. After deployment, lifecycle activities like updating the operating system, the SAP HANA revision, and switching workload to another compute module, can be executed in a standardized way for one or several servers.

Using the HPE Synergy D3940 Storage Module as persistent data storage offers the possibility of using the lifecycle activities without the need to configure external storage solutions. The storage can be handled like internal storage, yet offering the capabilities of external persistent storage.

This Reference Architecture is built upon the following composability concepts and capabilities of the HPE Synergy platform.

Fluid resource pools

HPE Synergy allows for the transformation of traditionally rigid physical systems into flexible virtual resource pools. HPE Synergy creates resource pools of “stateless” compute, storage, and fabric capacity that can be configured almost instantly to rapidly provision infrastructure for a broad range of applications.

Software-defined intelligence

The software-defined intelligence in HPE Synergy reduces operational complexity and enables IT organizations to make needed programmatic changes quickly and confidently, with minimal human intervention. HPE Synergy abstracts operational details and replaces them with high-level, automated operations. HPE Synergy uses templates to automatically implement change operations such as updating firmware, adding additional storage to a service, or modifying a network.

Unified API

HPE Synergy delivers automation through a unified API that provides a single interface to discover, inventory, configure, provision, update, and diagnose the composable infrastructure in a heterogeneous environment. This fully programmable interface integrates into dozens of popular management tools such as Microsoft® System Center, VMware® vCenter, and open source automation and DevOps tools such as Chef, Docker, and OpenStack.

Solution components

The hardware and software used for the Reference Architecture for SAP HANA on HPE Synergy D3940 Storage Module is described here.

Hardware

Table 1 shows the hardware components used for this Reference Architecture.

Table 1. Hardware components

Qty	Component	Purpose
1	HPE Synergy 12000 Frame	Infrastructure for compute, fabric, and management
1	HPE Synergy Composer	Infrastructure management
1	HPE Synergy Image Streamer	Infrastructure deployment
1	HPE Synergy 660 Gen10 Compute Module	Bare-metal host
1	HPE Synergy 480 Gen10 Compute Module	Bare-metal host
1	HPE Synergy 680 Gen9 Compute Module	Bare-metal host
1	HPE Synergy 480 Gen9 Compute Module	Bare-metal host
1	HPE FlexFabric Switch	Top of Rack network connectivity
1	HPE Synergy D3940 Storage Module	Storage Module with 12 x 1.8TB SSD for SSD only testing plus 24 x 1.2 TB HDD for testing hybrid approach
2	HPE Synergy 12Gb SAS Connection Module	SAS Connection Module
2	HPE VC SE 40Gb F8 Module	Virtual Connect Module

Figure 1 shows the components that were used for this effort - network connectivity modules and switches are not required for storage testing.

Note

While a single frame with a single HPE Synergy Image Streamer was used for this testing, the recommended production configuration for high availability is a pair of HPE Synergy Image Streamer appliances, and a pair of Virtual Connect SE 40Gb F8 Modules for Synergy, which provides Active-Active HA for volume storage. HPE Synergy Image Streamer used in production environments requires a minimum of three HPE Synergy Frames with two Virtual Connect SE 40Gb F8 Modules for Synergy, two HPE Synergy Image Streamers, and two HPE Synergy Composers.

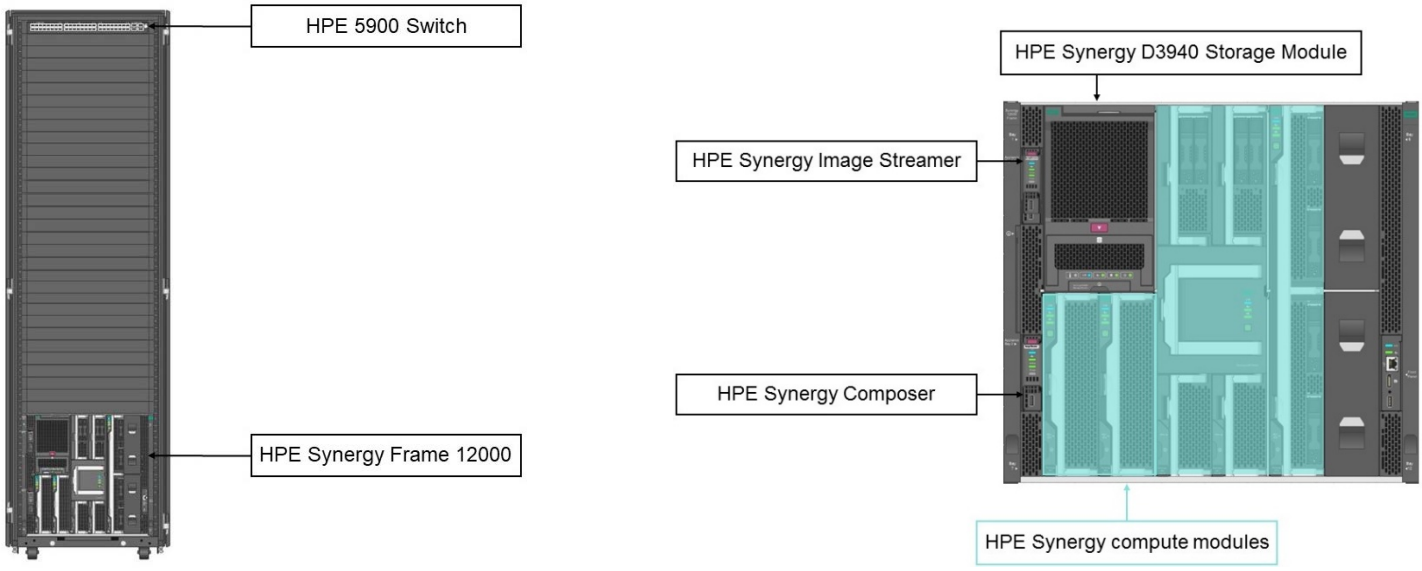


Figure 1. HPE Synergy Components used for this Reference Architecture

HPE Synergy Composer

HPE Synergy Composer provides enterprise-level management to compose and deploy system resources to your application needs. This management appliance uses software-defined intelligence with embedded HPE OneView to aggregate compute, storage, and fabric resources in a manner that scales to your application needs, instead of being restricted to the fixed ratios of traditional resource offerings.

HPE Synergy Image Streamer

HPE Synergy Image Streamer is a new approach for provisioning and updating composable infrastructure. This management appliance works with HPE Synergy Composer for fast software-defined control over physical compute modules with operating system and application deployment. HPE Synergy Image Streamer enables true stateless computing combined with the capability for image lifecycle management. This management appliance rapidly deploys and updates infrastructure.

HPE Synergy Image Streamer adds a powerful dimension to "infrastructure as code"—the ability to manage physical servers like virtual machines. In traditional environments, deploying an OS and applications is time-consuming because it requires building or copying the software image onto individual servers sequentially, possibly requiring multiple reboot cycles. In HPE Synergy, the tight integration of HPE Synergy Image Streamer with HPE Synergy Composer enhances server profiles with images and personalities for true stateless operation offering the possibility to provision several servers simultaneously.

HPE Synergy Composer, powered by HPE OneView, captures the physical state of the server in the server profile. HPE Synergy Image Streamer enhances this server profile (and its desired configuration) by capturing your golden image as the "deployed software state" in the form of bootable image volumes. These enhanced server profiles and bootable OS plus application images are software structures (infrastructure as code)—no compute module hardware is required for these operations. The bootable images are stored on redundant HPE Synergy Image Streamer appliances, and they are available for fast implementation onto multiple compute nodes at any time. This enables bare-metal compute modules to boot directly into a running OS with applications and allows multiple compute nodes to be quickly updated.

Figure 2 shows how HPE Synergy Composer and HPE Synergy Image Streamer manage a compute node via a server profile.

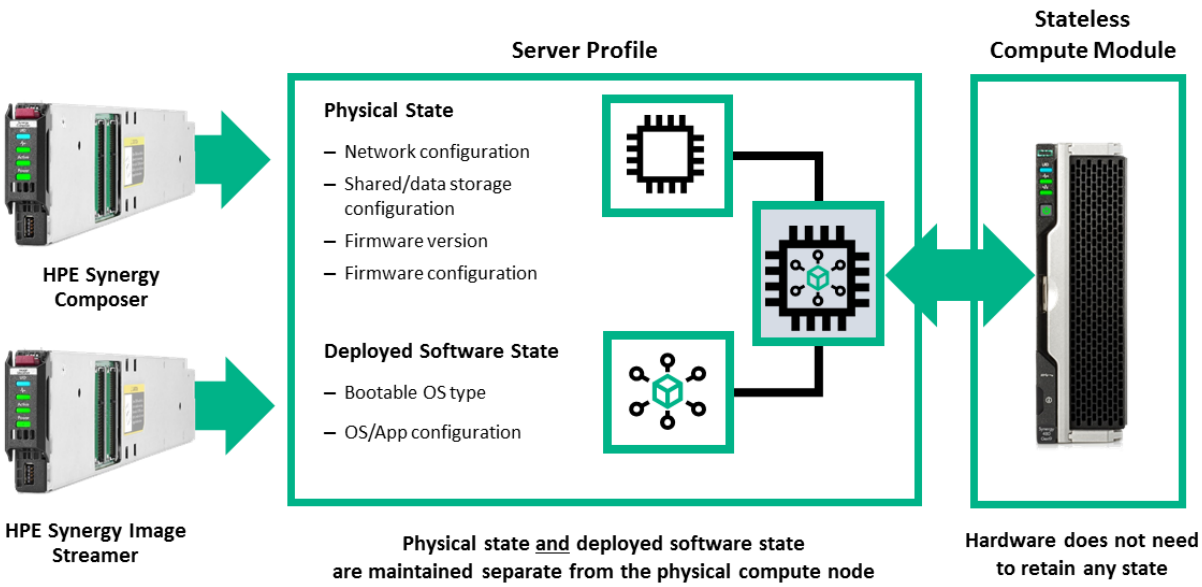


Figure 2. HPE Synergy Composer and HPE Synergy Image Streamer managing compute module with a server profile

HPE Synergy D3940 Storage Module

Each HPE Synergy D3940 Storage Module utilizes HPE Smart Array technology to accelerate performance, plus RAID protection and encryption to improve security and availability providing a fluid pool of storage resources for the composable infrastructure. Additional capacity for compute modules is easily provisioned and intelligently managed with integrated data services for availability and protection. The 40 SFF drive bays per storage module can be populated with 12G SAS or 6G SATA drives. The HPE Synergy D3940 Storage Module provides local storage to compute resources and can meet the demands of a wide range of data workloads. Pooled storage resources provide the flexibility and

performance needed to accommodate a wide range of workloads. Changes such as updating firmware are automatically implemented with the infrastructure online significantly reducing errors and delivering real-time compliance.

Software

The software components listed in Table 2 were utilized in this Reference Architecture.

Table 2. Software list

Component	Version
HPE Synergy Composer	4.10.03
HPE Synergy Image Streamer	4.10.04
HPE Synergy Image Streamer artifacts for SAP HANA	HPE-SLES12-SAP-HANA-DB-RA-2019-02-04-v4.1.zip HPE-RHEL7.x-SAP-HANA-DB-RA-2019-02-04-v4.1.zip
Operating System	SUSE Linux Enterprise Server for SAP Applications 12 SP4 Red Hat Enterprise Linux for SAP Solutions 7.6
SAP HANA	2.0 SPS03
SAP HANA HW Config Check Tool	2.00.012.05

Application software

SAP HANA

SAP HANA is a modern technology by SAP® and is offered as an in-memory database, enabling a radically different application architecture and a new philosophy with regards to the data model simplicity. SAP HANA offers a new way of solving current and future challenges with enterprise applications. More customers are transitioning to HANA and are accelerating on utilizing it as a mission-critical platform. In response, SAP has planned to convert all existing customers running traditional SAP applications to HANA-based applications by the year 2025.

For this Reference Architecture SAP HANA 2.0 SPS03 was used.

Hardware Configuration Check Tool

To run SAP HANA as a productive instance, minimum performance criteria defined by SAP have to be met. The Hardware Configuration Check Tool (HWCCT) determines with tests and reports if the hardware you intend to use for single host or scale out configurations meets these performance criteria.

The test tool has three modules:

- Landscape Test
- File System Test
- Network Test

For proofing the KPIs for SAP HANA TDI on HPE Synergy Compute Modules with the HPE Synergy D3940 Storage Module the File System Test has been executed. This test simulates and measures SAP HANA data and log IO throughput and latency in various block sizes on the IO subsystem. The test is performed by creating a test file, enlarge it to a specified size between 1GB and 32GB, overwrite the file and finally read it. This is performed with different block sizes: 4KB, 16KB, 64KB, 16MB and 64MB for data volume and 4KB, 16KB and 1MB for log volumes. Details for downloading and using the HWCCT are described in SAP Note 1943937—Hardware Configuration Check Tool—Central Note (SAP S-User required). For this Reference Architecture, HWCCT version 2.00.012.05 was used.

Best practices and configuration guidance for the solution

Server and Storage setup

For an easy and repeatable setup of the environment on each server, artifact bundles for the HPE Synergy Image Streamer have been leveraged for this Reference Architecture. It is also possible to setup a server without using HPE Synergy Image Streamer. The storage setup described below applies also to the manual server creation, without using the HPE Synergy Image Streamer. For the automated deployment of SAP HANA using HPE Synergy D3940 Storage Module, the artifact bundles HPE-SLES12-SAP-HANA-DB-RA-2019-02-04-v4.1.zip and HPE-RHEL7.x-

SAP-HANA-DB-RA-2019-02-04-v4.1.zip are available on GitHub. With the automated deployment of SAP HANA using HPE Synergy Image Streamer, the test systems for the HWCCT tests are configured and deployed in less than one hour, while having exactly the same environment.

Details on the general setup of the HPE Synergy environment and prerequisites for the SAP HANA deployment are given in the Reference Architecture SAP HANA lifecycle activity with HPE Synergy Image Streamer. This document describes the automated deployment and lifecycle activities of SAP HANA using HPE 3PAR storage. It can be used as a reference to setup the environment for the automated SAP HANA deployment and describes the lifecycle activities in detail. Differences to this document are described in this section.

The custom attribute "Storage" has been introduced in the deployment plans HPE – SLES12 – SAP HANA DB – deploy – 2019-02-04 and HPE – RHEL7.x - SAP HANA DB – deploy – 2019-02-04 for this Reference Architecture. It allows to choose if HPE 3PAR storage (HPE 3PAR StoreServ) or HPE Synergy D3940 Storage Module (HPE Synergy D3940) shall be used.

All the special functionality that has been described in the "Reference Architecture SAP HANA lifecycle activity with HPE Synergy Image Streamer" is also available with HPE Synergy D3940 Storage Module as persistent data storage:

- The SAP HANA database can be installed after the first boot of the server.
- The workload can be switched from one compute module to another.
- The OS Golden Image can be exchanged by another Golden Image with a patched OS version.
- The SAP HANA database can be updated.

During the creation of the new server profile, the custom attribute "Storage" has to be set to "HPE Synergy D3940" to use the HPE Synergy D3940 Storage Module as persistent data storage.

The HANA data and log storage for an HPE Synergy 660 Gen10 or HPE Synergy 480 Gen10 compute module can then be created using the local storage as shown in figure 3. In the first scenario, three SAS SSD disks are configured in RAID 5.

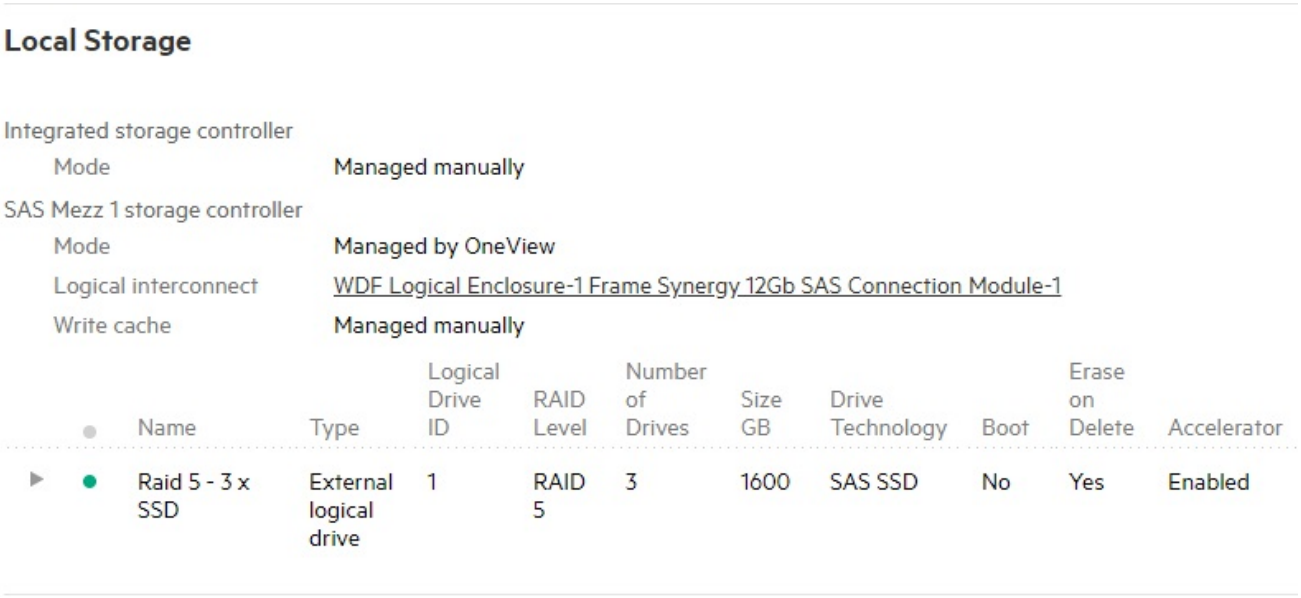


Figure 3. Local storage configuration during server profile creation on HPE Synergy 660 Gen10

Note

For HPE Synergy 680 Gen9 and Synergy 480 Gen9 compute modules, the write-back cache and the cache array accelerator have to be enabled using the HPE Smart Storage Administrator CLI:
ssacli ctrl slot=1 array a modify ssdsmartpath=disable
ssacli ctrl slot=1 ld 1 modify arrayaccelerator=enable

The second scenario uses a hybrid storage approach. A small number of SSDs are configured to act as SmartCache on the Smart Array controller while the HANA persistent data is stored on hard disk drives (HDD).

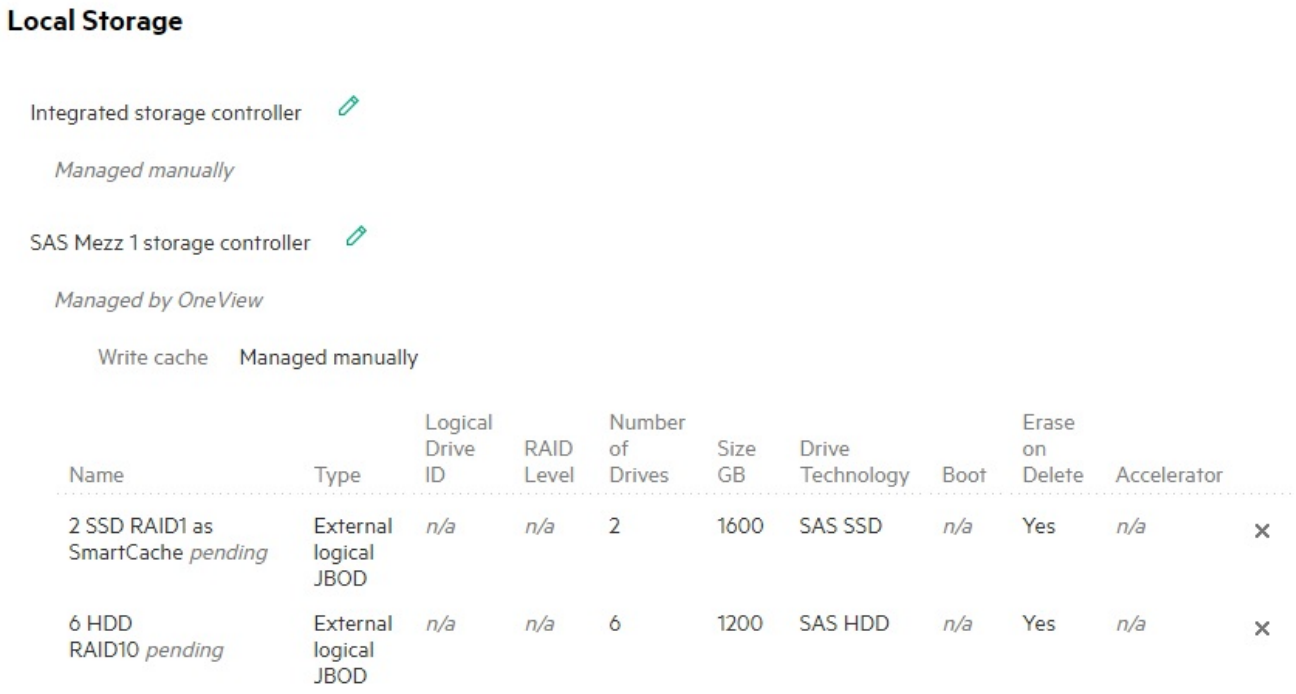


Figure 4. Hybrid storage configuration during server profile creation on HPE Synergy 480 Gen10

Note

The RAID Level for the HDD Array and the SmartCache array are not defined during the server profile creation. They are configured using the Smart Storage Administrator. Details of this configuration are listed in Appendix C.

HWCCT setup

Once the initial setup of the server and the configuration of the storage has been done using the HPE Synergy Image Streamer, the HWCCT test environment can be setup and test cases get executed. An installation of the SAP HANA database is not required.

- Download the tool from the SAP Support Portal and extract it into a new directory.
- For testing more than one server node, it is required to place the HWCCT home directory on a NFS shared directory to collect data of all tests server nodes in one common place.
- Ensure all node names are in /etc/hosts listed and there is passwordless access from the node starting the test to all involved nodes of a test run.
- Create and execute the .json test script files similar to the test samples in Appendix B for either a single or a multi node test. To determine the SAP HANA TDI reference information for a specific storage layout by running an HWCCT test, only the file system test of HWCCT is applicable. No network or EvalOS landscape test needs to be fulfilled

Capacity and sizing

SAP HANA TDI reference information

The sizing calculations related to the storage space requirements for an SAP HANA TDI production system are based on the SAP document, SAP HANA Storage Requirements. For more information, check the latest version to find out how much space in terms of Bytes a mounted file system for data or log has to provide to a SAP HANA production system. This RA concentrates on the storage sizing related to storage performance. This means how many IOPS and MB/s can be delivered by an IO subsystem submitted by the HWCCT test program to meet the SAP HANA TDI KPIs on a specific IO subsystem configuration.

Tested IO configurations

The first IO configuration successfully tested here is a RAID 5 set made out of three 1.8 TB SSDs with a net capacity of 1.6 TB per SSD as shown above. These three SSDs that are physically sitting in the HPE Synergy D3940 Storage Module were dedicated exclusively to one HPE Synergy 660 Gen10 Compute Module of a Synergy Frame. The compute module has a local Smart Array controller to whom the SSDs are made available by the HPE Synergy Composer. To meet the space requirements as a result of a SAP HANA sizing exercise it could be applicable to choose smaller SSDs than the tested ones and maybe more than three.

A larger SAP HANA system might have a need for more space than the tested SSDs and more of them may be more applicable. This depends on the type and size of SSDs HPE is offering at a specific point in time.

To meet the SAP HANA TDI KPIs, a minimum number of three SSDs is required. The performance characteristics of different types of SSDs are usually in the same range and way above the one's of HDDs. The limitation is the lower number of SSDs that can be made available to one HPE Synergy Compute Module or the number of SSDs in a RAID set of a Smart Array controller.

The second IO configuration meeting the SAP HANA TDI KPIs is a combination of HDDs and SSDs. While 6 HDDs in a RAID10 configuration hold SAP HANA data and log, in addition there are two SSDs in RAID 1, acting as SmartCache as extension of the Smart Array write back cache. The advantage of this configuration is the affordability compared to an SSD only configuration. The disadvantage of this configuration is the higher IO latency and the higher consumption of drive slots in the HPE Synergy D3940 Storage Module in case multiple SAP HANA production and development systems are planned.

Any chosen IO configuration has the overall limitation of 40 drives per HPE Synergy D3940 Storage Module and a single drive can be assigned to one compute blade at a given point in time.

Workload description and testing results

This chapter shows the results of the HWCCT file systems testing for two different storage configurations. For each configuration one single node and one multi node result is listed. On the left-hand side, the SAP HANA TDI KPIs can be seen. On the right-hand side the achieved results are shown in green.

All the SAP HANA TDI KPIs are clearly fulfilled.

In the first scenario, one Synergy 660 Gen10 Compute module has been configured with three SSDs in RAID 5. The results can be seen in figure 5.

SAP HANA Hardware certification for Enterprise Storage (TDI)

Volume	Block Sizes	Test File Size	KPIs				Results											
			Initial Write (MB/s)	Overwrite (MB/s)	Read (MB/s)	Latency (µs)	Initial Write (MB/s)			Overwrite (MB/s)			Read (MB/s)			Latency (µs)		
			Min	Min	Min	Max	min	av.	max	min	av.	max	min	av.	max	min	av.	max
Log	4K	5G	n.a.	30	n.a.	1000				1411	1411	1411	1455	1455	1455	35	35	35
	16K	16G	n.a.	120	n.a.	1000				2187	2187	2187	2344	2344	2344	40	40	40
	1M	16G	n.a.	250	250	n.a.				1666	1666	1666	3250	3250	3250			
Data	4K	5G	n.a.	n.a.	n.a.	n.a.												
	16K	16G	40	100	n.a.	n.a.	404	404	404	720	720	720	1850	1850	1850			
	64K	16G	100	150	250	n.a.	348	348	348	817	817	817	2605	2605	2605			
	1M	16G	150	200	300	n.a.	1611	1611	1611	1742	1742	1742	3521	3521	3521			
	16M	16G	200	250	400	n.a.	1706	1706	1706	1709	1709	1709	3245	3245	3245			
	64M	16G	200	250	400	n.a.	1689	1689	1689	1689	1689	1689	3230	3230	3230			

Figure 5. Single node HPE Synergy 660 Gen10 result having 3 SSDs in RAID 5 configured for SAP HANA data and log

Multiple nodes have been tested with the setup of three SSDs in RAID 5. The used Synergy Compute Modules have been HPE Synergy 660 Gen10, HPE Synergy 480 Gen10, HPE Synergy 680 Gen9, and HPE Synergy 480 Gen9. The results can be seen in figure 6.

SAP HANA Hardware certification for Enterprise Storage (TDI)

Volume	Block Sizes	Test File Size	KPIs				Results											
			Initial Write (MB/s)	Overwrite (MB/s)	Read (MB/s)	Latency (µs)	Initial Write (MB/s)			Overwrite (MB/s)			Read (MB/s)			Latency (µs)		
			Min	Min	Min	Max	min	av.	max	min	av.	max	min	av.	max	min	av.	max
Log	4K	5G	n.a.	30	n.a.	1000				741	1124	1317	818	1207	1388	32	67	109
	16K	16G	n.a.	120	n.a.	1000				2032	2126	2193	1614	1998	2184	37	72	116
	1M	16G	n.a.	250	250	n.a.				1546	1691	1824	3191	3223	3249			
Data	4K	5G	n.a.	n.a.	n.a.	n.a.												
	16K	16G	40	100	n.a.	n.a.	219	390	490	538	631	719	1248	1533	1846			
	64K	16G	100	150	250	n.a.	455	582	790	659	738	813	1917	2183	2342			
	1M	16G	150	200	300	n.a.	1110	1322	1485	1411	1564	1776	3373	3462	3563			
	16M	16G	200	250	400	n.a.	1624	1670	1711	1641	1677	1716	3113	3140	3167			
	64M	16G	200	250	400	n.a.	1603	1666	1747	1602	1674	1751	3149	3193	3244			

Figure 6. Multi node (4) HPE Synergy compute modules result having 3 SSDs in RAID 5 configured for SAP HANA data and log

In the second scenario, one HPE Synergy 660 Gen10 Compute module has been configured with 6 HDDs in RAID10 and 2 SSDs configured as SmartCache. The results can be seen in figure 7.

SAP HANA Hardware certification for Enterprise Storage (TDI)

Volume	Block Sizes	Test File Size	KPIs				Results											
			Initial Write (MB/s)	Overwrite (MB/s)	Read (MB/s)	Latency (µs)	Initial Write (MB/s)			Overwrite (MB/s)			Read (MB/s)			Latency (µs)		
			Min	Min	Min	Max	min	av.	max	min	av.	max	min	av.	max	min	av.	max
Log	4K	5G	n.a.	30	n.a.	1000				744	744	744	971	971	971	108	108	108
	16K	16G	n.a.	120	n.a.	1000				2049	2049	2049	1717	1717	1717	114	114	114
	1M	16G	n.a.	250	250	n.a.				1679	1679	1679	3205	3205	3205			
Data	4K	5G	n.a.	n.a.	n.a.	n.a.												
	16K	16G	40	100	n.a.	n.a.	220	220	220	555	555	555	1282	1282	1282			
	64K	16G	100	150	250	n.a.	578	578	578	668	668	668	1893	1893	1893			
	1M	16G	150	200	300	n.a.	1490	1490	1490	1410	1410	1410	3190	3190	3190			
	16M	16G	200	250	400	n.a.	1663	1663	1663	1678	1678	1678	3206	3206	3206			
	64M	16G	200	250	400	n.a.	1628	1628	1628	1632	1632	1632	3205	3205	3205			

Figure 7. Single node HPE Synergy 660 Gen10 result having 6 HDDs in RAID10 configured for SAP HANA data and log plus 2 SSDs as write-back with RAID 1 for SmartCache

Multiple nodes were then tested with the setup of 6 HDDs in RAID10 and 2 SSDs configured as SmartCache. The HPE Synergy Compute Modules used were HPE Synergy 660 Gen10, HPE Synergy 480 Gen10, and HPE Synergy 680 Gen9. The results can be seen in figure 8.

SAP HANA Hardware certification for Enterprise Storage (TDI)

Volume	Block Sizes	Test File Size	KPIs				Results											
			Initial Write (MB/s)	Overwrite (MB/s)	Read (MB/s)	Latency (µs)	Initial Write (MB/s)			Overwrite (MB/s)			Read (MB/s)			Latency (µs)		
			Min	Min	Min	Max	min	av.	max	min	av.	max	min	av.	max	min	av.	max
Log	4K	5G	n.a.	30	n.a.	1000				536	969	1190	608	795	973	33	77	108
	16K	16G	n.a.	120	n.a.	1000				923	938	954	1223	1556	1902	38	83	116
	1M	16G	n.a.	250	250	n.a.				858	868	887	1911	1944	1984			
Data	4K	5G	n.a.	n.a.	n.a.	n.a.												
	16K	16G	40	100	n.a.	n.a.	165	288	350	283	381	578	575	663	836			
	64K	16G	100	150	250	n.a.	377	500	614	767	805	875	1457	1684	2126			
	1M	16G	150	200	300	n.a.	711	792	856	956	972	1002	2163	2175	2195			
	16M	16G	200	250	400	n.a.	874	894	926	875	895	927	1992	2015	2043			
	64M	16G	200	250	400	n.a.	869	893	928	872	894	928	1991	2014	2045			

Figure 8. Multi node (3) Synergy compute modules result having 6 HDDs in RAID10 configured for SAP HANA data and log plus 2 SSDs as write-back with RAID 1 for SmartCache

Analysis and recommendations

Testing for this Reference Architecture showed, that SAP HANA TDI KPIs are fully met with SAP HANA on HPE Synergy Compute Modules and the HPE Synergy D3940 Storage Module. The testing also showed that more than one SAP HANA production and development system can be hosted on HPE Synergy Composable Infrastructure with the HPE Synergy D3940 Storage Module.

All HPE Synergy Compute Modules tested in this RA, configured with a minimum of three SSDs, meet the SAP HANA TDI KPIs and even the stricter KPIs for the SAP HANA appliance can be fulfilled for up to two systems. Testing multi node configurations with HWCCT showed that up to four productive systems can fulfill the TDI KPIs.

Having Synergy compute modules configured with a more affordable storage configuration of HDDs in combination with SSDs allows as well to run more than one SAP HANA production system. Up to three systems have been tested and the results fulfill the SAP HANA TDI KPIs. But the more systems are tested at one point in time the more the IO latency is growing and the bandwidth gets reduced even though the KPIs are still met.

Summary

This Reference Architecture describes the setup of SAP HANA in a Synergy environment using HPE Synergy D3940 Storage Module. The setup and the results of the SAP Hardware Configuration Check Tool are described in this document.

HPE Synergy provides a flexible, simple and efficient option for SAP HANA TDI environments:

- Flexible: Customers can chose the best storage option for their environment, either shared storage (3PAR) or local disks (D3940) can be leveraged with composable infrastructure capabilities.
- Simple: Reduce complexity by using common composable infrastructure and manage it with HPE OneView
- Efficient: Consolidate and standardize infrastructure for mixed workloads, while still meeting high performance requirements

The fluid resource pools and software-defined intelligence of HPE Synergy allow administrators to rapidly compose any configuration required, reducing deployment time repeatedly from hours or days to minutes. With the HPE Synergy D3940 Storage Module, persistent data storage can be handled like local storage in a Synergy environment, yet offering the possibility to add additional storage to a system in a fast and easy way.

The artifact bundles used in this Reference Architecture will create a server with a running SAP HANA database, using the HPE Synergy D3940 Storage Module as persistent data storage.

The SAP Hardware Configuration Check Tool tests showed that SAP HANA on HPE Synergy D3940 Storage Module meets the SAP TDI KPIs and is capable to handle more than one SAP HANA production system, depending on the chosen storage layout and configuration.

Using HPE Synergy as hardware platform for SAP HANA combines the advantages of composable infrastructure while meeting SAP's KPIs.

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 an HPE Services representative (hpe.com/us/en/services/consulting.html) or your HPE partner.

Appendix A: Bill of materials

Note

Part numbers are at time of 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 HPE Reseller or HPE Sales Representative for more details. hpe.com/us/en/services/consulting.html

Table A-1. Bill of materials

Qty	Part number	Description
		HPE Synergy Frame components
1	797740-B21	HPE Synergy 12000 Configure-to-order Frame with 1x Frame Link Module 10x Fans
1	804942-B21	HPE Synergy Frame Link Module
6	798095-B21	HPE Synergy 12000F 2650W AC Ti PS
1	804353-B21	HPE Synergy Composer
1	804937-B21	HPE Synergy Image Streamer
1	JG838A	HPE 5900CP 48XG 4QSFP+ Switch
2	794502-B23	HPE Virtual Connect SE 40Gb F8 Module for HPE Synergy
		HPE Synergy 660 Gen10 Compute Module components
2	871931-B21	HPE SY 660 Gen10 4S Configure-to-Order Compute Module
8	872138-B21	HPE Synergy 480/660 Gen10 Intel® Xeon-Gold 6142 Processor Kit
2	872138-L21	HPE Synergy 480/660 Gen10 Intel® Xeon-Gold 6142 FIO Processor Kit
4	785067-B21	HPE 300GB 12G SAS 10K 2.5in SC ENT HDD
32	815101-B21	HPE 64GB 4Rx4 PC4-2666V-L Smart Kit
2	777452-B21	HPE Synergy 3830C 16G FC HBA
2	777430-B21	HPE Synergy 3820C 10/20Gb Converged Network Adapter
2	804424-B21	HPE Smart Array P204i-c SR Gen10 Ctrlr
		HPE Synergy 680 Gen9 Compute Module components
1	834482-B21	HPE SY 680 Gen9 4S Configure-to-Order Compute Module
3	834500-B21	HPE Synergy 620/680 Gen9 Intel® Xeon® E7-8880 v4 Processor Kit
1	834500-L21	HPE Synergy 620/680 Gen9 Intel® Xeon® E7-8880 v4 FIO Processor Kit
1	814068-B21	HPE Smart Array P240nr/1GB FIO Ctrlr
2	785067-B21	HPE 300GB 12G SAS 10K 2.5in SC ENT HDD
8	805351-B21	HPE 32GB 2Rx4 PC4-2400T-R Kit
2	777452-B21	HPE Synergy 3830C 16G FC HBA
2	777430-B21	HPE Synergy 3820C 10/20Gb Converged Network Adapter
1	759557-B21	Smart Array P542D Controller
		HPE Synergy 480 Gen10 Compute Module components
1	871940-B21	HPE SY 480 Gen10 Configure-to-Order Compute Module
2	873381-B21	HPE Synergy 480/660 Gen10 Intel® Xeon-Gold 6130 Processor Kit

Qty	Part number	Description
1	873381-L21	HPE Synergy 480/660 Gen10 Intel® Xeon-Gold 6130 FIO Processor Kit
2	872475-B21	HPE 300GB SAS 10K SFF SC DS HDD
8	815100-B21	HPE 32GB 2Rx4 PC4-2666V-R Smart Kit
1	777452-B21	HPE Synergy 3830C 16G FC HBA
1	777430-B21	HPE Synergy 3820C 10/20Gb Converged Network Adapter
1	804424-B21	HPE Smart Array P204i-c SR Gen10 Ctrlr
		HPE Synergy 480 Gen9 Compute Module components
1	732350-B21	HPE SY 480 Gen9 Configure-to-Order Compute Module
2	826983-B21	HPE Synergy 480 Gen9 E5-2650v4 Kit
1	826983-L21	HPE Synergy 480 Gen9 E5-2650v4 FIO Kit
2	872475-B21	HPE 300GB SAS 10K SFF SC DS HDD
4	805349-B21	HPE 16GB 1Rx4 PC4-2400T-R Kit
1	777452-B21	HPE Synergy 3830C 16G FC HBA
1	777430-B21	HPE Synergy 3820C 10/20Gb Converged Network Adapter
1	759557-B21	Smart Array P542D Controller
		Storage
1	835386-B21	HPE Synergy D3940 CTO Storage Module
1	757323-B21	HPE Synergy D3940 Redundant I/O Adapter
2	755985-B21	HPE Synergy 12Gb SAS Connection Module with 12 Internal Ports
24	872479-B21	HPE 1.2TB SAS 10K SFF SC DS HDD
12	872382-B21	HPE 1.6TB SAS 12G MU SFF SC DS SSD

Appendix B: HWCCT test configuration

Example of a single node test_config.json file for the IO test of HWCCT to determine the KPI rating.

```
{
"report_id":"SY660_single_node_3SSD_R5_",
"use_hdb":false,
"blades":["host1"],
    "tests": [{
            "package": "FilesystemTest",
            "test_timeout": 0,
            "id": 2,
            "config": {"mount":{
                        "host1":["/hana/log"]
                        },
                        "duration":"long"
                      },
            "class": "LogVolumeIO"
        },
{
            "package": "FilesystemTest",
            "test_timeout": 0,
            "id": 3,
            "config": {"mount":{
                        "host1":["/hana/data"]
                        },
                       "parameter": {
                                     "max_parallel_io_requests":"128",
                                     "size_kernel_io_queue":"256"
                                    },
                        "duration":"long"
                      },
            "class": "DataVolumeIO"
        }

]
}
```

Example of a multi node test_config.json file for the IO test of HWCCT to determine the KPI rating.

```
{
"report_id":"BB_R1234_",
"use_hdb":false,
"blades":["host1","host2","host3","host4"],
    "tests": [{
            "package": "FilesystemTest",
            "test_timeout": 0,
            "id": 2,
            "config": {"mount":{
                        "host1":["/hana/log"],
                        "host2":["/hana/log"],
                        "host3":["/hana/log"],
                        "host4":["/hana/log"]
                        },
                         "parameter": {
                                     "max_parallel_io_requests":"128",
                                     "size_kernel_io_queue":"256"
                                    },
                        "duration":"long"
                      },
            "class": "LogVolumeIO"
        },
{
            "package": "FilesystemTest",
            "test_timeout": 0,
            "id": 3,
            "config": {"mount":{
                        "host1":["/hana/data"],
                        "host2":["/hana/data"],
                        "host3":["/hana/data"],
```

```
                    "host4":["/hana/data"]
                    },
                    "duration":"long"
                },
            "class": "DataVolumeIO"
        }

]
}
```

Appendix C: SmartCache configuration

In a hybrid disk scenario, where HDDs and SSDs both shall be used, the SmartCache has to be configured manually.

After the server profile creation in the HPE Synergy Composer, the created server must boot into the Smart Storage Administrator. Please make sure to use the same or higher version of the Smart Storage Administrator that is part of the SPP bundle used in the Synergy environment.

In the Smart Storage Administrator, one logical drive with all the HDDs shall be created in RAID10.

After enabling the HPE SmartCache, the SSDs are used to configure a SmartCache as write-back with RAID 1.

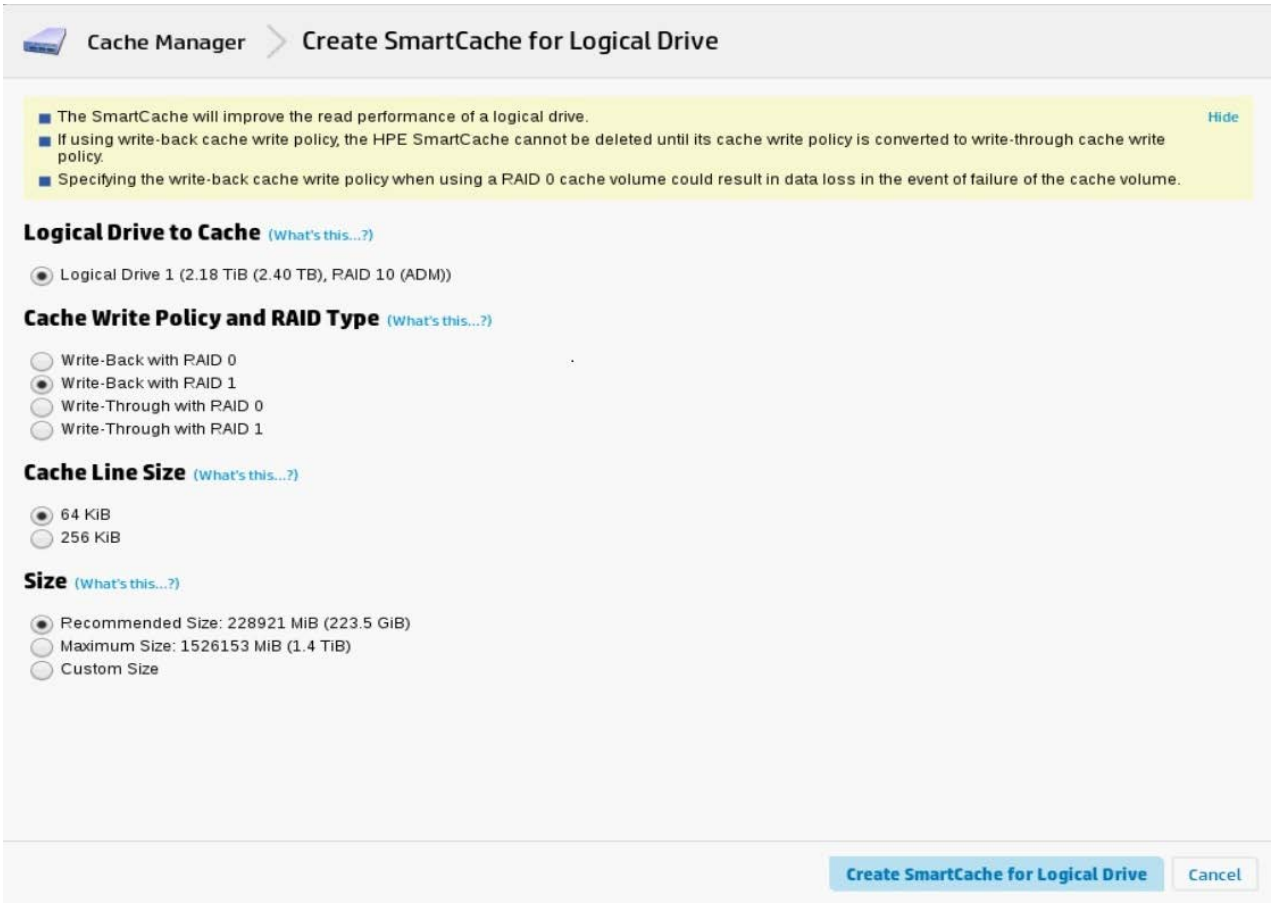


Figure C-1. SmartCache Configuration in the Smart Storage Administrator

After this manual configuration, the normal server boot process can be started, which is followed by the execution of the plan scripts.

Glossary

Name	Description
DB	Database
HDD	Hard Disk Drive
HPE	Hewlett Packard Enterprise
KPI	Key Performance Indicator
HWCCT	Hardware Configuration Check Tool
RA	Reference Architecture
SAP	Systems, Applications & Products in Data Processing
SID	SAP System Identification
SSD	Solid State Drive
TDI	Tailored Datacenter Integration

Resources and additional links

HPE Reference Architectures, hpe.com/info/ra

HPE Synergy, hpe.com/synergy

HPE Synergy Reference Architecture, hpe.com/info/synergy-ra

HPE Servers, hpe.com/servers

HPE Storage, hpe.com/storage

HPE Networking, hpe.com/networking

HPE Technology Consulting Services, hpe.com/us/en/services/consulting.html

HPE GitHub site for image streamer reference architecture, https://github.com/HewlettPackard/image-streamer-reference-architectures

HPE RA SAP HANA lifecycle activity with HPE Synergy Image Streamer, http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=a00049665enw

SAP HANA Platform (Core), http://help.sap.com/hana_platform

SAP Notes, http://support.sap.com/notes

SAP Software Download Center, https://support.sap.com/swdc

SAP System sizing Quick sizer tool, http://service.sap.com/sizing

SAP HANA Storage Requirements, http://sap.com/documents/2015/03/74cdb554-5a7c-0010-82c7-eda71af511fa.html

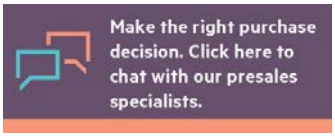
SAP Hardware Configuration Check Tool, https://launchpad.support.sap.com/#/notes/1943937

SAP HANA TDI FAQ document, http://sap.com/documents/2016/05/e8705aae-717c-0010-82c7-eda71af511fa.html

SAP HANA TDI, https://archive.sap.com/documents/docs/DOC-59755

SAP HANA Hardware Certification for Enterprise Storage, http://sap.com/dmc/exp/2014-09-02-hana-hardware/enEN/enterprise-storage.html

To help us improve our documents, please provide feedback at hpe.com/contact/feedback



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