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Operating System Security Hardening Guide for SAP HANA for SUSE Linux Enterprise Server 15 GA and SP1

SUSE Linux Enterprise Server for SAP Applications 15 GA and SP1

Soeren Schmidt, SAP Solution Architect (SUSE)
Markus Guertler, Senior Manager SAP Technology Team (SUSE)
Alexander Bergmann, Security Engineer (SUSE)

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This document guides through various hardening methods for SUSE® Linux Enterprise Server for SAP Applications to run SAP HANA.

Contents

1 Introduction

IT security is an essential topic for any organization. Newspapers report frequently about new IT security incidents such as hacked websites, successful Denial-of-Service attacks, or stolen user data like passwords, bank account numbers and other sensitive data.

In addition to the publicly reported attacks, there are also a large number of incidents that are not reported to the public. In particular, these cases are often related to espionage, where the affected party has no interest to report an incident. Security experts agree that, for protecting sensitive data, an organization must have a comprehensive security concept in place, taking all eventualities into account that can potentially lead into security risks. This starts with proper setup policies, like password and data protection policies for users and system administrators. It continues with a protected IT environment using for example firewalls, VPNs, and SSL in communication protocols. And it ends with hardened servers, intrusion detection systems, data encrypting and automated security reporting. Additionally, many organizations perform security audits on a regular basis to ensure a maximum of security in their IT environment.

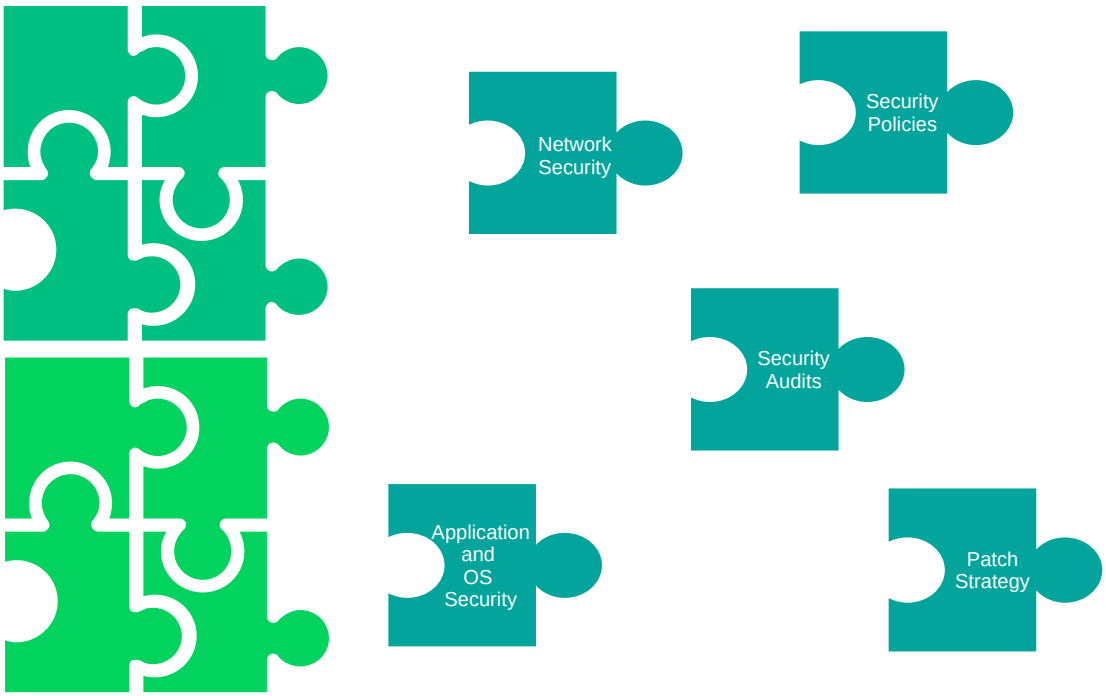

FIGURE 1: ELEMENTS OF A CORPORATE IT SECURITY

Comprehensive security concepts usually pay high attention to database systems, since databases belong to the most critical components in any IT environment. Database systems that potentially store sensitive data are by nature very popular targets for hackers and must therefore be protected. SAP HANA systems typically store business related information and are considered as being business critical. This is especially the case for ERP systems using SAP HANA. In addition, many other SAP applications using SAP HANA, like BW systems, may store sensitive data.

1.1 Security for SAP HANA

SAP takes the security topic very seriously. For SAP HANA, there is a comprehensive SAP HANA Security Guide (https://help.sap.com/doc/eec734dbb0fd1014a61590fcb5411390/2.0.05/en-US/SAP_HANA_Security_Guide_en.pdf) available. This guide describes in detail how to protect HANA from a database perspective. The guide also refers to security concepts for other connecting layers that are separate from the SAP HANA system, for example the network and storage layer. However, these topics are described only generically. There is no specific guidance on how to apply these recommendations on the operating system level.

1.2 Security for SUSE Linux Enterprise Server

The security of the underlying operating system is at least as important as the security of the SAP HANA database. Many hacker attacks target the operating system to gain access and sufficient privileges to attack the running database application. SUSE Linux Enterprise Server is the recommended and supported operating system for SAP HANA. SUSE has a long-running history in IT security for Linux operating systems. The company offers a comprehensive security package for SUSE Linux Enterprise Server to protect systems from all kind of security incidents. This package consists of the following components:

Security certifications

SUSE Linux Enterprise Server 12 has been awarded many important security certifications, such as the FIPS (Federal Information Processing Standard) 140-2 validation, or the Common Criteria EAL4+ certificate. Currently we are in the process of achieving the same for SUSE Linux Enterprise Server 15. For details visit https://www.suse.com/support/security/certifications/.

Security updates and patches

SUSE constantly provides security updates and patches for their SUSE Linux Enterprise operating systems and guarantees highest security standards during the entire product life cycle.

Documentation

SUSE has published a Hardening Guide and a Security Guide that describe the security concepts and features of SUSE Linux Enterprise Server 15. These guides provide generic security and hardening information valid for all workloads, not just for SAP HANA. For more details visit:

- https://documentation.suse.com/sles/15-SP2/html/SLES-all/book-hardening.html
- https://documentation.suse.com/sles/15-SP2/html/SLES-all/book-security.html

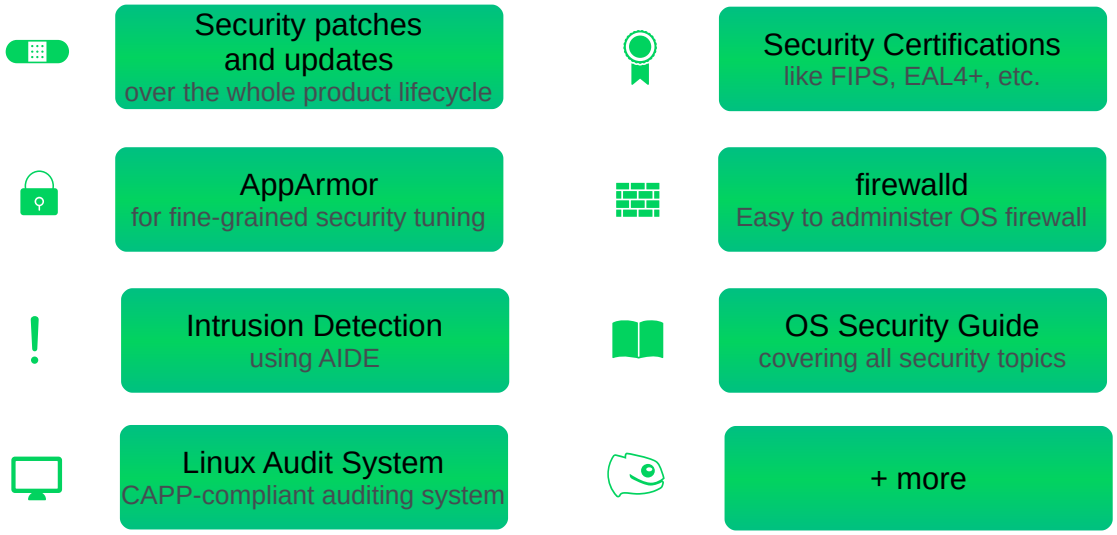

FIGURE 2: SECURITY COMPONENTS OF SUSE LINUX ENTERPRISE SERVER

1.3 About this document

To further improve the security level specifically for SAP HANA, SUSE provides the document at hand. It focuses on the security hardening of SUSE Linux Enterprise Server 15 running SAP HANA databases to fill the gap between the Security Guide for SUSE Linux Enterprise Server, the Hardening Guide for SUSE Linux Enterprise Server, and the SAP HANA Security Guide. The Hardening Guide for SUSE Linux Enterprise Server contains some of the recommendations found here, but also additional recommendations. Most of the recommendations can be applied to an SAP HANA installation after careful review and testing. SUSE collaborated with a large pilot customer to identify all relevant security settings and to avoid problems in real world scenarios. Also, SUSE and SAP are constantly cooperating in the SAP Linux Lab to provide the best compatibility with SAP HANA.

FIGURE 3: THE FIVE MAIN TOPICS OF THE OS SECURITY HARDENING FOR HANA

The guide at hand provides detailed descriptions on the following topics:

Security hardening settings for SAP HANA systems

The Linux operating system provides many tweaks and settings to further improve the operating system security and the security for the hosted applications. To be able to fit for certain application workloads, the default settings are not tuned for maximum security. This guide describes how to tune the operating system for maximum security when running SAP HANA specifically. In addition, it describes possible impacts, for example on system administration, and gives a prioritization of each setting.

Local firewall for SAP HANA

SUSE has developed a dedicated local firewall for SAP HANA systems to improve the network security of SAP HANA. This is done by only selectively opening network ports on external network interfaces that are really needed either by SAP HANA or other services. All remaining network ports are closed. The firewall has a broad range of features and is easy to configure. It is available as RPM package and can be downloaded from SUSE.

Remote Disk Encryption

Starting with SUSE Linux Enterprise Server for SAP Applications 12 SP2, SUSE introduced a new feature called **Remote Disk Encryption**. Classical Disk Encryption - available for years – always required a passphrase being entered during boot. That prevented its use in many setups because each boot needed a manual step. Remote Disk Encryption removes this manual step as it allows the encryption keys to be stored safely on a remote key server and to be automatically used during system boot.

Minimal package selection

The fewer operating system packages an SAP HANA system has installed, the less possible security holes it should have. Following that principle, this guide describes which packages are absolutely necessary and which packages can be safely discarded. As a positive side effect, a minimized number of packages also reduces the number of updates and patches that have to be applied to a system.

Security updates & patches

Open source software is frequently reviewed and tested for security vulnerabilities by open source developers, security engineers from the open source community, security companies and, of course, by the hackers. When a vulnerability has been found and reported, it is published in security advisories and usually gets fixed very quickly. SUSE constantly provides security updates and patches for all supported packages on SUSE Linux Enterprise

Server. This chapter explains which update and patch strategies are the best. It also details how to configure SUSE Linux Enterprise Server to frequently receive all relevant security updates.

In short, this guide covers all important topics in detail that are relevant for the operating system hardening of an SAP HANA system. Combining them with the other security features of SUSE Linux Enterprise Server 15, like the security certifications and the constantly provided security updates and patches, SAP HANA can run in a highly secure environment. This ensures that the implementation meets the security standards and corporate security concepts required by organizations of all sizes.

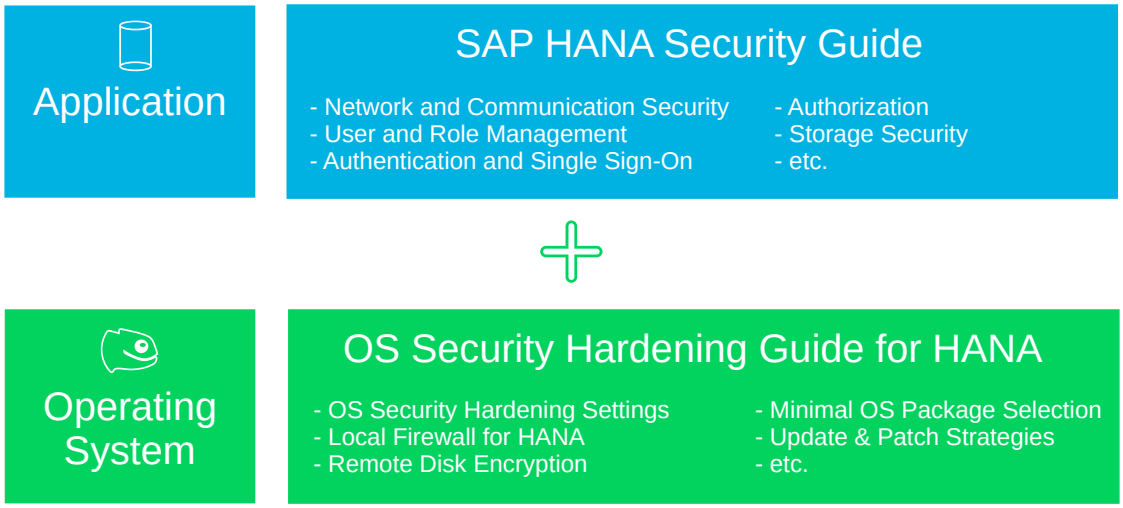

FIGURE 4: SAP HANA AND OPERATING SYSTEM SECURITY

2 SUSE Linux Enterprise security hardening settings for HANA

2.1 Introduction to Linux security hardening

SUSE Linux Enterprise Server already provides a high level of security with the standard installation. However, the standard security settings are generic, because they have to fit to all possible Linux server workloads. Also, many security settings have impacts on the comfort of

the system administration and possibly on the users of the system. Therefore, the SUSE Linux Enterprise Server standard security settings provide a good tradeoff between compatibility with all workloads, administrative comfort and a secure operating system environment.

SAP HANA is a very special workload with clearly defined requirements. For such a workload it is possible to have a more restrictive security configuration compared to the standard configuration. The goal of this guide is to strengthen the security configuration without affecting the compatibility with SAP HANA.

While security hardening results in higher security, it usually comes with the drawback of less administrative comfort and system functionality. This is a fact that every system administrator should be aware of. However, a system configured more restrictively can also provide a better level of protection and a lower risk of successful attacks. In many cases, company security policies, guidelines, or security audits force very high security standards which automatically result in systems configured more restrictively. The Linux operating system has many tweaks and settings that can improve the overall security of the operating system and its applications. These settings can be summarized in the following categories:

Authentication settings

Define for example who is allowed to login, the exact password policy, etc.

System access settings

Define which users are allowed to access the system locally and remotely using different login mechanisms (for example local logins via console TTY or remote logins via SSH)

Network settings

Define how certain layers of the network stack behave, for example the IP layer, or the TCP/UDP layer

Service permissions

Define the permissions of certain system service, for example disabling 'at' jobs

File permissions

Define the file access rights of certain security-critical system files

Logging & reporting

Change the behavior of the system logging, syslog forwarding to a central syslog server, automatic creation of reports (such as security reports) and forwarding of security-relevant information via email

2.2 Hardening settings for SAP HANA systems

Important

The measures in this chapter are described for the x86 architecture (AMD64/Intel 64), but apply for the POWER architecture as well. Because of the differences in the hardware, it might be necessary to adapt them accordingly (different device names, etc.)
Also, the graphical user interface is not covered. Running a GUI on a secure server should be avoided.

The following hardening settings improve the security of SUSE Linux Enterprise Server systems running an SAP HANA database. These settings are based on the recommendations of a security audit, which was performed on a SUSE Linux Enterprise Server standard installation, running an SAP HANA database.

Note

Read the SUSE Linux Enterprise Server Security Guide and the SUSE Linux Enterprise Server Hardening Guide for additional measures (see https://documentation.suse.com/) (Choose "SUSE Linux Enterprise Server" instead of "SUSE Linux Enterprise Server for SAP Applications".

For each setting, the following details are provided:

- Description: Details of the setting
- Procedure: How to apply the setting
- Impact: Possible impact for system administrators or users
- Priority: High, Medium, Low

Based on the impact of a particular setting, a system administrator or a security engineer can decide if the loss of administrative comfort is worth the gain in security.

The prioritization can be used to help decide which settings should be applied to meet security requirements. High priority settings should be applied where possible, whereas low priority settings can be treated as optional.

Important

Disclaimer: We strongly recommend to execute all described hardening settings on a non-productive (such as a DEV or QA) system first. We also recommend to **backup the system** before doing any changes. If btrfs/snapper is being used, creating a snapshot of the root file system is advised. Furthermore, we recommend to test the functionality of SAP HANA and all related applications and services after applying the settings. Since SAP HANA installations, use cases, hardware and installed services are likely to be different from the test audit, it cannot be guaranteed that all settings work correctly. It even cannot be completely excluded that they potentially have a negative impact on the functionality of the system.

If it is not possible to test the settings on a non-productive system, the changes should only be made within a maintenance window. The maintenance window should provide enough time for a proper system functionality test, or for restoring the system if necessary.

2.2.1 Installing SUSE security checker

Description

The SUSE security checker (`seccheck`) performs certain security checks, executed via cron jobs, on a regular basis, and generates reports. These reports are usually forwarded via email to root. More details about `seccheck` can be found in the file **/usr/share/doc/packages/seccheck/README** or at https://www.suse.com/documentation/sles-15/single-html/book_hardening/book_hardening.html#sec.sec_prot.general.seccheck.

Important

The password check is not done because the password-cracking software tool `john` is not available on SUSE Linux Enterprise Server. The check would fail silently.

Procedure

Install package `seccheck`:

```
zypper in seccheck
```

Impact

- Daily and weekly reports via email to the root user.
- Requires a properly setup email forwarding.

Priority

Medium

2.2.2 Configuring mail forwarding for root user

Description

To receive information about the security relevant changes and incidents, it is strongly recommended to enable email forwarding for the user root to a dedicated email account for the collection of system mails.

Procedure

1. Install 'Yast2-mail':

```
zypper in yast2-mail
```

2. Start the 'YaST' mail module:

```
yast mail
```

3. Choose 'Permanent' as connection type.
4. Enter the address of the internal mail gateway as outgoing mail server and configure authentication if required.
5. Do **NOT** enable 'accept external SMTP connections'.
6. Enter the email address to forward the root emails (this is typically a dedicated system mail collection account).
7. Save the settings.
8. Test the settings with:

```
mail root

subject: test
```

```
test
.
```

9. Verify that the email has been delivered with the command `mailq`.

Impact

- Requires an accessible SMTP server.
- Requires somebody who regularly checks the mails of the 'root' user.

Priority

High

2.2.3 Forwarding syslog files to a central syslog server

Description

Log files should be forwarded from an SAP HANA node to a central **syslog** server. This prevents syslog files from being manipulated by an attacker. In addition, it allows administrators to have a central view on the syslog files.

Procedure

This procedure explains a basic syslog forwarding setup. For a more sophisticated setup consult the **RSyslog** manual at https://www.rsyslog.com/doc/master/index.html#manual.

On the target syslog server (running SUSE Linux Enterprise Server 15)

1. Edit `/etc/rsyslog.d/remote.conf`
2. Uncomment the following lines in the 'UDP Syslog server' or 'TCP Syslog Server' block of the configuration file and enter the IP address and port of the interface `rsyslogd` shall listen:
   TCP example

```
$ModLoad imtcp.so
$UDPServerAddress <ip>
$InputTCPServerRun <port>
```

   UDP example

```
$ModLoad imudp.so
$UDPServerAddress <ip>
```

```
$UDPServerRun <port>
```

3. Restart `rsyslog`:

```
systemctl restart rsyslog.service
```

On the SAP HANA node

1. Edit `/etc/rsyslog.d/remote.conf`
2. Uncomment the appropriate line (TCP or UDP) and replace 'remote-host' with the address of the central log server:
   TCP example

```
# Remote Logging using TCP for reliable delivery
# remote host is: name/ip:port, e.g. 192.168.0.1:514, port optional
*.* @@remote-host
```

   UDP example

```
# Remote Logging using UDP
# remote host is: name/ip:port, e.g. 192.168.0.1:514, port optional
*.* @remote-host
```

3. Restart `rsyslog`:

```
systemctl restart rsyslog.service
```

4. Verify the proper function of the syslog forwarding using the command:

```
logger "hello world"
```

   The log message “hello world” should now appear on the central syslog server.

Impact

- Requires a central syslog server.

Priority

Medium

2.2.4 Disabling `ctrl-alt-del`

Description

This prevents a reboot of a system via serial console and/or external keyboard.

Procedure

Create the following symlink:

```
ln -s /dev/null /etc/systemd/system/ctrl-alt-del.target
```

Impact

- A system reboot cannot anymore be performed via a local keyboard or a remote management session.
- This can be irritating for system administrators, but it also helps to prevent accidental reboots.

Priority

Medium

2.2.5 Implementing `cron.allow`

Description: The `cron.allow` file specifies a whitelist of users that are allowed to execute jobs via the cron system. The file does not exist by default. This means every user (except those listed in `cron.deny`) can create cron jobs.

Procedure

Create an empty file `/etc/cron.allow` to prevent a user from creating cron jobs:

```
touch /etc/cron.allow
```

Info

Location of user crontabs: `/var/spool/cron/tabs`

Impact

- SAP HANA users ('<sid>adm') and other users are not allowed anymore to create their own cronjobs.

Priority

Low

2.2.6 Implementing `at.allow`

Description

The `at.allow` file specifies a whitelist of users that are allowed to execute scheduled one-time running jobs, so-called 'at' jobs, via the 'at' job execution system. This file does not exist by default. This means that every user (except those listed in `at.deny`) can create 'at' jobs.

Procedure

Create an empty file `/etc/at.allow` to prevent a user from creating 'at' jobs:

```
touch /etc/at.allow
```

Impact

- The functionality of one-time 'at' jobs gets disabled.

Priority

Medium

2.2.7 Restricting `sudo` for general users

Description

The `sudo` command allows users to execute commands in the context of another user, typically the root user. The `sudo` configuration consists of a ruleset that defines the mappings between commands to execute, their allowed source, and target users and groups. The configuration is stored in the file `/etc/sudoers`. Like the command `su`, `sudo` asks for the root password by default. However, unlike `su`, `sudo` remembers the password and allows further commands to be executed as root without asking again for the password for five minutes. Therefore sudo should only be enabled for selected users, such as **admin** users.

Procedure

1. Edit the file `/etc/sudoers`, for example by executing `visudo`.
2. Comment out the line to:

```
#ALL ALL=(ALL) ALL # WARNING! Only use this together with 'Defaults targetpw'!
```

3. Uncomment this line to:

```
%wheel ALL=(ALL) ALL
```

4. Add all system administrator users to the group wheel:

```
usermod -aG wheel <admin_user>
```

Important

The user added to the wheel group has to log out and log in again to get the new group membership applied.

Tip

If `sudo` asks for the password of the target user instead of the user invoking `sudo`, uncomment (default) the line `Defaults targetpw # ask for the password of the target user i.e. root`. For more details, read the man page of `sudoers`.

Impact

- Prohibits `sudo` command functionality for all users, other than the ones that are members of the group 'wheel'.
- Note that the `su` command is still available for other users.

Priority

High

2.2.8 Adjusting default `umask`

Description

The command `umask` specifies the default XOR-masking for access rights for newly created files. We recommend to change this value to 077. This will force newly created files and directories to be not read/write/execute enabled for groups and other users.

Procedure

Edit the file `/etc/login.defs` and change the `umask` value:

```
UMASK 077
```

Tip

The PAM module `pam_umask.so` (in `/etc/pam.d/common-session`) applies the `umask` setting made in `/etc/login.defs`. Refer to the respective man page for alternatives.

Impact

- Newly created files and directories are not read-, write- and executable by users other than the creating user.

Remark

To take changes into effect, a logout and fresh login of all user sessions is required.

Priority

High

2.2.9 Modifying login definitions according to corporate security policies

Description

The file `/etc/login.defs` describes the login settings for users, such as password expiration times, password aging, the number of allowed login retries, `umask` settings, etc. It does not provide options to set the password policy. All changes apply only to newly created accounts. To change existing accounts, use the `passwd` and `chage` commands. Adjust the settings according to your corporate security policies.

Procedure

Edit the file `/etc/login.defs` and make changes according to your policies.

```
PASS_MAX_DAYS   90
PASS_MIN_DAYS   7
PASS_WARN_AGE   14
```

This example sets default password expiration values for all newly created users:

- Password expires after 90 days
- Warns 14 days before the password expires
- Allows a user to change the password only every seven days

The `chage` command prints information about the current password expiration state for a particular user.

```
chage -l <user name>
```

Remark

It is also to possible to specify password expiration times and similar settings on a per-user basis using the `useradd` command. More information about password aging can be found in the SUSE Linux Enterprise Server 15 Hardening Guide, section 2.26 Enabling Password Aging.

Impact

- Some `login.defs` settings, like the password expiration time, reject users to log in after their passwords have expired.
- These settings require system administrators to inform their users about the password expiration times. Users are required to actively change their passwords from time to time.

Priority

Medium

2.2.10 Setting up password failure counts for users

Description

Password failure counts prevent users from logging in after a defined number of failed login attempts. SUSE Linux Enterprise Server provides this mechanism via the PAM system. We do not recommend to use password failure counts, as they can be misused for denial-of-service attacks of certain user accounts. If your corporate policy requires to set up password failure counts for users, refer to the SUSE Linux Enterprise Server 15 Security and Hardening Guide, section 15.4.3 Locking user accounts after too many login failures.

2.2.11 Setting up password strengthening for user accounts according to corporate policies

Description

The default password policy for user accounts on a default SUSE Linux Enterprise Server system is already quite strong. For example, a password cracking library is used to prevent too simple and too short passwords. In some cases, it is required to configure the password strengthening exactly according to a corporate password policy. This is possible by changing the PAM password authentication settings in the file `/etc/pam.d/common-password`. Use the `pam-config` utility to modify the PAM password strengthening settings. The changes are reflected in the file `/etc/pam.d/common-password`. Change the settings according to your requirements.

```
pam-config --add \
--cracklib-retry=3 \
--cracklib-minlen=8 \
--cracklib-lcredit=-1 \
--cracklib-ucredit=-1 \
--cracklib-dcredit=-1 \
--cracklib-ocredit=0 \
--cracklib-difok=5
```

This example configures the password strengthening according to the following rules:

- Ask user up to a maximum number of three times to enter a new valid password
- Minimum of eight characters
- At least one uppercase alpha character
- At least one lowercase alpha character
- At least one number
- An unlimited amount of special characters, such as `_, !, %`
  A new password must differ by at least five characters from the old password. More information on password strengthening options can be found in the man page `man pam_cracklib`.

Impact

- The passwords for system users have to be set according to the defined policies.
- The root user is allowed to overrule the password policy.
- When setting password expiration times, users can not login anymore after their passwords have expired.

Priority

Medium

2.2.12 Configuring user remote login restriction

Description

Use the file `access.conf` to control remote access to the system for the root and any other user accounts. The configured accounts are restricted to log in from a certain IP subnet via SSH.

Procedure

1. Edit the file `/etc/pam.d/sshd` and append:

   ```
   auth required pam_access.so
   ```

   See `man access.conf` for configuration details.

2. Edit file `/etc/security/access.conf` (see `man access.conf` for configuration details):

   ```
   + : <sid>adm : <network/netmask>
   + : sapadm : <network/netmask>
   + : <admin user> : <network/netmask>
   - : ALL : ALL
   ```

Warning

Do not use the `pam-config` utility here. It only supports `pam_access` as global module. The configuration above is not suitable to be used globally for all services and can cause a denial of access for the entire system!

Impact

- Only whitelisted users coming from the specified IP subnet are allowed to log in via SSH.
- Remote root login is prohibited.

Priority

Medium

2.2.13 Setting up password for rescue mode

Description

The root password is needed in rescue mode (rescue.target) to access the system. On SUSE Linux Enterprise Server versions, no change has to be made.

2.2.14 Adjusting `sysctl` variables to Improve network security

Note

This section only covers settings for IPv4. There a similar IPv6 parameters available if required.

Description

`sysctl` (system control) variables change certain kernel parameters that influence the behavior of different parts of the operating system, such as the Linux network stack. These kernel parameters can be looked up in the `proc` filesystem, in `/proc/sys/`. Many kernel parameters can directly be changed by echo'ing a value into a parameter file. However, these changes are not persisted and are lost after a system reboot. Therefore we recommend to make all changes in the `sysctl` configuration file.

Procedure

Create a configuration file (`man 5 sysctl.d` for details) in `/etc/sysctl.d/` and set the following variables:

```
net.ipv4.conf.default.rp_filter = 1
net.ipv4.conf.all.rp_filter = 1
```

This setting enables the reverse path filter in strict mode. The setting ensures that the answers to incoming IP packets are always sent out via the interface the packet also has been received. If the system would direct the answer packet to a different outgoing interface according to the routing table, this packet would be discarded. The setting prevents certain kind of IP spoofing attacks, such as those used for DDoS attacks.

```
net.ipv4.conf.default.accept_source_route = 0
net.ipv4.conf.all.accept_source_route = 0
```

This setting disables the acceptance of packets with the SRR option set in the IPv4 packet header. Packets that use “Source Routing” are rejected. This prevents IP packet redirection such as a redirection to a host behind a firewall that is not directly reachable.

```
net.ipv4.tcp_syncookies = 1
```

The TCP SYN Cookie Protection is enabled by default. A 'SYN Attack' is a denial of service attack that consumes all the resources on a machine. Any server that is connected to a network is potentially subject to such an attack.

```
net.ipv4.icmp_echo_ignore_broadcasts = 1
```

ICMP echo requests (ping) can be sent to a broadcast address to scan a network for existing hosts / IPs or to perform a ICMP flood within a network segment. This setting ignores icmp echo packets, sent to a broadcast address.

```
net.ipv4.icmp_ignore_bogus_error_responses = 1
```

This setting avoids filling up log files with unnecessary error messages coming from invalid responses to broadcast frames. See RFC 1122 'Requirements for Internal Hosts - Communication Layers' for more information.

```
net.ipv4.conf.default.secure_redirects = 0
net.ipv4.conf.all.secure_redirects = 0
```

Accepting "secure" ICMP redirects (from those gateways listed as default gateways) has few legitimate uses. It should be disabled unless it is absolutely required.

```
net.ipv4.conf.default.accept_redirects = 0
net.ipv4.conf.all.accept_redirects = 0
```

This disables the acceptance of ICMP redirect messages. These messages are usually sent by gateways to inform a host about a better route to an outside network. These redirects can be misused, for example for man-in-the-middle attacks.

```
net.ipv4.tcp_max_syn_backlog = 4096
```

The TCP SYN backlog defines the number of SYN packets that are queued for further processing. When the queue limit is exceeded, all new incoming syn-packets are dropped. This improves the protection against TCP SYN flood attacks.

```
net.ipv4.ip_forward = 0
```

IP forwarding is the IP routing functionality of a Linux system. SAP HANA systems should never act as routers. Therefore IP forwarding is disabled.

```
net.ipv4.conf.default.send_redirects = 0
net.ipv4.conf.all.send_redirects = 0
```

IP redirects should only be sent by routers / gateways. As SAP HANA systems do not act as gateways, redirects are disabled.

Impact

- This changes the behavior of the IP network stack, which might cause some network problems or performance issues with certain network setups and devices (such as firewalls) in some rare cases.

Priority

High

2.2.15 Changing home directory permissions from 755 to 700

Description

By default, home directories of users are accessible (read, execute) by all other users on the system. As this is a potential information leak, home directories should only be accessible by their owners. SAP HANA system users ('<sid>adm') have their home directories in the directories `/usr/sap/<sid>/home/`. As this directory structure is located in the domain of SAP, we do not describe any changes here.

Procedure

- The following commands will set the permissions to 700 (directory only accessible for the user) for all home directories in `/home`:

```
chmod 755 /home
```

```
for a in /home/*; do echo "Changing rights for directory $a"; chmod 700 ”$a”;
 done
```

Impact

- System users are not allowed anymore to access other users home directories.
- An exception is made to '<sid>adm' users with their home directories in `/usr/sap/<sid>/home`.

Priority

Medium

2.2.16 Modifying permissions on certain system files

Description

Many system files are group- or world-readable by default. For those files that carry sensitive information, this can be a security risk. Changing the file permissions of these files to more restrictive values increases the security. SUSE provides the tool `chkstat` to check and set file permissions of certain files that are defined in one of the following configuration files:

```
permissions.local
permissions.easy
permissions.paranoid
permissions.secure
```

The `permissions.local` file is dedicated for user-defined file permissions.

Procedure

For SAP HANA systems we recommend to use the `permissions.easy` pattern plus some additional file permissions that will be stored in the `permissions.local` pattern.
First, set the permissions in the correct order in `/etc/sysconfig/security`:

```
...
PERMISSION_SECURITY="easy local"
...
```

Next, add the following permission settings to the file `/etc/permissions.local`:

```
#
```

```
# HANA Security Hardening
#
/etc/at.allow                   root:root       0400
/etc/bash.bashrc                root:root       0444
/etc/csh.cshrc                  root:root       0444
/etc/csh.login                  root:root       0444
/etc/shadow                     root:shadow     0440
/etc/rsyslog.conf               root:root       0400
/etc/crontab                    root:root       0400
/etc/cron.d                     root:root       0700
/etc/cron.hourly                root:root       0700
/etc/cron.daily                 root:root       0700
/etc/cron.weekly                root:root       0700
/etc/cron.monthly               root:root       0700
/etc/login.defs                 root:root       0400
/etc/security/access.conf       root:root       0400
/etc/sysctl.conf                root:root       0400
/etc/X11/xdm/Xservers           root:root       0444
/root                           root:root       0700
/root/.cshrc                    root:root       0400
/var/log/boot.log               root:root       0640
/var/log/sa                     root:root       0770
#
# Changing permissions of utmp files would cause the commands
# w, who and last not to work anymore for non-root users
#
# Uncomment these lines, if you are really sure about that
/var/run/utmp                   root:utmp       0600
/var/log/wtmp                   root:utmp       0600
```

Now apply the permissions:

```
chkstat --system --set
```

Impact

- Some system administration tasks that require access to files mentioned above and that are usually performed as normal system user have to be performed as root user.

Priority

Medium

3 SAP HANA firewall

3.1 SAP HANA network communication

Note

The SAP HANA firewall currently only includes rules for IPv4.

The section "Network Security" of the SAP HANA Security Guide (https://help.sap.com) recommends that different components of the SAP HANA database should operate in different network zones. Also, the network communication should be restrictively filtered to follow a minimal communication approach.

In practice, this results in segmenting the network communication of certain SAP HANA components into multiple dedicated IP networks (ISO/OSI Layer 3). The SAP HANA system is connected with exactly one interface to each IP network. Typically, these interfaces are logical bonding interfaces that include two or more physical interfaces for redundancy. The physical interfaces are connected to separated Ethernet network segments (ISO/OSI Layer 2).

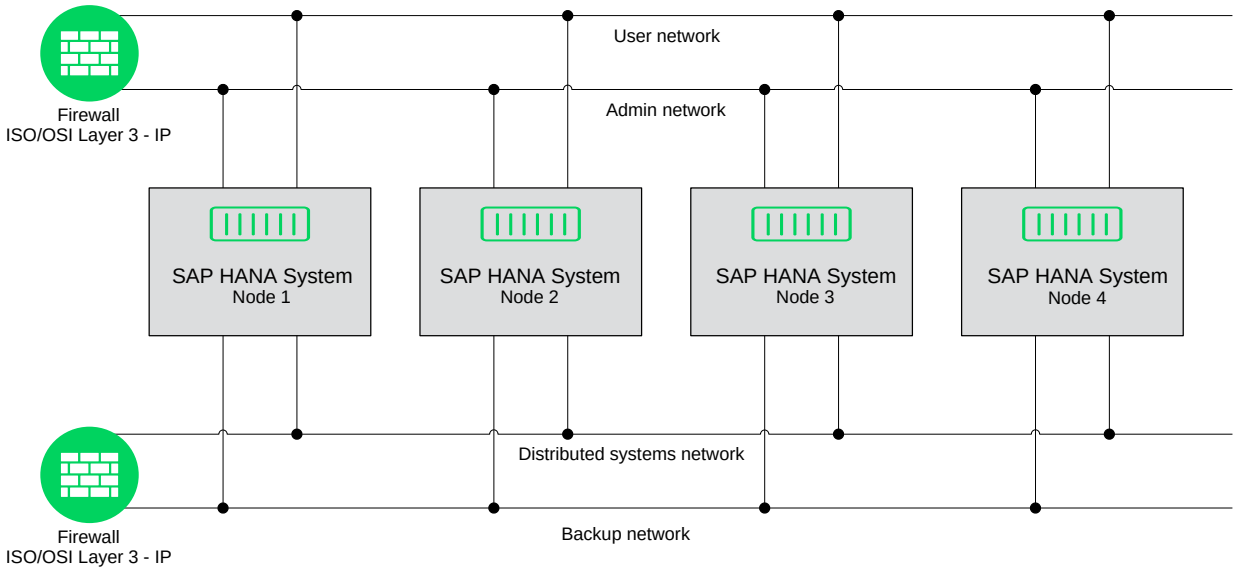

FIGURE 5: EXAMPLE OF A SAP HANA NETWORK DIAGRAM WITH EXTERNAL FIREWALLS

All SAP HANA networks should be either isolated (this means distributed system networks), or if they require communication from other networks (this means user communication), they should be behind an external firewall. This external firewall should only allow traffic for a SAP HANA network that is required for the communication with the SAP HANA services that are listening on this network.

In some cases an external firewall cannot be provided, or certain networks are shared between many servers but not just SAP HANA database systems. In these case, a local running firewall can take over some of the functionalities of an external firewall.

3.2 Local firewall for SAP HANA

The security of an SAP HANA database can be further improved by configuring a locally running firewall. This firewall should only allow network communication on ports where HANA services or other required system services are listening. Communication to all other ports should be dropped and optionally be logged. This complies with the “minimal communication approach” suggested in the SAP HANA Security Guide.

SUSE developed a dedicated local firewall for SAP HANA, based on Linux `iptables`. This firewall takes all requirements from typical SAP HANA systems into account.

The firewall provides the following features:

- Predefined SAP HANA services definitions (according to the SAP HANA Master Guide)
- Protection of multiple SAP HANA instances running on one server
- Interface / service mappings for an unlimited number of interfaces
- Possibility to directly use service definitions from /etc/services
- Option to restrict access to services to certain source networks
- Simulating option that prints the `iptables` commands to the console instead of executing them (What if…)

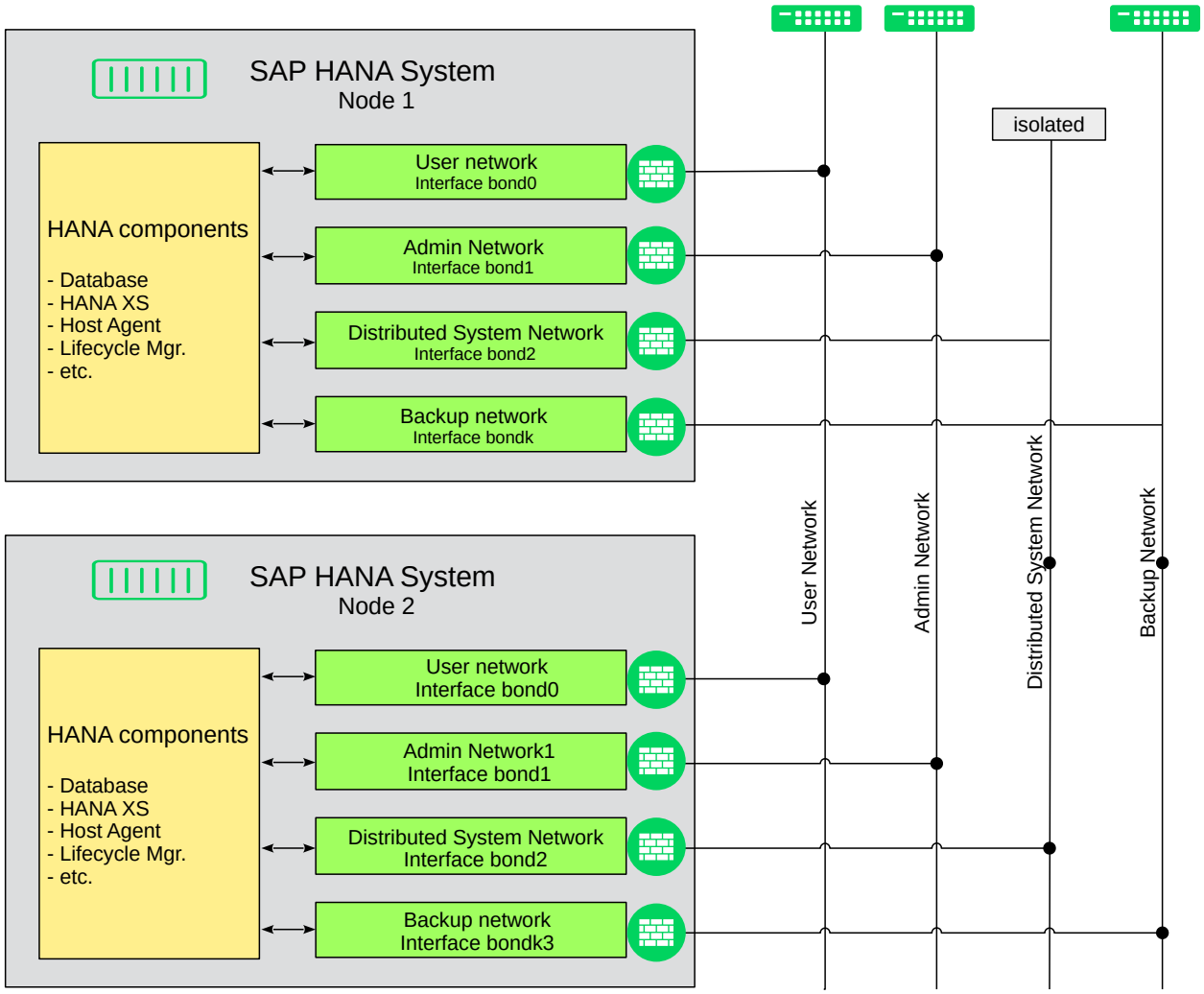

FIGURE 6: EXAMPLE OF A SAP HANA FIREWALL NETWORK DIAGRAM

Not every scenario requires having a dedicated local firewall on the SAP HANA servers. For example, if all SAP HANA networks are behind a properly configured external firewall, a local firewall is not necessarily required.

However, in some cases it helps to improve the network security. It can even improve network debugging capabilities (→ logging of dropped packets). The most common cases for running a local firewall are:

- when an external firewall is not available to protect non-isolated SAP HANA networks from other networks (e.g. user network).
- when an external firewall can not be configured restrictively enough to only allow network communication for particular SAP HANA ports for certain SAP HANA networks.

- when an external firewall provides not enough security zones.
- when a protected network contains many different servers, such as non-SAP servers, in the same network.

There are several other reasons why a local firewall could make sense. For example, a local firewall prevents unwanted services or daemons listening TCP or UDP ports and receiving connections. That is because all not specifically allowed network ports are blocked by default. Also, unauthorized network traffic received on blocked ports can be logged. This allows to easily identify unwanted connection attempts. Last but not least, a local firewall can be a set requirement by corporate security policies or security audits.

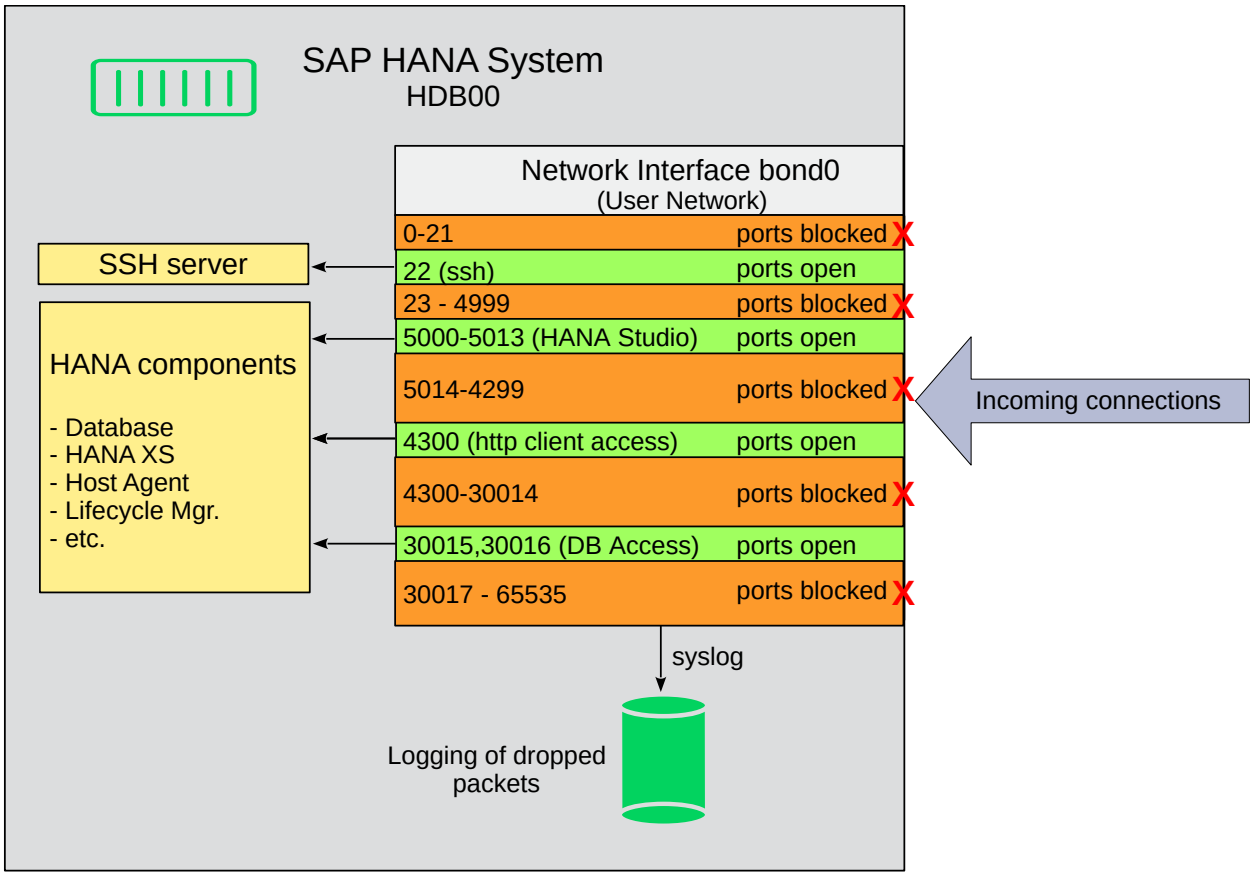

FIGURE 7: EXAMPLE OF A SAP HANA FIREWALL NETWORK TRAFFIC FLOW (PORTS ARE EXEMPLARY)

3.3 Installation

The SAP HANA firewall is available from the repositories for SUSE Linux Enterprise Server for SAP Applications 15 and extends `firewalld` by adding rulesets.

```
zypper install HANA-Firewall
```

The package installs the following files:

`/usr/sbin/hana-firewall`	Firewall executable. A usage description can be printed with the command: `/usr/sbin/hana-firewall --help`
`/etc/hana-firewall/`	Main configuration file
`/etc/sysconfig/hana-firewall`	Directory for HANA services and user defined services
`/usr/share/man/man8/hana-firewall.8.gz`	Man page for the HANA firewall

3.4 Configuration

With SUSE Linux Enterprise Server 15, `firewalld` replaces SUSE Firewall2, and HANA-Firewall is now an integral part. To get familiar with `firewalld`, refer to the SUSE Linux Enterprise Server 15 Security Guide, section 18.4 firewalld (https://www.suse.com/documentation/sles-15/singlehtml/book_security/book_security.html#sec.security.firewall.firewalld).

Important

Before setting up the SAP HANA firewall, you first need to configure `firewalld` for all non-SAP related services like SSH.

To configure the SAP HANA firewall, follow the respective instructions detailed in the SUSE Linux Enterprise Server for SAP Applications Guide, section Configuring HANA-Firewall (https://www.suse.com/documentation/sles-for-sap-15/singlehtml/book_s4s/book_s4s.html#sec.s4s.configure.firewall-hana).

Tip

It is recommended to use the YaST HANA-Firewall module. There is no simple way to do this on the command line.

3.5 Services

3.5.1 Service definitions

A service is a named definition of TCP or UDP ports used by a specific network service. Common services are defined in `/etc/services`. For an easier configuration of the firewall, additional services are provided by the package, or can even be created manually. The HANA Firewall service definitions are stored in the directory `/etc/hana-firewall/`. Each file defines one service and allows to define a list of ports or port ranges for TCP and UDP.

3.5.2 Predefined services

The 'SAP HANA Administrators Guide' and the 'SAP HANA Security Guide' describe all services and the required TCP/UDP ports that SAP HANA uses. These services can also be found in the tabular overview "TCP/IP Ports of All SAP Products" at https://help.sap.com/viewer/ports. Most of these services are available as predefined services in the HANA firewall:

TABLE 1: LIST OF SHIPPED SAP HANA SERVICE DEFINITIONS (HANA-FIREWALL 1.1.5)

Service Name	Description
`HANA cockpit`	More information may be found in the SAP knowledge base article 2389709.
`HANA database client access`	Provide access to system database and all tenant databases.
`HANA data provisioning`	Event streaming via SQLDBC (ODBC/JDBC) protocol.
`HANA HTTP client access`	Allow web browser access to HANA.
`HANA distributed systems`	Internal network communication for multi-host (distributed) installation.
`HANA system replication`	Internal network communication for system replication for both single and multi container setup.

Service Name	Description
`HANA studio lifecycle manager`	Allow connection to HANA lifecycle manager via host agent.
`Software provisioning manager`	The port 4237 will allow web browsers to access software provisioning web UI remotely.
`HANA special support`	The ports should be used in rare technical support scenarios. See HANA administration guide for more details.

3.5.3 User-defined services

To create a new service, run:

```
hana-firewall define-new-hana-service
```

Follow the instructions on the screen. After the service has been created, you have to generate the XML files:

```
hana-firewall generate-firewalld-services
```

Now the service should appear in the YaST HANA Firewall module and can be assigned.

Testing and activation ~~~~~~~~ After the firewall has been configured, it should carefully be tested. After that, make sure that the firewall is started on system boot automatically:

```
systemctl enable firewalld.service
```

Warning

Ensure there is no other non-SUSE firewall enabled that might start automatically.

4 SUSE Remote Disk Encryption

All data processed by SAP HANA can contain sensitive information that need to be protected. Depending on the version the data volume, redoing log files or database backups can be encrypted by the SAP HANA itself. For details consult the SAP HANA Security Guide at https://help.sap.com.

If the internal encryption of SAP HANA should not or cannot be used, you can encrypt directories containing sensitive data via Remote Disk Encrypting available in SUSE Linux Enterprise Server for SAP Applications. When using the internal encryption, the various encryption keys are stored on disk in the SSFS which is located by default in `<home-of-sidadm>/.hdb/<host-identity>/SSFS_HDB.DAT`. The SSFS itself is encrypted with the SSFS master key, normally located in $DIR_GLOBAL/hdb/security/ssfs/, which is protected only by file permissions. To protect this key or the SSFS Remote Disk Encrypting can help to reach higher security. It will not store any key of SAP HANA directly, but can encrypt the part of the file system where the keys are located.

SUSE Remote Disk Encryption uses block devices as an encrypted container for arbitrary directories. It allows to store the encryption keys safely on a remote key server. To mount the device, the host contacts the key server on a TLS secured connection to retrieve the necessary keys automatically to unlock the data. Clearly the key server should be a dedicated, security-hardened, and protected system, since anyone with access to this system can retrieve the keys and decrypt the data.

The setup of client and server is described in more detail in the SUSE Linux Enterprise Server for SAP Applications guide, section 10 Encrypting Directories Using cryptctl at https://www.suse.com/documentation/sles-for-sap-15/.

5 Minimal operating system package selection

5.1 Background

A typical Linux installation has many files that are potentially security-relevant. This is especially true for binary files and executables. Also, every running service might potentially be vulnerable to a local or remote attack. Therefore it is recommended to have as less files (binaries, executables, configuration files) as possible installed and as few services as possible running.

SUSE Linux Enterprise Server provides an RPM package for each logical component, like a Linux application, a service or a library. An RPM package groups all files, including executables, other binaries, configuration files and documentation files, that belong to this particular component. The most common packages are grouped by use cases as 'Installation Patterns'. These patterns can be selected during the operating system installation or later via YaST to easily get an installation that fits the requirements of a particular use case, for example for an SAP server with development tools.

Reducing the number of installed RPM packages to a minimum lowers the amount of potentially vulnerable files on the system. This significantly improves the overall security of a system. Furthermore, a low number of installed packages reduces the number of required (security) updates and patches that have to be applied to the system on a regular basis. SAP HANA is a very complex application, shipped in different versions, and having many additional components, which makes it hard to choose the minimal list of packages.

5.2 Required installation patterns and packages

The required software for SAP HANA is described in 'SUSE Linux Enterprise Server 15.x for SAP Applications Configuration Guide for SAP HANA' attached to SAP note '1944799 - SAP HANA Guidelines for SLES Operating System Installation' and lists the necessary patterns.

The recommendation is to install the system with the role "Minimal" (pattern "Base System"). Then add the patterns "Enhanced Base System" (which pulls in the patterns "AppArmor", "Software Management" and "YaST System Administration") and "SAP Application Server Base". The pattern "X Window System" should be installed only if needed. This results in a total amount of 746 packages, or 941 package if "X Window System" has been installed.

For SSL support, the `SAPCRYPTOLIB` (SAP package) and the SAR archiver tool should be installed in addition.

In some rare cases, the support might ask for the installation of additional packages. Therefore, we generally recommend to have SUSE Linux Enterprise Server update repositories configured on your HANA system to be able to quickly install new packages.

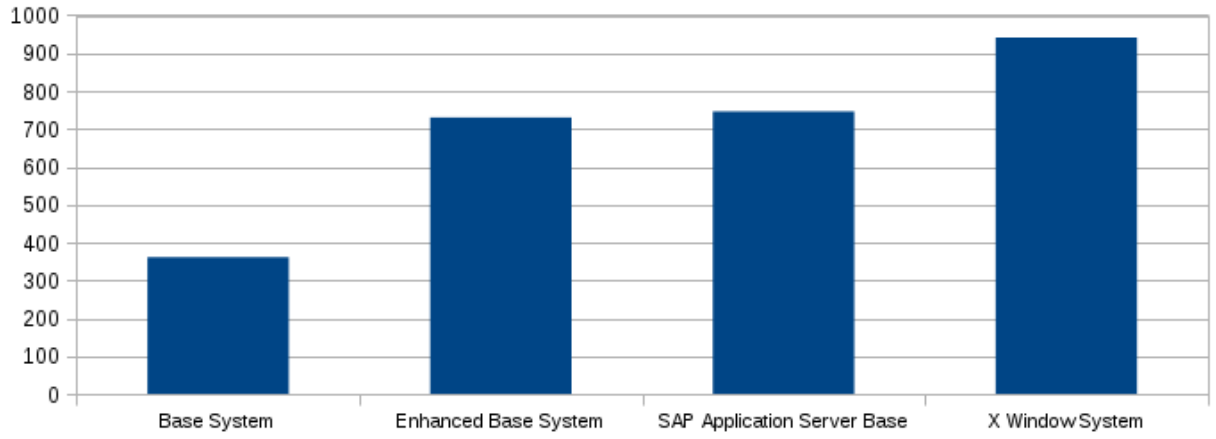

FIGURE 8: COMPARISON OF THE AMOUNT OF INSTALLED PACKAGES BETWEEN CERTAIN PACKAGE SELECTIONS

6 Security updates

6.1 Security updates for SUSE Linux Enterprise Server 15

No different from commercial software, open source software is tested by hackers and security experts for vulnerabilities. Also, it can contain programming errors. These facts may result in security risks. As soon as newly found security vulnerabilities are reported, for example on security mailing-lists or by security advisories, the affected code usually gets fixed quickly – sometimes even within hours. This is usually done either by the authors of the affected application, by security experts in the community, or by the Linux distributors.

For SUSE Linux Enterprise Server, the resulting security patches are quickly incorporated into the corresponding software package and published as security updates through our update channels. As soon as they are available there, they can be downloaded by all SUSE Linux Enterprise Server customers, and should be applied immediately.

6.2 SUSE Linux Enterprise Server update channels

To receive security updates (and other updated packages) on SAP HANA systems, the SUSE update channels must be configured properly. Usually SAP HANA systems do not have direct access to the Internet. This requires an update proxy between the corporate network and the Internet. Thus SUSE provides the Subscription Management Tool (SMT) or Repository Mirroring Tool (RMT), or SUSE Manager.

To verify that your HANA system has been configured properly to receive updates, check if it has been registered to the SUSE update channels:

```
zypper lr
```

This command lists the available software repositories of a SUSE Linux Enterprise Server instance. The output should show the update channels for all enabled modules of the particular Service Pack.

There are many ways to install new patches and also to selectively install just the security updates. The most common way to install only security updates is to execute the following commands:

```
zypper ref # Refreshes the update sources
zypper patch -g security # Install security patches only
```

6.3 Update and patch strategies

In many cases, organizations have corporate polices in place that describe requirements regarding updates and patches for their Linux servers.

The following overview describes some of the most common update and patch strategies, and their advantages and disadvantages.

6.3.1 Installing all new updates and patches on a regular basis

Description

This strategy promotes the installation of new updates and patches for example once a day or once per week, either manually by a system administrator or using automatic update tools like YOU (YaST Online Update) or SUSE Manager. Since SUSE does not implement any new features between Service Packs, the installation of updates and patches (including security updates) is usually uncritical for a system. However, in some rare cases, updates might cause problems and can compromise the stability of a system.

Advantages

The System is always up-to-date and latest security updates are applied quickly. This makes a system very secure.

Disadvantages

In some rare cases, updates and patches might cause problems. Also, some updates (for example kernel updates) require a reboot.

Recommendation

This is a good strategy for all non-productive HANA systems, but not for systems that are in production.

6.3.2 Installing all new updates and patches during maintenance windows

Description

This strategy is very similar to the last one, but it ensures that a SAP HANA system is out of production or tagged with a limited availability during the update cycle. This is a very commonly used strategy for systems running large databases.

Advantages

Problematic updates will not put a productive SAP HANA system into danger.

Disadvantages

Since maintenance windows usually have longer time frames in between (for example once a month), systems might not be up-to-date from a security perspective.

Recommendation

This is only a good strategy if important security updates are installed outside of the usual maintenance windows.

6.3.3 Selectively installing new updates and patches

Description

A selective installation of patches and updates, for example of security updates only, further reduces the probability of installing problematic updates. This strategy is frequently combined with updating systems on a regular basis. The selective installation of packages can be performed using zypper, YaST or SUSE Manager.

Advantages

The system is mostly up-to-date with (almost) all security patches installed.

Disadvantages

Selecting packages has to be done manually and creates recurring effort, if one of the filters provided by zypper (for example cve number, category, severity) cannot be used.

Recommendation

This is probably the best update strategy, but also the most complicated one.

Tip

An important issue with updates in most cases is the reboot and the involved downtime. Some kernel updates are shipped as live patches and do not require a reboot anymore. More details can be found in the SUSE Linux Enterprise Server 15 Administration Guide, section 8 Live Kernel Patching with KLP.

6.3.4 Not updating

Description

A system is not registered to the SUSE update channels and no updates are applied.

Advantages: This has only disadvantages.

Disadvantages

Constantly increasing number of known security vulnerabilities make the system an ideal target for hacker attacks.

Recommendation

We strongly recommend to subscribe to the SUSE update channels and to install at least security-updates on a regular basis.

Which update strategy fits best for the SAP HANA systems in an organization heavily depends on the corporate updating & patching policies / guidelines. It also depends on the requirements of a particular SAP HANA system. For important SAP HANA systems, a more conservative update strategy should be chosen. For test systems, updates might even be applied automatically, for example by using YOU (YaST Online Update), on a regular basis.

7 Outlook

Even though this guide already covers most security hardening topics, we are planning to provide further improvements. Also, later versions of SAP HANA might have changed, or new requirements regarding the hardening settings, the firewall or the minimal package selection might apply in future. It is planned to incorporate these new requirements as soon as they occur.

We recommend to check for updated versions of this document from time to time at the SUSE documentation pages at https://documentation.suse.com.

8 About the authors

This document has been developed by Markus Guertler (Architect & Technical Manager, SAP Linux Lab), Soeren Schmidt (Solutions Architect, SAP Linux Lab) and Alexander Bergmann (Software Security Engineer, SUSE Maintenance & Security team).

9 Further information and references

The following table provides an overview of sources for further information regarding the discussed topics in this guide.

SUSE Security Portal	http://www.suse.com/security
SUSE Linux Enterprise Server Security Guide	https://www.suse.com/documentation/sles-15/singlehtml/book_hardening/book_hardening.html
SAP HANA Security Guide	http://help.sap.com/hana/SAP_HANA_Security_Guide_en.pdf
SAP HANA Master Guide	http://help.sap.com/hana/SAP_HANA_Master_Guide_en.pdf
SAP HANA Guidelines for SLES Operating System Installation	SAP note 1944799
SUSE Linux Enterprise Server 15: Installation Note	SAP note 2578899

If you have any questions, comments or feedback on this document, do not hesitate to contact us under the email address saphana@suse.de (mailto:saphana@suse.de).

10 Documentation updates

This chapter lists content changes for this document since its first release.

v1.3

- Changed title to reflect, that for 15 SP2 and later a changed guide is available.

v1.2

- Removed the following chapters (content was moved to the official Hardening Guide for SUSE Linux Enterprise Server):
  - "Allow root login only via the first local console (tty1)"
  - "Prohibit login as root via ssh"
  - "2.2.11 Set default inactive time to 1"
- Added comment about x86/Power and GUI on top of "SUSE Linux Enterprise Security Hardening Settings for HANA"

v1.1

- Removed obsolete comment about SAP Note 1944799 in "Further Information & References"
- Reworked "Set default inactive time to 1 day"
- Added comment about x86/Power and GUI on top of "SUSE Linux Enterprise Security Hardening Settings for HANA"
- Added missing SAP Note 1944799

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