2205917 - SAP HANA DB: Recommended OS settings for SLES 12 / SLES for SAP Applications 12

Version	61	**Type**	SAP Note
Language	English	**Master Language**	English
Priority	Recommendations / Additional Info	**Category**	Consulting
Release Status	Released for Customer	**Released On**	13.11.2020
Component	HAN-DB (SAP HANA Database)		

Please find the original document at **https://launchpad.support.sap.com/#/notes/ 2205917**

Symptom

You want to configure optimal settings for running HANA on SLES 12 / SLES for SAP Applications 12 (only SLES Service Packs supported by SAP HANA according to SAP Note 2235581)

Other Terms

HANA, DB, BW on HANA, Suite on HANA, S/4HANA, BW/4HANA, SLES 12, SLES12, SLES for SAP Applications 12, Linux, speed, performance

Reason and Prerequisites

You are running SAP HANA in any flavour on SLES 12 or SLES for SAP Applications 12 and you want to configure optimal Linux settings. For better readability of this SAP Note - if not mentioned explicitly otherwise - "SLES" is used as a synonym for "SLES for SAP Applications". In this SAP Note, the term "SAP HANA" refers to SAP HANA 1.0 and SAP HANA 2.0, unless explicitly stated. SAP HANA must be installed and configured according to SAP Note 1944799. If not mentioned otherwise, the listed recommendations are valid for all Service Packs of SLES 12 supported by SAP HANA. The OS versions and Service Packs supported by SAP HANA are listed in SAP Note 2235581.

Solution

To optimize the use of SAP HANA with SLES 12, apply the following settings. In virtual and cloud environments, architectural limitations can exist, so that some recommendations cannot be applied or deviate. For example, CPU power management can be unavailable. Please refer to the provider of the virtualization or cloud solution concerning such limitations.

Supported Kernel versions and patches to use with certified hardware for SAP HANA on SLES 12 or SLES for SAP Applications 12

You can use official SLES 12 Linux kernels and packages shipped by SUSE, including security and bug fixes provided via "Long Term Service Pack Support (LTSS)" for SLES 12. It is recommended to apply the latest kernel update, unless there are specific reasons against doing so. Using updated Linux kernels and packages from SLES Service Packs not listed in SAP Note 2235581 is not supported and will break the certification.

SLES 12 GA (no SP) and SLES 12 SP1 requirements

- Kernel update: Older versions of the Linux kernels shipped with SLES 12 GA (no SP) and SLES 12 SP1 provide excess information in /proc/<pid>/maps and /proc/<pid>/numa_maps, which can affect

HANA performance under certain circumstances. SUSE has fixed the excess information, and also fixed several other bugs in the kernel. A bug in the XFS filesystem, which could lead to data inconsistencies, was fixed with Linux kernel version 3.12.51-52.31.1 (SLES 12) resp. Linux Kernel 3.12.51-60.20.2 (SLES 12 SP1). For more background information about this specific XFS-problem, please consult SAP Note 2246163. Various security bugs were fixed with 3.12.61-52.72.1 (SLES 12 GA) resp. 3.12.74-60.64.40.1 (SLES 12 SP1) or newer (see SUSE TID 7019001 for more details).

- If you are using sapconf or saptune, please refer to SAP Note 1275776.

To enable these changes, a system reboot is required.

SLES 12 SP2 requirements

- Kernel update: SUSE has fixed a number of bugs in older kernel versions. Please upgrade the Linux kernel to version 4.4.120-92.70.1 or newer (see SUSE Update Advisories for more details)
- glibc-2.22-51.6 or newer
- systemd-228-142.1 or newer
- If you are using sapconf or saptune, please refer to SAP Note 1275776.
- If you are using an XFS filesystem, we recommend to deactivate the fstrim service, which may cause XFS metadata corruption. However if you want to use the fstrim service, please upgrade the Linux kernel as described in SUSE's knowledge base article https://www.suse.com/support/kb/doc/?id=7022921.

To enable these changes, a system reboot is required.

SLES12 SP3 requirements

- Linux kernel update: Please upgrade the Linux kernel to version 4.4.120-94.17.1 or newer.
- If you are using sapconf or saptune, please refer to SAP Note 1275776.

To enable these changes, a system reboot is required.

SLES12 SP4 requirements

- On IBM Power machines, please upgrade the Linux kernel to version 4.12.14-95.13.1 or newer. See SAP Note 2774105 for more information.
- For distributed HANA installations, please ensure to have the package libssh2-1 installed.

SLES12 SP5 requirements

- On IBM Power machines, please upgrade the Linux kernel to version 4.12.14-122.17 or newer. See SAP Note 2774105 for more information.
- For distributed HANA installations, please ensure to have the package libssh2-1 installed.

Additional 3rd-party kernel modules

If additional 3rd-party binary kernel modules are loaded that complicate support for both SAP and the OS vendor (SUSE), then the following SAP Note applies:
784391 - SAP support terms and 3rd-party Linux kernel drivers

Configure sapconf or saptune

SAP suggests the use of sapconf or saptune. Please refer to SAP Note 1275776 for details. They contain many of the settings mentioned below. Hardware settings (such as "power regulator" or "efficiency mode") may override the settings requested by the operating system.

Increase UserTasksMax

The default task limit of systemd for user slices can be to low for HANA workloads (only relevant for SLES 12 SP2 and higher).
In order to increase the limit either

1. Configure saptune according to SAP Note [1275776](#)
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note [1275776](#).
3. Create the file "/etc/systemd/logind.conf.d/sap.conf" with the following content:
   [Login]
   UserTasksMax=infinity

To enable this change, a system reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape. In case you already have a running HANA instance, rebooting the server should only be done when a standby server is configured. Do not reboot all servers at once. For single node instances a downtime has to be considered.

Turn off autoNUMA balancing

SAP HANA is a NUMA (non-uniform memory access) aware database. Thus it does not rely on the Linux kernel's features to optimize NUMA usage automatically. Depending on the workload, it can be beneficial to turn off automatical NUMA balancing (autoNUMA). In order to permanently switch off autoNUMA either

1. Configure saptune according to SAP Note [1275776](#)
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note [1275776](#).
3. Edit /etc/default/grub
   search for the line starting with "GRUB_CMDLINE_LINUX_DEFAULT" and append to this line
   numa_balancing=disable
   Save your changes and run
   # grub2-mkconfig -o /boot/grub2/grub.cfg
   After a reboot, autoNUMA will be disabled.
4. Use YaST2 bootloader, execute
   # yast bootloader
   choose "Kernel Parameters" tab (ALT-k) and edit the "Optional Commandline Parameters" section by appending
   numa_balancing=disable

To enable this change, a system reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape. In case you already have a running HANA instance, rebooting the server should only be done when a standby server is configured. Do not reboot all servers at once. For single node instances a downtime has to be considered.

Disable transparent hugepages

With SLES 12, the usage of transparent hugepages (THP) is generally activated for the Linux kernel. The THP allows the handling of multiple pages as hugepages to reduce the translation lookaside buffer (TLB) footprint, in situations where it might be useful. Due to the special manner of HANA's memory management, the usage of THP may lead to hanging situations and degradations.

To check the current configuration run the following command:

cat /sys/kernel/mm/transparent_hugepage/enabled

Its output should read:

always madvise [never]

If this is not the case you can disable the THP usage at runtime by issuing the following:

echo never > /sys/kernel/mm/transparent_hugepage/enabled

There is no need to shut down the database to apply this configuration. This setting is then valid until the next system start. To persist the disabling of THP usage you have the following options:

1. Configure saptune according to SAP Note 1275776
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note 1275776.
3. Edit /etc/default/grub
   search for the line starting with "GRUB_CMDLINE_LINUX_DEFAULT" and append to this line
   transparent_hugepage=never
   Save your changes and run
   # grub2-mkconfig -o /boot/grub2/grub.cfg
   After a reboot, the usage of THP will be disabled.
4. Use YaST2 bootloader, execute
   # yast bootloader
   choose "Kernel Parameters" tab (ALT-k) and edit the "Optional Commandline Parameters" section by appending
   transparent_hugepage=never

To enable this change, a system reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape. In case you already have a running HANA instance, rebooting the server should only be done when a standby server is configured. Do not reboot all servers at once. For single node instances a downtime has to be considered.

Configure C-States for lower latency in Linux (applies to Intel-based systems only)

Modern CPUs implement idle states to save energy or to allow neighbor CPUs to run with higher clock frequency when there's no work to do. On the one hand, the additional time needed to stop and restart the execution of the code can cause performance degradations. On the other hand, prohibiting CPUs to enter idle states can limit the operating frequency of their neighbor CPUs. Idle states can be impacted by BIOS settings.

A recommended balance can be achieved by limiting the wake-up latency from CPU power-saving states (C-states) to 70 microseconds (usecs), which restricts idle states to "light sleep", by choosing one of the following options:

1. Configure saptune according to SAP Note 1275776
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'

saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note 1275776.

If you are neither using sapconf nor saptune, you can limit C-states to "very light sleep" by setting the following kernel parameters:

intel_idle.max_cstate=1 processor.max_cstate=1

To set this parameter permanently, use one of the following options:

1. Edit /etc/default/grub
   search for the line starting with "GRUB_CMDLINE_LINUX_DEFAULT" and append to this line
   intel_idle.max_cstate=1 processor.max_cstate=1
   Save your changes and run
   # grub2-mkconfig -o /boot/grub2/grub.cfg
   After a reboot the usage of C-states C2 and higher will be disabled.

2. use YaST2 bootloader, execute
   # yast bootloader
   choose "Kernel Parameters" tab (ALT-k) and edit the "Optional Commandline Parameters" section by appending
   intel_idle.max_cstate=1 processor.max_cstate=1

To enable this change, a system reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape. In case you already have a running HANA instance, rebooting the server should only be done when a standby server is configured. Do not reboot all servers at once. For single node instances a downtime has to be considered.

CPU Frequency/Voltage scaling (applies to Intel-based systems only)

The clock frequency and voltage of modern CPUs can scale, in order to save energy when there's less work to be done. However HANA as a high-performance database benefits from high CPU frequencies.

We suggest to set the CPUs to high-performance mode. This can be achieved by setting the cpufreq governor to "performance" using one of the following options:

1. Configure saptune according to SAP Note 1275776
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note 1275776.
   Please set "GOVERNOR=performance" in the sapconf configuration /etc/sysconfig/sapconf.
3. Add the following command to a script executed on system boot, such as /etc/init.d/boot.local:
   # cpupower frequency-set -g performance

Verify the settings with:

   # cpupower frequency-info

Energy Performance Bias (EPB, applies to Intel-based systems only)

Linux obeys the EPB bit in the CPU flags since kernel 3.x. Consequently, it configures the CPUs according to

the global "energy performance bias" setting in the BIOS.

We suggest to set the EPB using one of the following options:

1. Configure saptune according to SAP Note 1275776
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note 1275776.
   Please set "PERF_BIAS=performance" in the sapconf configuration /etc/sysconfig/sapconf.
3. Set Energy Performance Bias or EPB in the BIOS to "Maximum performance"
4. Add the following command to a script executed on system boot, such as /etc/init.d/boot.local:
   # cpupower set -b 0

Kernel samepage merging (KSM)

The KSM feature helps reduce physical memory overhead by detecting memory pages with identical content. The feature is useful for VMs, but the space-time tradeoff does not pay off for HDB instances not running in VMs. Kernel samepage merging is usually deactivated by default.

If you nevertheless activated KSM, we recommend to disable it again using one of the following methods:

1. Configure saptune according to SAP Note 1275776
   with saptune solution 'HANA'
   # saptune solution apply HANA
   or specifically with saptune note '2205917'
   # saptune note apply 2205917
2. Install sapconf with sap-hana profile according to SAP Note 1275776.
3. Add the following command to a script executed on system boot, such as /etc/init.d/boot.local:
   # echo 0 > /sys/kernel/mm/ksm/run

IBM EnergyScale for POWER9 Processor-Based Systems (applies to IBM Power systems only)

EnergyScale provides functions that help the user to understand and control IBM server power and cooling usage. SAP HANA performance benefits from high frequency. However, clients may choose any mode except for "Static Power Saver Mode" for their productive instances. If the experienced performance is capped by the CPU, the first step is to ensure the "Maximum Performance Mode" is selected. The package pseries-energy must not be installed. Changing the power management mode can be accomplished via the ASMI interface or on the HMC only. Kindly refer to IBM's EnergyScale documentation for this feature at https://www.ibm.com/downloads/cas/6GZMODN3.

IBM EnergyScale for POWER8 Processor-Based Systems (applies to IBM Power systems only)

The On Chip Controller (OCC) controls core frequency. Any tunings for turbo frequency should be done using the Flexible Service Processor Advanced System Management (FSP ASM) page or the IBM Hardware Management Console (HMC) and not from within a PowerVM guest partition. The package pseries-energy must not be installed. Kindly refer to IBM's EnergyScale documentation for this feature at http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=POW03125USEN.

Linux Pagecache Limit

For SAP HANA systems, we recommend to use the default setting of an unlimited Linux Page Cache by

setting the parameter vm.pagecache_limit_mb to "0", as configuring the OS Pagecache Limit with small values has shown to cause hang conditions in high load situations. In cases where other tools in your environment (for example some 3rd party backup utilities) access the filesystems directly and create memory paging problems, you may carefully follow the instructions in SAP Note 1557506.

Network settings

Recommendations for network configuration are given in SAP Note 2382421.

Intel Cluster-On-Die (COD) / sub-NUMA clustering technology

HANA is not supported neither on Intel Cluster-On-Die (COD) technology nor on sub-NUMA clustering technology.

Please note: All mentioned changes require root access on operating system level. Future implementations might lead to changes of these recommendations.

Software Components

Software Component	Release
HDB	1.00 - 1.00
HDB	2.00 - 2.00

Other Components

Component	Description
BC-OP-LNX-SUSE	SUSE Linux

This document refers to

SAP Note/KBA	Title
2814271	SAP HANA Backup fails on Azure with Checksum Error
2382421	Optimizing the Network Configuration on HANA- and OS-Level
2235581	SAP HANA: Supported Operating Systems
1984787	SUSE LINUX Enterprise Server 12: Installation notes

1943937	Hardware Configuration Check Tool - Central Note
1557506	Linux paging improvements
1523337	SAP HANA Database 1.00 - Central Note
1514967	SAP HANA: Central Note

This document is referenced by

SAP Note/KBA	Title
2981495	HANA is failing to start and system got hung post OS patching
2794425	Crash dump with signal 4 when updating HANA Database
2790462	HANA Server connection is not available or timed out after upgrade to SUSE 15 from SUSE 12
2748378	Failed to update HANA 2.0 due to "CPU is not supported. Instruction set 'sse4.2' is missing" error
2712166	Installation of SAP HANA Database 2.00.033.00 with Linux SLES 12.3 fails with SIGNAL 4 (SIGILL)
2647673	HANA Installation Failure with signal 11 core dumped
2000000	FAQ: SAP HANA Performance Optimization
2100040	FAQ: SAP HANA CPU
2470289	FAQ: SAP HANA Non-Uniform Memory Access (NUMA)
2100566	Frequently Asked Questions for Lenovo/IBM SAP HANA support script
2931291	SAP HANA 2 SPS03 Revision 037.07
2887843	SAP HANA 2 SPS03 Revision 037.06
2871788	SAP HANA 2 SPS03 Revision 037.05
2876629	SAP HANA 2 SPS04 Revision 046.00
2859502	SAP HANA 2 SPS04 Revision 045.00
2848885	SAP HANA 2 SPS04 Revision 044.00
2806646	SAP HANA 2 SPS03 Revision 037.02
2801533	SAP HANA 2.0 SPS 02 Database Maintenance Revision 024.10
2780510	SAP HANA 2 SPS03 Revision 037.01
2779784	SAP HANA 2 SPS04 Revision 041.00
2757584	SAP HANA 2 SPS04 Revision 040.00

2739616	SAP HANA 2 SPS02 Revision 024.09
2728470	SAP HANA 2 SPS02 Revision 024.08
2706557	SAP HANA 2 SPS02 Revision 024.07
2595211	SAP HANA 2 SPS01 Revision 012.05
2690036	SAP HANA 2 SPS03 Revision 034.00
2686085	SAP HANA 2 SPS02 Revision 024.06
2675471	SAP HANA 2 SPS03 Revision 033.00
2660349	SAP HANA 2 SPS02 Revision 024.05
2649438	SAP HANA 2 SPS02 Revision 024.04
2645129	SAP HANA 2 SPS03 Revision 032.00
2639970	SAP HANA 2 SPS02 Revision 024.03
2633969	SAP HANA 2 SPS02 Revision 024.02
2628197	SAP HANA 2 SPS03 Revision 031.00
2621291	SAP HANA 2 SPS02 Revision 024.01
2625648	Indexserver crashes with "rc=22: Invalid argument" due to bug in glibc
2588272	SAP HANA Support for aggregated virtualized environments
2588112	SAP HANA 2 SPS02 Revision 024.00
2579033	Indexserver Crashes With Execution::JobExecutorImpl::insertJobsIntoNumaNode DoWork
2578795	SAP HANA 2 SPS03 Revision 030.00
2567797	SAP HANA 2 SPS02 Revision 023.00
2557386	SAP HANA 2 SPS01 Revision 012.03
2547324	SAP HANA 2 SPS02 Revision 022.00
2544464	SAP HANA 2 SPS01 Revision 012.04
2536620	SAP HANA 2 SPS01 Revision 012.02
2514020	SAP HANA 2 SPS01 Revision 012.01
2513384	SUSE Linux Enterprise Server for SAP Applications on Azure
2460914	SAP HANA Platform 2.0 SPS 02 Release Note
1857315	HANA server disappears/crashes without a crashdump
2491865	SAP HANA 2 SPS02 Revision 020.00

2478892	SAP HANA 2 SPS00 Revision 002.02
2477906	SAP HANA 2 SPS01 Revision 012.00
2471313	SAP HANA 2 SPS00 Revision 002.01
2456795	SAP HANA 2 SPS01 Revision 011.00
2404375	SAP HANA Platform 2.0 SPS 01 Release Note
2235581	SAP HANA: Supported Operating Systems
2429940	SAP HANA 2 SPS00 Revision 002.00
2422689	SAP HANA 2 SPS01 Revision 010.00
2405803	SAP HANA 2 SPS00 Revision 001.00
2380257	SAP HANA Platform 2.0 SPS 00 Release Note
2363299	SAP HANA 2 SPS00 Revision 000.00
2246163	Indexserver crashes in the onLoad method
2369910	SAP Software on Linux: General information
2309342	SUSE Linux Enterprise High Availability Extension on AWS for SAP HANA
1944799	SAP HANA Guidelines for SLES Operating System Installation

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