White Paper

Intel® Optane™ Persistent Memory
Database Management

Accelerating Database Performance for SAP HANA Workloads

HCLTech's SAPBase90 solution on Intel® Optane™ persistent memory delivers high capacity, high performance, and lower TCO

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Table of Contents

Executive Summary

In a fast-paced digital industry where time-to-market is crucial for enterprises, the aggressive growth of data and attendant disciplines has piled additional stress on the performance of traditional Database Management Systems (DBMS). To address the slow nature of traditional DBMS, especially due to I/O bottlenecks, SAP introduced SAP HANA (High-performance Analytic Appliance), which is a database that stores data in-memory instead of keeping it on a disk. This makes SAP HANA unique and significantly faster than other DBMS on the market today and allows companies to process massive amounts of data with near-zero latency, query data in an instant, and become truly data-driven.

HCLTech's SAPBase90 is a next-gen SAP solution based on a set of unique pre-configured implementation accelerators built leveraging SAP S/4HANA best practices gathered from over 20 years of experience working in various industry verticals. SAPBase90 extends S/4HANA's formidable capabilities by adding specific configurations, enhancements, templates, and change management tools. This solution is available for customers on subscription-based consumption model.

With that objective, HCLTech has developed a solution reference architecture for SAPBase90 running on Intel® Optane™ persistent memory (PMem) based on the current best practices from Intel and HCLTech. HCLTech validated the performance of this solution for future sizing needs and also using performance as a metric, a comparative study between SAPBase90 configured to use persistent memory and that without using persistent memory.

Introduction to HCLTech SAPBase90

Certified by SAP, HCLTech's SAPBase90 is a set of unique pre-configured implementation accelerators built by HCLTech, which leverages SAP best practices for SAP S/4HANA.

SAPBase90 contains preconfigured solutions, accelerators, industry, and process-specific subject matter. Our SAPBase90 templates enable organizations to achieve rapid implementation, with 90% of their processes coming straight out of the box. The remaining 10% are reimagined for competitive differentiation using design thinking.

Our SAPBase90 accelerators bring multiple benefits to any S/4HANA project, including:

- Focusing on adopting the available SAP best practices during design and validation, rather than trying to reinvent the wheel or blueprinting
- Reducing project timelines significantly – driving a faster return of investment
- Simplifying user adaption and ensuring compatibility with future innovations

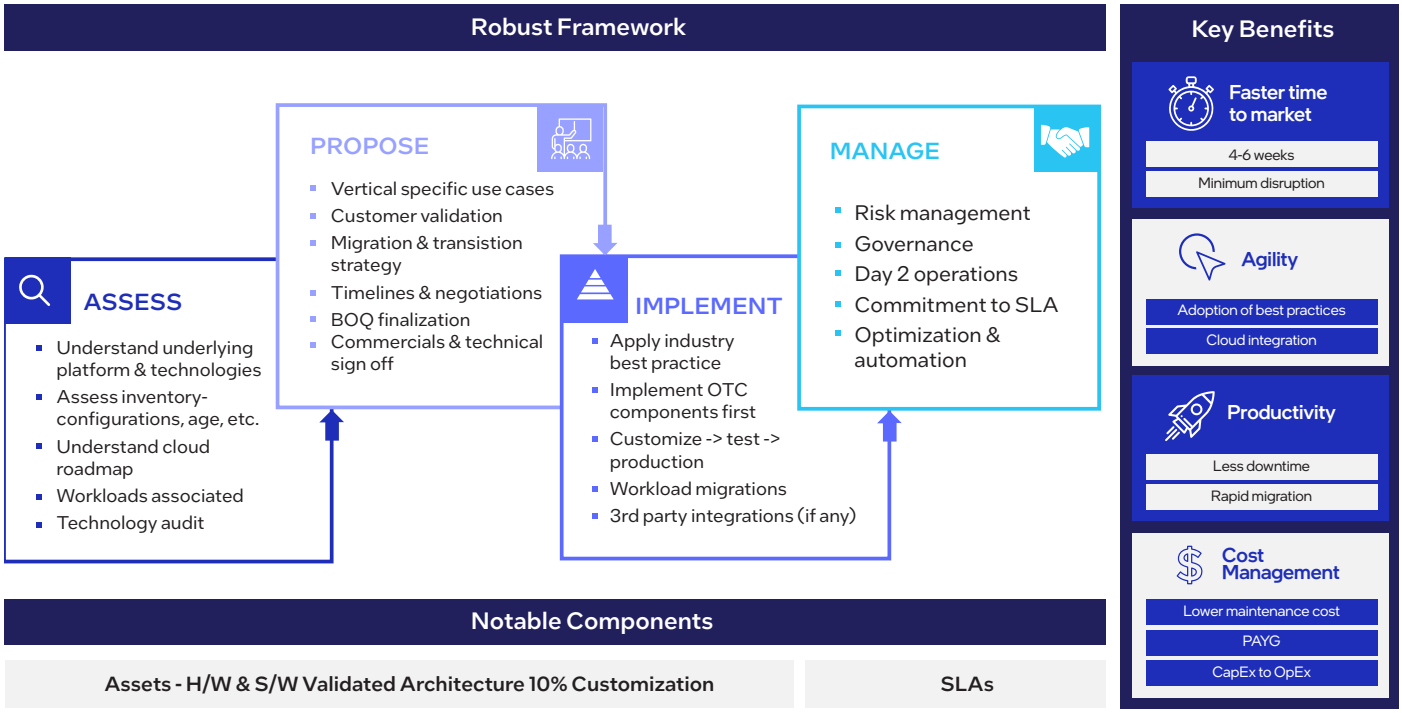


Figure 1: SAPBase90 framework

Introduction to Intel® Optane™ Persistent Memory for SAPBase90

Intel® Optane™ PMem solutions usable for SAP HANA is a first in-memory database, which performs all database operations directly on the in-memory data structures. Traditionally, SAP HANA uses volatile memory and synchronizes it with the persistence level on disk using mechanisms like save points. This approach has a disadvantage; during an SAP HANA restart all data must be reloaded from disk to memory, which could be time-consuming.

Intel® Optane™ PMem is an emerging class of memory that combines the qualities of both DRAM and flash storage and bridges the gap between disk storage and main memory. They come in 2 modes:

Memory Mode – In Memory Mode, the DRAM acts as a cache for the most frequently accessed data, while the Intel® Optane™ DC persistent memory provides large memory capacity. Cache management operations are handled by the Intel® Xeon® Scalable processor's integrated memory controller. When data is requested from memory, the memory controller first checks the DRAM cache, and if the data is present, the response latency is identical to DRAM. If the data is not in the DRAM cache, it is read from the Intel® Optane™ DC PMem with slightly longer latency.

Data is volatile in Memory Mode; it will not be saved in the event of power loss. Persistence is enabled in the second mode, called App Direct.

App Direct Mode – Applications and the operating system are explicitly aware there are two types of direct load/store memory in the platform and can direct which type of data read or write is suitable for DRAM or Intel® Optane™ DC PMem.

Operations that require the lowest latency and don't need permanent data storage can be executed on DRAM, such as database "scratch pads". Data that needs to be made persistent or structures that are very large can be routed to the Intel® Optane™ PMem. To make data persistent in memory, App Direct Mode should be used.

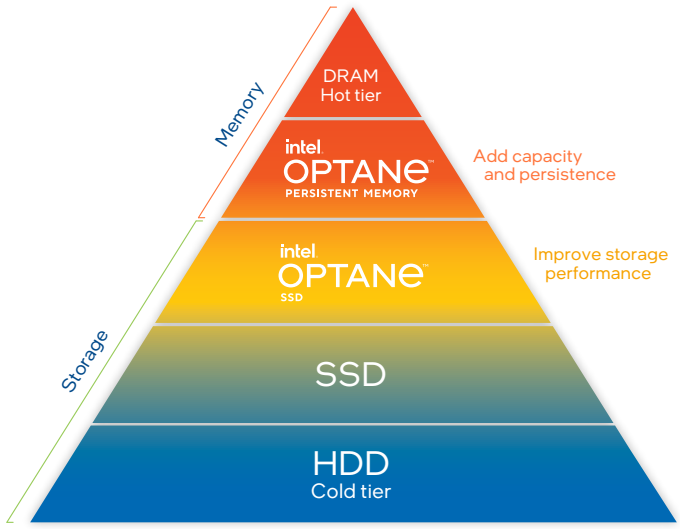
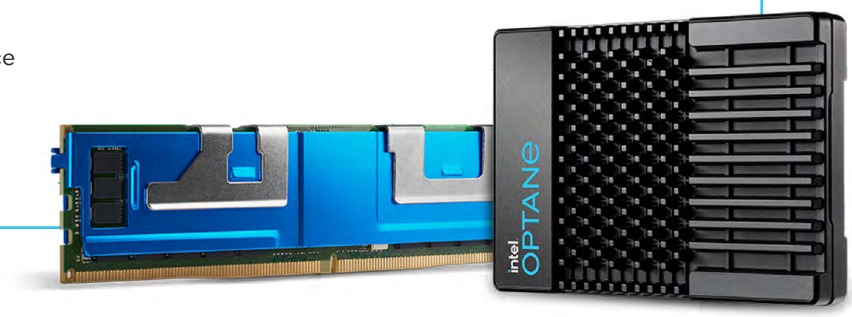


Figure 2: NextGen storage with persistent memory

Objectives & Methodology:

The objective is to test the performance of SAPBase90 system using Intel® Optane™ PMem. This includes setting up the below configuration and then executing the performance tests:

- Set up the hardware and software environment for SAP/S4 HANA on Intel® Xeon® processors + Intel® Optane™ PMem with best practices from Intel and SAP
- Performance validation
- Development of the solution reference architecture
- Define validation plan on solution performance
- VMware setup and network setup
- OS file system creation
- Installation of SAP HANA 2.0 DB configured to utilize Intel® Optane™ PMem
- Installation of S4HANA 2022 application
- Execute performance tests and create the performance report



Objective	Test Methodology	Observations
▪ Prove SAPBase90 performance increases with Intel® Optane™ PMem ▪ Analyze the configuration ratio needed between PMem and DRAM usage ▪ Observe the performance variance query execution on SAPBase90 database platforms to support business operations	Virtual Machines (VMs) were provisioned on the hardware using VMware ESXi Hypervisor to compare the performance of SAPBase90 platform with and without PMem. ▪ One set of VMs were used to install a distributed installation of SAPBase90 using SAP HANA DB which is configured without using any PMem ▪ Second set of VMs were used to install a distributed installation of SAPBase90 using SAP HANA DB which is configured to use PMem ▪ Time taken to restart HANA was compared when using PMem as against when not using PMem ▪ Measure compliance using SAP HANA HCMT tool ▪ Use SGEN to generate/trigger loads and compare the impact of PMem on long running SAP jobs	▪ Quicker system startup time – test results confirmed that the system startup was reduced after data was loaded in Intel® Optane™ PMem ▪ System performance gains – SAPBase90 reported good performance gains to typical DRAM usages ▪ High system stability was seen in a short period of time ▪ Adoption of Intel® Optane™ PMem – low installation and training was required for engineers to adopt and provision SAPBase90 on Intel® Optane™ PMem

Figure 2: Summary of the testing methodology and observations*

*Hardware Configuration: 2 x Xeon-SP Gold 6238L, 12 x 128GB Quad Rank x4 DDR4-2933, 12 x 128GB Optane 100-series Persistent Memory, 6 x 3.2TB SAS 12G Mixed Use SFF SC PM1645a SSD, 2 x Ethernet 10Gb 2-port SFP+ X710-DA2 Adapter dual port NIC. VMware ESXi Hypervisor Version: ESXi 7.0 , OS version: SUSE Linux Enterprise Server 15 SP4, SAP HANA DB version info: version: 2.00.063.00.1655123455 branch: fa/hana2sp06 machine config: linuxx86_64 SAP Version: SAP S4HANA 2022

Test Scenario

The test was designed to determine how using PMem instead of DRAM modules influences SAPBAse90 platform performance. We wanted to establish the following characteristics:

- Time to load memory
- Performance impact in parallel queries
- Performance impact in sequential queries
- Time reduction of SAPBase90 system restart

Based on these aims, the following steps were considered:

- **Test A** - measured memory load times for large data sets
- **Test B** - measured throughput in parallel queries
- **Test C** - measured the execution time of sequential queries
- **Test D** - measured the restart times of SAPBase90 system

Testing Results

The table below shows the performance figures for PMem configurations in comparison to DRAM configurations. For tests A, B and C, we noted the relative performance gains/losses compared to DRAM configurations. For test D, the restart time is given in mins.

	DRAM	PMEM	Total	Test A (Memory load speed for large data sets)	Test B (Throughput in parallel queries)	Test C (Execution speed of sequential queries)	Test D (Restart times)
DRAM Configuration	250GB		250GB				11min
DRAM+PMEM Configuration	250GB	500GB	750GB	No notable performance gains seen	No notable performance gains seen	No notable performance gains seen	2min
	Remarks						Shorter times are better

P.S: It needs to be noted that these performance results were observed for a freshly installed SAPBase90 system which had non-production minimalist business data stored in the persistent memory. In case of a production environment which has significant amount of data stored in Columnstores which are loaded onto the persistent memory, the performance gains achieved by using persistent memory are expected to be greater that those achieved in this testing

Conclusion

Our performance comparison tests for SAPBase90 on Intel PMem confirms:

- Faster startup and shutdown timeframes (~5.5x% improvements) with significant reduction in system downtime and lower operational costs
- Process more data in real-time with increased memory capacity
- Lower TCO by transforming the data storage hierarchy
- Improve business continuity with PMem and fast data loads at startup

References

- SAP HANA Administration Guide, section "Persistent Memory"
- 2618154 - SAP HANA Persistent Memory - Release Information
- 2700084 - FAQ: SAP HANA Persistent Memory
- White Paper: Intel Optane Persistent Memory and SAP HANA Platform Configuration on VMware ESXi
- SAP HANA Hardware and Cloud Measurement Tools Guide
- https://www.intel.com/content/dam/support/us/en/documents/memory-and-storage/data-center-persistent-mem/Intel-Optane-DC-Persistent-Memory-Quick-Start-Guide.pdf
- https://www.sap.com/products/technology-platform/hana/what-is-sap-hana.html

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Disclaimers

Performance varies by use, configuration and other factors. Learn more at https://intel.com/benchmarks

Performance results are based on testing as of dates shown in configurations and may not reflect all publicly available updates. See backup for configuration details.

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