Fast-Start-Solutions for SAP HANA on Power
Overview and Comparison

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Focus: SAP HANA Scale-up and Scale-out solutions

Target:
- SAP HANA 2.0
- POWER9

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<td>Initial Version</td>
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<td>0.1</td>
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Preface
Running SAP HANA on IBM Power Systems offers customers a consistent platform for their HANA-based and traditional applications, best-in-class performance, resilience for critical workloads, and most flexible infrastructure. Existing IT assets - servers, storage, as well as skills and operation procedures - can easily be (re-)used leveraging the SAP HANA Tailored Data Center Integration (TDI) concept, instead of enforcing additional investment into dedicated SAP HANA appliances.

This paper will show how a HANA can be started 2 to 18 times faster exploiting different IBM technologies.

About This Document
This document is intended for architects and specialists planning an SAP HANA® on POWER® deployment. It describes the design considerations for hardware, networking, and software components of the SAP HANA on POWER solution stack.
This guide does not replace existing SAP HANA documentation and sizing guides. It serves as a supplement to the existing SAP HANA documentation and SAP Sizing methods to provide specific guidance on how to meet all SAP requirements when running SAP HANA on IBM Power Systems™, IBM System Storage®, IBM PowerVM®, and Linux Operating Systems.

IBM employees can access the ISICC SAP HANA on Power Systems Community (IBM only) for up-to-date materials complementary to this guide.

The most recent document version can be downloaded from IBM TechDocs: http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102502

Feel free to provide feedback and change requests for this document via email to isicc@de.ibm.com.

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Marc-Stephan Tauchert is a System Specialist at IBM Germany. In his 25+ years’ experience in designing and implementing SAP Solutions on IBM Power Systems, he has covered various topics and roles. As Technical Sales Consultant and SAP Solution Architect, he supports customer situations regarding the connectivity of SAP Applications and Infrastructure, SAP sizing, and hybrid solutions. He is an expert in SAP Database and Application performance, including SAP HANA.
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Introduction
This planning guide supports the architecture and implement new technologies on Power for SAP HANA environments. This technical document is based on experimental tests done at SAP in Walldorf in cooperation with the ISICC. This planning guide will focus on the available Fast-Start-Solutions for SAP HANA on Power.

Hardware setup for Fast-Start-Solution used
This section lists the used hardware but does not necessarily define all requirements for every client’s production SAP HANA instances.

The test has been conducted on a Power 9 system 9040-MR9 which has the following hardware features:
- 48 cores
- 8192 GB memory
- 3 x PCIe2 16Gb 2-Port Fibre Channel Adapter
- 4 x PCIe3 3.2TB NVMe Flash Adapter II x8
- 1 x SAS RAID Controller, PCIe3 x8, Quad-port 6Gb
- 2 x PCIe2 4-Port (10GbE SFP+ & 1GbE RJ45) Adapter

Following Logical Partitions are defined:
- 2 x Virtual I/O Server with 1 dedicated core and 4 GB main memory
- 1 x SAP HANA database server with 28 dedicated cores and 512 to 4196 GB main memory
- 1 x SAP Netweaver Application Server with 16 dedicated cores and 512 GB main memory

Software and Firmware levels:
- The firmware level of the Power 9 system should equal or greater VM940_FW940.00 (27) (used in this comparison test)
- Firmware level of the PCIe3 3.2TB NVMe Flash Adapter II x8 adapters should be MN14MN14
- The Virtual I/O Servers based on the version 2.2.6.31.
- The SAP Netweaver Application Server based on SLES 12 SP4 and SAP Netweaver Kernel 7.49
- The SAP HANA database server has the OS version SLES15 SP1 and the SAP HANA version 2.00.044.00.1571081837

SAP HANA DatabaseContent
- SAP Netweaver 7.50
- Data volume of 7.8 billion records which maps to 3 TB main memory usage by SAP HANA.

Process and test overview
For all different Fast-Start-Solutions the same start and stop method are processed. On each Fast-Start-Solution all different start states of the system are tested and compared. All test
results are based on multiple start and stop actions. All result measurements in this document are normalized, average values. The start and stop measurement times are extracted from the SAP HANA indexserver trace file. The verification about a performance impact on the application side between the different Fast-Start-Solutions, were based on Online Analytical Processing (OLAP) workload without performance difference. The SAP HANA database size was 3 TB after loading all data into memory.

Architecture and setup instructions
This chapter provides information about the implementation and setup of the different Fast-Start-Solutions. This documentation will only provide an overview and will not replace the regular configuration and implementation guides of these Fast-Start-Solutions.

Fast-Start-Solution with TMPFS:
This solution based on temporary filesystems which are defined on the operating system level. These temporary filesystems are working like RAM based filesystems. For each NUMA node one temporary filesystem has to be created and mounted to a specific HANA directory. The Figure 1 shows a scheme which part of SAP HANA will be stored in the temporary filesystems.

![Figure 1: Scheme of tmpfs solution design](https://help.sap.com/viewer/6b94445c94ae495c83a19646e7c3fd56/2.0.04/en-US/ce158d28135147f099b761f8b1ee43fc.html)

Detailed setup instructions can be found in the “SAP HANA Administration Guide for SAP HANA Platform - SAP HANA Fast Restart Option” at:
https://help.sap.com/viewer/6b94445c94ae495c83a19646e7c3fd56/2.0.04/en-US/ce158d28135147f099b761f8b1ee43fc.html

IBM Systems Solution for SAP HANA on POWER and IBM System Storage
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Fast-Start-Solution with vPMEM
The vPMEM solution is very similar to the tmpfs solution for SAP HANA Fast-Start option. The main difference between the vPMEM and the tmpfs solution is the placement of the memory. The tmpfs Fast-Start-Solution using the main memory of the LPAR, while the vPMEM Fast-Start-Solution is using the persistent memory which is defined for the LPAR. In total the summary of main memory and persistent memory have the same size like the tmpfs or the Rapid-Cold-Start solution. The Figure 2 shows the scheme of architecture for vPMEM with SAP HANA on Power.

More details about the configuration and sizing for virtual persistent memory can be found here: http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102502

Fast-Start-Solution with Rapid-Cold-Start
This solution is not based on a technology using main memory compared to vPMEM and tmpfs. Instead it is using NVMe devices to optimize the read performance of the attached I/O components. Figure 3 shows the design of the Rapid-Cold-Start-Solution.
Figure 3: Scheme of the Rapid-Cold-Start solution

Detailed setup documentation can be found here:  
http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102502

Fast-Start-Solution with Internal NVMe PCIe cards and NVMe SAN Storage
From previous measurements traditional internal and external Storage attachments are added in the comparison.  
The detailed setup documentation for SAN attachments is part of the SAP TDI process. The instructions on how to setup HANA based on internal discs can be found here: 
http://www.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP102502
**Scenario comparison between the different Fast-Start-Solutions**

During the lifetime of a SAP HANA system there could be a lot of different trigger for start and stop the SAP HANA and the underlying Operating System. The following table (Table 1) gives an overview about these different trigger’s and the impact for the different Fast-Start-Solutions.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>tmpfs</th>
<th>vPMEM</th>
<th>Rapid-Cold-Start</th>
<th>Internal NVMe Cards</th>
<th>FS9100 NVMe Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAP HANA start (initial)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SAP HANA start after stop</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SAP HANA restart</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>SAP HANA service restart</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Operating system reboot</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Operating system update/service patch</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>System restart</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*Table 1: Different scenario’s / trigger’s for start and stop actions*

**Application memory comparison**

The application performance differences between the different Fast-Start-Solutions goes to zero. The following table shows the memory configuration and memory usage by SAP HANA on the tested scenarios.

<table>
<thead>
<tr>
<th></th>
<th>Standard</th>
<th>tmpfs</th>
<th>vPMEM</th>
<th>NVMe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total memory</td>
<td>4091 GB</td>
<td>4091 GB</td>
<td>4006 GB</td>
<td>4091 GB</td>
</tr>
<tr>
<td>No Persistent memory</td>
<td>4091 GB</td>
<td>4091 GB</td>
<td>511 GB</td>
<td>4091 GB</td>
</tr>
<tr>
<td>Persistent memory</td>
<td>0 GB</td>
<td>0 GB</td>
<td>3495 GB</td>
<td>0 GB</td>
</tr>
<tr>
<td>Memory by SAP HANA</td>
<td>2921 GB</td>
<td>2923 GB</td>
<td>2924 GB</td>
<td>2924 GB</td>
</tr>
</tbody>
</table>

*Table 2: Memory values*

**Performance differences between the Fast-Start solution variants**

The following table contains the measurement data of the startup and stop tests for the benefit validation of the different Fast-Start methods for SAP HANA. This table considered only the startup and stop behavior of SAP HANA. The start and stop times for LPAR operations or system operations are not included in this table.

---

1 The complete memory based on the addition of vPMEM and main memory configured in the HMC for the specific test state of the LPAR differ due to the need of 100% equal distribution needs and can be ignored.
The time values are based on HH:MM:SS. The startup and stop time information’s are extracted from the index server trace files of the SAP HANA environment. All tests are running up to minimum 3 times. The result values in the table below are average values. It is important to emphasize that the factors the startup is improved has no correlation to the runtime and heavily depends on the amount of data residing inside HANA. Hence, it is recommended to validate if the targeted Business application already supports SAP HANA Native Storage Extension (NSE) to first start reducing the amount of memory loaded and hence the overall memory consumption.

<table>
<thead>
<tr>
<th>Standard</th>
<th>tmpfs</th>
<th>vPMEM</th>
<th>Rapid-Cold</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Start times after</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Power Off</td>
<td>00:35:45</td>
<td>00:29:00</td>
<td>00:31:02</td>
</tr>
<tr>
<td>Benefit against Standard</td>
<td>x1,2</td>
<td>x1,2</td>
<td>x6,5</td>
</tr>
<tr>
<td><strong>Start times after</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LPAR down</td>
<td>00:32:13</td>
<td>00:28:51</td>
<td>00:02:27</td>
</tr>
<tr>
<td>Benefit against Standard</td>
<td>x1,1</td>
<td>x13</td>
<td></td>
</tr>
<tr>
<td><strong>Start times after</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAP HANA stop (Table load = 5 parallel)</td>
<td>00:31:44</td>
<td>00:02:22</td>
<td>00:02:24</td>
</tr>
<tr>
<td>Benefit against Standard</td>
<td>x13</td>
<td>x13</td>
<td>nearly x6,5</td>
</tr>
<tr>
<td><strong>Start times after</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SAP HANA stop (Table load = 12 parallel)</td>
<td>00:31:05</td>
<td>00:01:41</td>
<td>00:01:42</td>
</tr>
<tr>
<td>Benefit against Standard</td>
<td>x18</td>
<td>x18</td>
<td>x7</td>
</tr>
<tr>
<td><strong>Stop times</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Benefit against Standard</td>
<td>00:01:38</td>
<td>00:01:00</td>
<td>00:01:01</td>
</tr>
<tr>
<td></td>
<td>x1,6</td>
<td>x1,6</td>
<td>x1,1</td>
</tr>
</tbody>
</table>

Table 3: Startup times, stop times and their benefits

Based on older measurements moving to a FS9100 model a startup time improvement of factor 2-3x can be expected at minimum. For the PCIe NVMe local disks 5x startup improvements are easily to be achieved.

**Referenced documents**

[SAP HANA on IBM Power Systems and IBM System Storage - Guides](#)
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