2292690 - SAP HANA DB: Recommended OS settings for RHEL 7

Version 37 SAP Note **Type Master Language English** Language **English** Recommendations / Additional Info **Priority** Consulting Category **Release Status** Released for Customer Released On 27.07.2020

Component HAN-DB (SAP HANA Database)

Please find the original document at https://launchpad.support.sap.com/#/notes/2292690

Symptom

You want to configure optimal settings for running HANA or HANA2 on RHEL for SAP HANA 7.

Other Terms

HANA, DB, BW on HANA, Suite on HANA, S/4HANA, BW/4HANA, RHEL for SAP HANA 7, RedHat, Linux, speed, performance

Reason and Prerequisites

You are planning to run SAP HANA on Red Hat Enterprise Linux 7 and want to configure optimal Linux settings. For better readability of this SAP Note - if not mentioned explicitly otherwise - "RHEL" is used as a synonym for "Red Hat Enterprise Linux for SAP HANA" (RHEL for SAP HANA) or "Red Hat Enterprise Linux for SAP Solutions" (RHEL for SAP Solutions). In this Note, the term "SAP HANA" refers to SAP HANA 1 or SAP HANA 2, unless explicitly stated. Depending on which version of SAP HANA that is used RHEL 7 must be installed and configured according to the appropriate configuration guide attached to SAP note 2009879. If not mentioned otherwise, the listed recommendations are valid for all minor versions of RHEL 7 supported by SAP HANA. The RHEL 7 minor releases supported by SAP HANA are listed in SAP note 2235581.

Solution

To optimize the use of SAP HANA with RHEL 7, apply the following settings. In virtual and cloud environments, architectural limitations can exist, so that some recommendations cannot apply 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 RHEL 7

You can use all official RHEL 7 Linux Kernels and packages shipped by Red Hat for the RHEL 7 minor releases supported by SAP HANA, including security and bug fixes provided via "Extended Update Support" for the supported RHEL 7 minor releases. Using updated Linux Kernels and packages from RHEL 7 minor releases not listed in SAP Note 2235581 is not supported and will break the certification. Alternate kernels on IBM Power systems are not supported neither.

To ensure that systems do not get accidentaly updated, all RHEL 7 servers running SAP HANA must be subscribed to the "Extended Update Support" channels for "RHEL 7.x for SAP HANA" (where x stands for the respective minor version of RHEL 7) or the "E4S" channels when using "Red Hat Enterprise Linux for SAP Solutions" (RHEL for SAP Solutions)

Please refer to the following Red Hat knowledge base articles for instructions on how to configure your

system accordingly:

Red Hat Enterprise Linux for SAP HANA: system updates and supportability (Red Hat customer portal login required)

How to subscribe RHEL 7 SAP HANA system to Extended Update Support (EUS) channel? (Red Hat customer portal login required)

How to subscribe SAP HANA systems to the Update Services for SAP Solutions (Red Hat customer portal login required)

• Minor Release-specific requirements

The following lists RHEL 7 minor release-specific package requirements where needed:

- RHEL 7.2 specific package requirements
 - kernel-3.10.0-327.62.4.el7 or newer
- RHEL 7.3 specific package requirements
 - kernel-3.10.0-514.36.5.el7 or newer
 - glibc-2.17-157.el7_3.5 or newer
 - tuned-profiles-sap-hana-2.7.1-3.el7_3.3 or newer
- RHEL 7.4 specific package requirements
 - kernel-3.10.0-693.11.6 or newer
 - tuned-profiles-sap-hana-2.8.0-5.el7 4.2 or newer
- RHEL 7.6 specific package requirements
 - kernel-3.10.0-957.1.3 or newer
- RHEL 7.7 specific package requirements
 - kernel-3.10.0-1062.21.1.el7.x86_64 resp. kernel-3.10.0-1062.26.1.el7.ppc64le or newer

· Additional 3rd-party kernel modules

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

784391 - SAP support terms and 3rd-party Linux kernel drivers

Configure tuned to use profile "sap-hana"

The tuned profile "sap-hana", which is provided by Red Hat as part of RHEL 7 for SAP HANA, contains many of the settings mentioned below and configures some additional settings. Therefore the "sap-hana" tuned profile must be activated on all systems running SAP HANA:

yum install tuned-profiles-sap-hana

systemctl start tuned

systemctl enable tuned

tuned-adm profile sap-hana

On RHEL 7.4 when using versions of the tuned-profiles-sap-hana package older than 2.8.0-5.el7_4.2 or on RHEL 7.3 when using versions of the tuned-profiles-sap-hana package older than 2.7.1-3.el7_3.3, the "sap-hana" tuned profile must be modified as follows before it can be used. Copy "/usr/lib/tuned/sap-hana/tuned.conf" to "/etc/tuned/sap-hana/tuned.conf" (the /etc/tuned/sap-hana directory must be created if it doesn't exist) and then change the "/etc/tuned/sap-hana/tuned.conf" file as shown here:

[cpu]

..

force_latency=70

Turn off auto-numa 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. For this purpose, add "kernel.numa_balancing = 0" to /etc/sysctl.d/sap_hana.conf (please create this file if it does not already exist) and reconfigure the kernel by running

sysctl -p /etc/sysctl.d/sap_hana.conf

Additionally the "numad" daemon must be disabled:

systemctl stop numad # systemctl disable numad

• Disable transparent hugepages

With RHEL 7, the usage of transparent hugepages (THP) is generally activated in the Linux kernel. THP allow the handling of multiple pages as hugepages reducing the translation lookaside buffer footprint (TLB), 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 performance degradations. If you use the "sap-hana" tuned profile as described above "Transparent HugePages (THP)" will be disabled via the profile and you don't need to additionally change this setting manually. To disable the usage of transparent hugepages during runtime, set the kernel settings at runtime with the command # 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 this option, it is nessesary to edit the OS bootloader configuration. The location of the bootloader configuration file is in the file /etc/default/grub.

First, modify the file /etc/default/grub and append the following parameter to the line starting with "GRUB_CMDLINE_LINUX":

transparent_hugepage=never

Then, in case of a non-UEFI configuration, activate the new configuration by issuing the command # grub2-mkconfig -o /boot/grub2/grub.cfg

Or, in case of an UEFI configuration use

grub2-mkconfig -o /boot/efi/EFI/redhat/grub.cfg

Afterwards a reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape.

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

The Linux kernel shipped with RHEL 7 includes a cpuidle driver for recent Intel CPUs: intel_idle. This driver leads to a different behaviour in C-states switching. The normal opererating state is C0, when the processor is put to a higher C state, which saves power. But for low latency applications, the additional time needed to stop and start the execution of the code will cause performance degradations. If you are using tuned with the sap-hana profile, the CPU idle states are managed by tuned. If you are not using tuned with the sap-hana profile, we recommend to limit the C-states to C0 and C1 by setting the following parameter:

processor.max_cstate=1

Additionally you should also configure the "intel_idle" kernel module to allow C-State C1: intel_idle.max_cstate=1

You can set this parameter in the kernel commandline by modifying /etc/default/grub. Append the following parameter to the line starting with "GRUB_CMDLINE_LINUX":

processor.max_cstate=1 intel_idle.max_cstate=1

To enable these changes, the GRUB2 configuration needs to be rebuilt:

On non-UEFI systems run

grub2-mkconfig -o /boot/grub2/grub.cfg

On UEFI systems run

grub2-mkconfig -o /boot/efi/EFI/redhat/grub.cfg

Afterwards a reboot is required. In a scale-out environment, those changes have to be done on every server of the landscape.

For more information on setting C-States see https://access.redhat.com/site/solutions/202743 (Red Hat customer portal login required).

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

Linux is using a technology for power saving called CPU governors to control CPU frequency and power consumption. By default Linux uses the governor "ondemand", which will dynamically scale frequency and voltage up and down depending on CPU load. If you want to maximize CPU performance at the cost of increased energy consumption, SAP recommends to use the governor "performance".

If you use the "sap-hana" tuned profile as described above, the "performance" governor is configured via the profile and you don't need to additionally change this setting manually.

If not using "sap-hana" tuned profile, insert the following code in a system startup script such as /etc/rc.d/boot.local:

cpupower frequency-set -g performance

The setting will be applied during system boot. To take effect immediately, the cpupower command can be run on ther commandline.

To check the current settings you can use the following command:

cpupower frequency-info

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

The Linux 3.x kernel obeys the EPB bit in the CPU flags. Consequently, it configures the CPUs according to the global "energy performance bias" setting in the BIOS.

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

- 1. Set Energy Performance Bias or EPB in the BIOS to "Maximum performance"
- 2. Activate the 'sap-hana' tuned profile as described above which will set EPB to 'performance
- 3. Add the following command to a script executed on system boot, such as /etc/init.d/boot.local: # cpupower set -b 0

(see 'cpupower help set' for more information)

To verify that EPB has been set correctly you can run the following command:

cpupower info

If the command reports 'perf-bias: 0' EPB has been set to the correct value.

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.

As documented in chaper <u>'8.3 Kernel Same-page Merging (KSM)' in the 'RHEL 7 Virtualization Tuning and Optimization Guide</u> KSM is normally only activated on RHEL 7 if the system is configured as a virtualization hypervisor.

If KSM is enabled we recommend to disable it by adding the following command to a script executed

on system boot, such as /etc/init.d/boot.local:

echo 0 > /sys/kernel/mm/ksm/run

Execute the command to turn off KSM immediately.

The following command can be used to verify that KSM is disabled:

cat /sys/kernel/mm/ksm/run

If the command returns '0' it means KSM is deactivated.

SELinux

RHEL 7 is delivered with SELinux enabled by default.

Since there is no SELinux policy available for SAP HANA, leaving SELinux enabled can lead to problems when running SAP HANA on RHEL.

To disable SELinux change the line:

SELINUX=enforcing

to

SELINUX=disabled

in /etc/sysconfig/selinux and reboot the system.

The command 'getenforce' can be used to check the current SELinux status. If it returns 'Disabled' then SELinux is completely disabled.

• Update systemd to avoid HANA crashes due to unintended deletion of IPC segments (semaphores, shared memory, message queues)

Due to incorrect default settings in the systemd package shipped with RHEL7, HANA can crash after installation when the <SID>adm user logs out or cron-jobs or other tasks running for the <SID>adm user end. To avoid this issue, please ensure that the systemd package gets updated to at least version systemd-219-19.el7_2.4. Please reboot the system after updating the packge for the changes in it to take effect. See https://access.redhat.com/solutions/2062273 for more information. (Red Hat customer portal login required).

 Database startup fails with an error message "/etc/sudoers mismatch for required permissions of Storage Connector" when using hdb_ha.fcClientLVM

Comment out the following line in /etc/sudoers (using visudo command):

Defaults requiretty

It should be changed to the following:

#Defaults requiretty

 Message "ERROR: Id.so: object '/opt/rh/SAP/lib64/compat-sap-c++.so' from LD_PRELOAD cannot be preloaded: ignored." when running commands as <SID>adm user on commandline

This message can occur with SAP HANA1 only. For SAP HANA2, the note <u>2338763</u> applies. The environment configuration of the <SID>adm user contains a reference to the compat-sap-c++ library which is not required on RHEL7. This error message is harmless. To get rid of it, you can do the following:

• If (T)CSH is used as the default shell remove the following line in the file 'hdbenv.csh' in the home directory of the <SID>adm user:

setenv LD_PRELOAD /opt/rh/SAP/lib64/compat-sap-c++.so

• If BASH is used as the default shell remove the following lines in the file 'hdbenv.sh' in the home directory of the <SID>adm user:

LD_PRELOAD=/opt/rh/SAP/lib64/compat-sap-c++.so

export LD_PRELOAD

 Message "Cannot access required library '/opt/rh/SAP/lib64/compat-sap-c++-5.so': No such file or directory" when installing SAP HANA 2

As documented in SAP note <u>2338763</u> HANA 2 requires the compat-sap-c++-5 package. Please follow the instructions in the note to get this package installed.

• 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.

Network settings

Please follow the recommendations for network configuration 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: Unless noted otherwise all changes mentioned above require root access on operating system level. It is recommended to reboot the system after the changes have been appiled. 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-RH	Red Hat Linux

This document refers to

SAP Note/KBA	Title
2526952	Red Hat Enterprise Linux for SAP Solutions
2235581	SAP HANA: Supported Operating Systems
2228351	Linux: SAP HANA Database SPS 11 revision 110 (or higher) on RHEL 6 or SLES 11
2009879	SAP HANA Guidelines for Red Hat Enterprise Linux (RHEL) Operating System
2002167	Red Hat Enterprise Linux 7.x: Installation and Upgrade
1943937	Hardware Configuration Check Tool - Central Note
1888072	SAP HANA DB: Indexserver crash instrcmp_sse42
1523337	SAP HANA Database 1.00 - Central Note
1514967	SAP HANA: Central Note

This document is referenced by

SAP Note/KBA	Title
2100040	FAQ: SAP HANA CPU
2748378	Failed to update HANA 2.0 due to "CPU is not supported. Instruction set 'sse4.2' is missing" error
2675961	Unable to add host with storage_partition option as a normal user in HANA
2757584	SAP HANA 2 SPS04 Revision 040.00
2690036	SAP HANA 2 SPS03 Revision 034.00
2931291	SAP HANA 2 SPS03 Revision 037.07
2876629	SAP HANA 2 SPS04 Revision 046.00
2887843	SAP HANA 2 SPS03 Revision 037.06
2859502	SAP HANA 2 SPS04 Revision 045.00
2235581	SAP HANA: Supported Operating Systems
2578795	SAP HANA 2 SPS03 Revision 030.00
2621291	SAP HANA 2 SPS02 Revision 024.01

2491865 SAP HANA 2 SPS02 Revision 020.00 2422689 SAP HANA 2 SPS01 Revision 010.00 2471313 SAP HANA 2 SPS00 Revision 002.01 2369910 SAP Software on Linux: General information 2871788 SAP HANA 2 SPS03 Revision 037.05 2806646 SAP HANA 2 SPS03 Revision 037.02 2801533 SAP HANA 2 SPS02 Database Maintenance Revision 024.10 2839970 SAP HANA 2 SPS02 Revision 012.00 2477906 SAP HANA 2 SPS01 Revision 012.00 2514020 SAP HANA 2 SPS01 Revision 012.01 2536620 SAP HANA 2 SPS01 Revision 012.02 2557386 SAP HANA 2 SPS01 Revision 012.03 2363299 SAP HANA 2 SPS00 Revision 002.00 2544464 SAP HANA 2 SPS00 Revision 002.04 2405803 SAP HANA 2 SPS00 Revision 002.00 2429940 SAP HANA 2 SPS01 Revision 002.00 2478892 SAP HANA 2 SPS02 Revision 002.00 2478892 SAP HANA 2 SPS02 Revision 002.00 2456795 SAP HANA 2 SPS02 Revision 002.00 2466795 SAP HANA 2 SPS02 Revision 024.00 2588112 SAP HANA 2 SPS02 Revision 024.00 2693498		
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SAP HANA 2 SPS03 Revision 033.00
SAP HANA 2 SPS03 Revision 037.01
SAP HANA 2 SPS04 Revision 041.00
Indexserver crashes with "rc=22: Invalid argument" due to bug in glibc
SAP HANA 2 SPS04 Revision 044.00
SAP HANA Platform 2.0 SPS 02 Release Note
SAP HANA Platform 2.0 SPS 01 Release Note
SAP HANA Platform 2.0 SPS 00 Release Note
Red Hat Enterprise Linux High Availability Add-On on AWS for SAP NetWeaver and SAP HANA
Red Hat Enterprise Linux HA Add-On on Azure
Transparent Huge Pages (THP) on SAP HANA Servers

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