

SUSE Solution Security Risk Report 2022

All SUSE Products

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SUSE Solution Security is committed to delivering best in class software security to its customers and to the open source community. The primary objectives are to treat software security as an ongoing and continual process.

The goal of this report is to provide a summary of all security vulnerabilities which affected SUSE products in calendar year 2022.

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1 Motivation

SUSE Solution Security is committed to delivering best in class software security to its customers and to the open source community. The primary objectives are to treat software security as an ongoing and continual process that never ends. This implies to:

- promptly react to security incidents and deliver premium quality security updates.
- continuously improve the security related functionality in SUSE products.
- continuously contribute to the rapidly growing maturity of open source software.
- respect the open source software security principles of openness, transparency and traceability.

The SUSE Security Team addresses all aspects of software security on an ongoing basis. Any software can contain errors (both deliberate and accidental) which could affect the system's security, including design flaws, programming errors, and backdoors. In addition, software security cannot be thought of as a state you can achieve at a specific point in time. Instead, it is a process that must be executed with professional expertise and continuous development. This persistent focus is what has given open source software, Linux and SUSE an excellent reputation for security.

The objective of this report is to provide a summary of all security vulnerabilities which affected SUSE products in calendar year 2022. We will go into details on the high impact vulnerabilities which affected our products in 2022 and elaborate on how we responded to these incidents.

2 Background

A modern Linux operating system, such as SUSE Linux Enterprise Server for enterprise use or the openSUSE community distribution for home use, features a rich set of security programs and functions. Those range from access control, intrusion prevention and detection, flexible and trustworthy authentication mechanisms, encryption for files and network connections, file integrity checking utilities, to network analysis tools and monitoring/logging utilities for your system. To complement this, there are advanced tools that help you to securely configure and administer your system, and to securely download and install update packages. These utilities are standard in SUSE products. The update packages fix security bugs that have been found after

your product has been released. The security features of your Linux system are waiting for you to explore them. SUSE encourages our customers to take advantage of them to further improve the level of privacy and security that is built into every system by default.

Programs are usually written by humans, and humans make mistakes. By consequence, all software can contain errors. Some of these errors appear as instabilities (the software or the entire system crashes), while others may not have any apparent, visible effect. However, some software errors may introduce a security risk. A local or a remote attacker may be able to feed specially drafted data to the software which takes advantage of the programming error. In the case of a remotely exploitable bug, the data comes from an attached network device, such as a cable or DSL modem, or a wireless network interface card. The application then either crashes, resulting in a Denial of Service (DoS) attack, or it executes code that originates from the attacker, transferring control over the execution context from what the programmer intended to what the attacker has in mind for the exploitation of the error. Depending on the software's function, the resulting security breach can impose little or high security risks for your data and your system, potentially giving an attacker the opportunity to delete, alter or even steal your data, or use the system for his own purposes.

The SUSE Solution Security team is responsible for handling all SUSE product-related security incidents. In that team, clear and well-defined roles are assigned for tracking new incidents and coordinating needed updates. The team works with all SUSE engineering software specialists.

We use multiple sources to understand security incidents. These sources include the Mitre and NVD Common Vulnerabilities and Exposures (CVE) databases, various security mailing lists (OSS security, Linux distros, distros, bugtraq, and full-disclosure), direct reports, and other Linux vendors databases. We are also part of various pre-notification mailing lists for software components, like Xen, Samba, X.ORG. Confidential pre-notifications about vulnerabilities will be treated according to established responsible disclosure procedures.

3 Incident rating and tracking

We rate the severity of incidents with two different systems, a simplified rating system and the Common Vulnerability Scoring System (CVSS) v3.1 scoring system. The CVSS is an open framework for communicating the characteristics and severity of software vulnerabilities. It is being developed by the US-based non-profit organization FIRST.org: Its main goal is to assign the right score to a vulnerability to help security administrators prioritize responses and resources to specific threats. CVSS v3.1 scoring consists of three metric groups: Base, Temporal, and Environmental. The Base group represents the intrinsic qualities of a vulnerability that are constant

over time and across user environments. The Temporal group reflects the characteristics of a vulnerability that change over time. The Environmental group represents the characteristics of a vulnerability that are unique to a user's environment. The Base metrics produce a score ranging from 0 to 10, which can then be modified by scoring the Temporal and Environmental metrics. A CVSS score is also represented as a vector string, a compressed textual representation of the values used to derive the score. Today, SUSE uses the Base score methodology to evaluate vulnerabilities throughout the support life cycle of our products. SUSE keeps the right to adjust the final score of the vulnerability as more details become known and available throughout the analysis. The most current CVSS resources can be found at <https://www.first.org/cvss/> . The CVSS v3.1 calculator used by SUSE could be found at <https://www.first.org/cvss/calculator/3.1> . The framework is measuring the severity of a given vulnerability, not the associated risk alone. The scoring of any vulnerability may vary with different analysts hence the final score could be slightly different between vendors impacted by that vulnerability. For a more accurate assessment of the impact, vendors and application owners must always consider factors outside of CVSS such as exposure or threat.

The security incidents are tracked in our own workflow system. Technical details are tracked in the SUSE bug-tracking system, and the updated software package is built, processed, and published by our internal “Open Build System”. Internal Service Level Agreements (SLAs) corresponding to the severity rating are monitored and reviewed regularly. Our packagers backport the required security fixes to our version of the software. To protect the stability of our customer setups, we only rarely do minor version upgrades. After receiving fixes for the affected software, four eye reviews cross-check the source patches. Several automated checks verify source and binary compatibility and the completeness of patch meta information. They also check whether patches can be installed without problems. Dedicated QA teams provide integration, bugfix, and regression testing for all updates before they are released to our customers. After the release of an update, automated processes publish the updates, update notices, and cross reference information on our CVE index pages and machine-readable OVAL and CVRF XML information.

The objective of this report is to provide a summary of all security vulnerabilities which affected SUSE products in calendar year 2022. We will go into details on the high impact vulnerabilities which affected our prour products in 2022 and elaborate on how we responded to these incidents. For a better understanding of our classification mechanisms, we have described our rating system along with the equivalency of each rating to the CVSS v3.1 scoring calculator:

TABLE 1: INCIDENT RATING AND CVSS SCORE

| Rating | CVSS Score | Definition |
|-----------|---------------|--|
| Critical | 9.0 and above | This rating is given to flaws that could be easily exploited by a remote unauthenticated attacker and lead to system compromise (arbitrary code execution) without requiring user interaction. These are the types of vulnerabilities that can be exploited by worms. Flaws that require an authenticated remote user, a local user, or an unlikely configuration are not classed as critical impact. |
| Important | 7.0 to 8.9 | This rating is given to flaws that can easily compromise the confidentiality, integrity, or availability of resources. These are the types of vulnerabilities that allow local users to gain privileges, allow unauthenticated remote users to view resources that should otherwise be protected by authentication, allow authenticated remote users to execute arbitrary code, or allow remote unauthenticated users to cause a denial of service without user interaction. |
| Moderate | 4.0 to 6.9 | This rating is given to flaws that may be more difficult to exploit but could still lead to some compromise of the confidentiality, integrity, or availability of resources, under certain circumstances. These are the types of vulnerabilities that could have had a critical impact or important impact but are less easily exploited based on a technical evaluation of the flaw, or affect unlikely configurations. Local, persistent (service needs to be restarted) denial of service conditions for basic system services (kernel, systemd, polkit, dbus, etc.) with and without user interaction should also be rated “moderate”. |

| Rating | CVSS Score | Definition |
|--------|------------|---|
| Low | up to 3.9 | This rating is given to all other issues that have a security impact. These are the types of vulnerabilities that are believed to require unlikely circumstances to be able to be exploited, or where a successful exploit would give minimal consequences. |

4 When to prefer version upgrades over backports

It is a general policy rule that no new upstream versions of a package are introduced into our enterprise products. This rule is not an absolute rule however. For certain types of packages, in particular antivirus software, security concerns weigh heavier than the conservative approach that is preferable from the perspective of quality assurance. For packages in that class, occasionally newer versions are introduced to a released version of an enterprise product line.

Sometimes also for other types of packages the choice is made to introduce a new version rather than a backport. This is done when producing a backport is not economically feasible or when there is a very relevant technical reason to introduce the newer version.

5 Major security vulnerabilities in 2022

5.1 pwnkit

Overview

In the beginning of January, Qualys securcal root exploit in "pkexec" component of polkit. The pkexec application is a setuid tool designed to allow unprivileged users to run commands as privileged users according predefined policies. Local attackers could use the setuid root /usr/bin/pkexec binary to reliably escalate privileges to root. The previous version of pkexec did not handle the calling parameters count correctly and ends trying to execute environment variables as commands. An attacker could leverage this by crafting environment variables in such a way it would induce pkexec to execute arbitrary code. When successfully executed the attack could cause a local privilege escalation from unprivileged users able to execute pkexec to root.

This vulnerability affected all SUSE Linux Enterprise Server 12 and SUSE Linux Enterprise Server 15 service packs. It did not affect SUSE Linux Enterprise Server 11, as it used a previous generation called “PolicyKit”.

Solution

Installing the updated packages provided by SUSE is sufficient to fix the problem. Use

```
zypper lp -a --cve=CVE-2021-4034
```

to search for the specific patch information. A restart of the service is not required.

Note that for any SPx (Service Pack level) which is no longer in general support, an LTSS or ESPOS subscription may be needed to obtain the update. See the SUSE “CVE Page” link in the “References” paragraph below for more details about each SPx. In future releases, SUSE has split out `pkexec` from the default installed `polkit-1` packages, to allow reducing the attack surface if `pkexec` is not required on the system.

Workaround

It is also possible to remove the `setuid` bit from `/usr/bin/pkexec` with

```
chmod 755 /usr/bin/pkexec
```

or even by deleting `/usr/bin/pkexec` until fixed packages can be installed.

SUSE does not recommend removing the `setuid` bit as it will cause breakage on the system. Removing the `setuid` permission from the `pkexec` binary will prevent it from working properly for legitimate use cases. This means that any application which relies on `pkexec` execution will stop working, possibly causing unexpected system errors and behavior. The workaround prevents exploitation and might be the right thing to do given how easy the exploit is, but customers must be aware that this will break functionality until the update is installed.

References

- SUSE CVE Web page for CVE-2021-4034: <https://www.suse.com/security/cve/CVE-2021-4034.html>
- SUSE Technical Information Document (TID) 000020564: <https://www.suse.com/support/kb/doc/?id=000020564>

5.2 Samba `vfs_fruit` remote code execution

Overview

Researcher Orange Tsai from DEVCORE reported a remote buffer overflow in the “fruit” `vfs` module of Samba, tracked under CVE-2021-44142. The fruit module, which is used by Samba for Apple-related extended attribute storage, can be exploited by remote attackers with access to the Samba server to execute code as the Samba server (basically as root). The Samba `vfs_fruit` module uses extended file attributes (EA, `xattr`) to provide “[...] enhanced compatibility with Apple SMB clients and interoperability with a Netatalk 3 AFP file server.” Samba versions prior to 4.13.17, 4.14.12 and 4.15.5 with `vfs_fruit` configured allow out-of-bounds heap read and write via specially crafted extended file attributes. A remote attacker with write access to extended file attributes can execute arbitrary code with the privileges of `smbd`, typically root.

Solution

The “fruit” `vfs` module is not configured by default. To determine if it is used, check for a line starting with `"vfs objects="` with “fruit” listed in `/etc/samba/smb.conf`.

Packages containing a fix for this security issue were made available quickly. They should be installed using

```
zypper patch --cve=CVE-2021-44142
```

for applying the fixed packages.

References

- SUSE TID 000020564: <https://www.suse.com/support/kb/doc/?id=000020564> ↗
- SUSE CVE-2021-4034 Web page: <https://www.suse.com/security/cve/CVE-2021-4034.html> ↗

5.3 Remote Stack Overflow in the `tipc` networking module of the Linux kernel

Overview

The Transparent Inter Process Communication (TIPC) is an IPC mechanism designed for intra-cluster communication. It represents the cluster topology using the concept of nodes and the links between these nodes. A stack overflow flaw was found in the Linux kernel's TIPC protocol functionality in the way a user sends a packet with malicious content where the number of domain member nodes is higher than the 64 allowed. This flaw allows a remote user to crash the system or possibly escalate their privileges if they have access to the TIPC network.

As part of the monitoring framework the "Overlapping Ring Supervision Algorithm" was introduced to monitor neighbouring nodes in the cluster. This also introduced a security bug that could be exploited to execute a remote Denial of Service (DoS) attack on systems using TIPC and `FORTIFY_SOURCE` enabled.

Solution

Installing the updated packages provided by SUSE is sufficient to fix the problem. Use the following command to search for the specific patch:

```
zypper lp -a --cve=CVE-2022-0435
```

or

```
zypper patch --cve=CVE-2022-0435
```

to apply the fixes.

After a kernel update a restart is required. Unless you are using the SUSE Linux Enterprise Live Patching extension, for which SUSE provides the live patch to fix this vulnerability allowing you to patch the kernel without shutting down your system and reducing the need for planned downtime and increasing service availability.

References

- SUSE TID 000020580: <https://www.suse.com/support/kb/doc/?id=000020580> ↗
- SUSE CVE-2022-0435 Web page: <https://www.suse.com/security/cve/CVE-2022-0435.html> ↗

5.4 Dirty Pipe

Overview

On Monday, March 7th, security researcher Max Kellermann published a new software vulnerability that affect users of the Linux kernel. The vulnerability, called Dirty Pipe (CVE-2022-0847), impacts Linux kernels 5.8 and later, and allows local attackers to overwrite files even if they had only read permissions, allowing for easy privilege escalation. The issue is triggered by a combination of two bugs, one bug in Linux kernels 4.9 and newer and made exploitable by the second bug introduced in Linux kernel 5.8. Our currently maintained SUSE Linux Enterprise products are not affected as they ship older Linux kernels than 5.8. The upcoming SUSE Linux Enterprise 15 SP4 with Linux kernel 5.14 will be already fixed before shipment.

Solution

We have released fixes for the first bug for SUSE Linux Enterprise 12 SP4 and newer and SUSE Linux Enterprise 15 and newer, even though they are not directly affected. To install the respective patch, use

```
zypper patch --cve=CVE-2022-0847
```

References

- SUSE TID 000020603: <https://www.suse.com/support/kb/doc/?id=000020603> ↗
- SUSE CVE-2022-0847 Web page: <https://suse.com/security/cve/CVE-2022-0847.html> ↗
- SUSE blog article: <https://www.suse.com/c/suse-statement-on-dirty-pipe-attack/> ↗
- Wep page of dirty pipe: <https://dirtypipe.cm4all.com/> ↗

5.5 Boothole 3

Overview

GRUB developers and security researchers have identified more security relevant bugs in the GRUB2 and shim boot loaders, which could be used by local attackers to circumvent the secure boot chain. This vulnerability has similar effects and considerations as the original Boothole and Boothole2 issues. For regular users with their machine under full control this is less of an issue as in scenarios relying on secure boot, like public systems.

Solution

Boothole 3 consists of the following security vulnerabilities:

- CVE-2021-3695: A crafted PNG grayscale image may have led to out-of-bounds write in heap.
- CVE-2021-3696: A crafted PNG image may have led to out-of-bound write during huffman table handling.
- CVE-2021-3697: A crafted JPEG image could have led to buffer underflow write in the heap.

These security issues require attackers to supply crafted images to GRUB2, which is unlikely in common local scenarios, but can allow bypassing the secure boot chain.

- CVE-2022-28733: Fixed net/ip to do ip fragment maths safely. If GRUB2 is loading artefacts from the network, a Man-In-The-Middle attack could be used to execute code. This is an uncommon scenario.
- CVE-2022-28737: Fixed a buffer overflow in shim.
- CVE-2022-28734: Fixed net/http OOB write for split HTTP headers.
- CVE-2022-28735: GRUB2 verifier framework changes to avoid potential bypasses.
- CVE-2022-28736: Fixed a use-after-free in chainloader command.

SUSE is switching to a new secure boot signing key for secure boot signed artefacts. We have released GRUB2 updates, with incremented SBAT revision on AMD64/Intel 64 and signed with the new secure boot key to allow disabling it on IBM Z and IBM Power. SUSE also released

Linux kernel updates signed with the new signing key in June 2022 and following days on our regular “second Tuesday of the month” kernel release time. In 2022 we released a new shim version that disallows use of the previous secure boot keys and fixes a shim security issue, with incremented SBAT version after all the previous updates.

References

- SUSE TID 000020668: <https://www.suse.com/support/kb/doc/?id=000020668> ↗

grub2 security issues

- SUSE CVE-2022-28736 Web page: <https://www.suse.com/security/cve/CVE-2022-28736> ↗
- SUSE CVE-2022-28735 Web page: <https://www.suse.com/security/cve/CVE-2022-28735> ↗
- SUSE CVE-2022-28734 Web page: <https://www.suse.com/security/cve/CVE-2022-28734> ↗
- SUSE CVE-2022-28733 Web page: <https://www.suse.com/security/cve/CVE-2022-28733> ↗
- SUSE CVE-2021-3697 Web page: <https://www.suse.com/security/cve/CVE-2021-3697> ↗
- SUSE CVE-2021-3696 Web page: <https://www.suse.com/security/cve/CVE-2021-3696> ↗
- SUSE CVE-2021-3695 Web page: <https://www.suse.com/security/cve/CVE-2021-3695> ↗

shim security issue

- SUSE CVE-2022-28737 Web page: <https://www.suse.com/security/cve/CVE-2022-28737> ↗

5.6 Side-channel information leaks / denial of service attack against MMIO registers

Overview

Security researchers and Intel engineers have identified several transient execution side-channel information leak attacks and one denial of service attack when accessing MMIO registers.

Multiple flavors of these issues have been identified:

- CVE-2022-21166: Device Register Partial Write (DRPW) Some endpoint MMIO registers incorrectly handle writes that are smaller than the register size. Instead of aborting the write or only copying the correct subset of bytes (for example, 2 bytes for a 2-byte write), more bytes than specified by the write transaction may be written to the register. On some processors, this may expose stale data from the fill buffers of the core that created the write transaction. This issue is mitigated using CPU Microcode and Operating System (kernel) code changes.
- CVE-2022-21127: Update to Special Register Buffer Data Sampling The RDSAND, RDSEED, SGX EGET KEY instructions use the low bandwidth MMIO interface, and their content could be sampled using side-channel information leak methods. This issue is being mitigated with CPU Microcode updates.
- CVE-2022-21125: Shared Buffers Data Sampling (SBDS) After propagators may have moved data around the uncore and copied stale data into client core fill buffers, processors affected by MFBDS can leak data from the fill buffers. This issue is mitigated using CPU Microcode and Operating System (kernel) code changes.
- CVE-2022-21123: Shared Buffers Data Read (SBDR) It is similar to Shared Buffer Data Sampling (SBDS) except that the data is directly read into the architectural software-visible state. This issue is mitigated using CPU Microcode and Operating System (kernel) code changes.
- CVE-2022-21180: Undefined MMIO Hang While not directly related to side channel information leaks, overly long MMIO reads to short MMIO registers could lead to machine hangs, causing a denial of service. This will be fixed by filtering out too long MMIO reads in kernel / hypervisor software.

Solution

An updated Intel CPU Microcode was published in the Intel IPU 2022.1 release, released by SUSE in `ucode-intel` version 20220510 packages. SUSE released kernel updates to mitigate the leaks. A new kernel boot command line option has been introduced, called `mmio_stale_data`.

Configuration:

```
- mmio_stale_data=off
```

Mitigation is disabled.

```
- mmio_stale_data=full
```

Mitigation is enabled, but SMT is still enabled so information might leak on the same CPU core.

```
- mmio_stale_data=full,nosmt
```

Mitigation is enabled, and SMT is disabled so the mitigation is complete. Note that this option is also covered by using the generic “mitigations” option.

References

- SUSE Technical Information Document (TID) 000020669: <https://www.suse.com/support/kb/doc/?id=000020669> ↗
- SUSE CVE-2022-21166 Web page: <https://www.suse.com/security/cve/CVE-2022-21166> ↗
- SUSE CVE-2022-21127 Web page: <https://www.suse.com/security/cve/CVE-2022-21127> ↗
- SUSE CVE-2022-21123 Web page: <https://www.suse.com/security/cve/CVE-2022-21123> ↗
- SUSE CVE-2022-21125 Web page: <https://www.suse.com/security/cve/CVE-2022-21125> ↗
- SUSE CVE-2022-21180 Web page: <https://www.suse.com/security/cve/CVE-2022-21180> ↗
- Article: <https://www.intel.com/content/www/us/en/developer/articles/technical/software-security-guidance/advisory-guidance/undefined-mmio-hang.html> ↗
- Article: <https://www.intel.com/content/www/us/en/developer/articles/technical/software-security-guidance/technical-documentation/processor-mmio-stale-data-vulnerabilities.html> ↗

5.7 RETBLEED transient execution information leak side-channel attack

Overview

Security researchers Johannes Wikner and Kaveh Razavi from ETH Zuerich have identified a new transient execution information leak caused by “return” CPU instructions on Intel and AMD x86 systems. In certain scenarios the return instructions turn to use the indirect branch predictor, which can be influenced by Branch Target Injection attacks aka Spectre-BTI. This allows local attackers to execute code to leak sensitive data out of the kernel, same as other Spectre like vulnerabilities.

Affected CPUs:

- Intel Skylake and newer Intel x86 CPU generations
- AMD Bulldozer (family 0x15) up to Zen 3
- Arm CPUs that are also vulnerable to Spectre variant 2

Solution

Various mitigation methods have been implemented and can be selected manually or are selected automatically. IBPB (Indirect Branch Prediction Barrier) can be used to flush the indirect branch predictor. This has performance impact, but is the safest option. On Intel Skylake the IBRS feature is used (Indirect Branch Restricted Speculation), which clears the branch history buffer from lower privileged entries. Go to the “References” paragraph for instructions on each mitigation type.

References

- SUSE Technical Information Document (TID) 000020693: <https://www.suse.com/support/kb/doc/?id=000020693> ↗
- SUSE CVE-2022-29900 Web page: <https://www.suse.com/security/cve/CVE-2022-29900> ↗
- SUSE CVE-2022-29901 Web page: <https://www.suse.com/security/cve/CVE-2022-29901> ↗
- SUSE CVE-2022-28693 Web page: <https://www.suse.com/security/cve/CVE-2022-28693> ↗
- SUSE CVE-2022-23825 Web page: <https://www.suse.com/security/cve/CVE-2022-23825> ↗

5.8 openssl 3 certificate parsing buffer overflow

Overview

Security researcher “Polar Bear” has reported a buffer overflow in `openssl` when parsing X.509 certificates. This problem could be used by remote attackers to cause overflows in `openssl`-based servers parsing, for example client certificates, or client overflows when parsing server certificates.

This problem only affects `openssl 3.x` and newer, older `openssl` versions are not affected. `openssl 3` is only shipped as a secondary library starting with SUSE Linux Enterprise 15 SP4. No package currently uses `openssl 3`.

Solution

Patches are available for download and install for SUSE Linux Enterprise 15 SP4.

References

- SUSE CVE-2022-3602 Web page: <https://www.suse.com/security/cve/CVE-2022-3602.html>
- SUSE CVE-2022-3786 Web page: <https://www.suse.com/security/cve/CVE-2022-3786.html>

6 Vulnerability Management in 2022

The SUSE Solution Security team constantly monitors all the software components used in our products for security issues. More and improved tools are now available for finding out zero-day vulnerabilities and scanning for existing vulnerabilities. Such instruments can validate and report back if the application code written is following the standard security best practices or there are major gaps in potential attack vectors such as buffer overflow, denial of service or unwanted elevated access. It is clear that developers are becoming more and more security-aware and the quality of the code being developed has greatly improved in both quantity and quality. While we notice an increasing number of important vulnerabilities, the number of critical vulnerabilities is going down year over year.

TABLE 2: VULNERABILITIES WITH A UNIQUE CVE IDENTIFIED, IMPACTING SUSE PRODUCTS IN 2022

| Low | Moderate | Important | Critical |
|-----|----------|-----------|----------|
| 100 | 637 | 436 | 15 |

TABLE 3: SECURITY UPDATES AND PATCHES RELEASED TO FIX THESE VULNERABILITIES IN 2022

| Low | Moderate | Important | Critical |
|-----|----------|-----------|----------|
| 58 | 584 | 2364 | 101 |

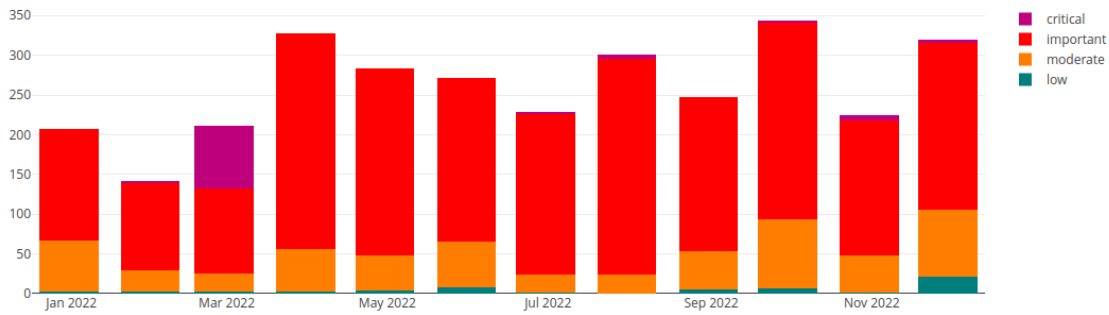


FIGURE 1: SECURITY UPDATES AND PATCHES RELEASED PER MONTH IN 2022

7 Secure Software Supply Chain

Securing our software supply chain is a top priority for SUSE to protect our customers security risks, known and zero-day vulnerabilities. Ensuring that no threat actor can inject malicious code into our build service systems is certified by industry leading security certifications. Our teams continually work to certify all SUSE products, and develop security solutions to offer our customers the highest level of trust and reliability.

A new industry standardization effort named Supply chain Levels for Software Artifacts (SLSA), started by Google and driven by several industry stakeholders, aims to protect the integrity of the software supply chain. SLSA defines four levels of assurance, going from basic requirements at level 1 to strict rules and documentation requirements at level 4. While the SLSA standard is still in development, SUSE already considers it as a great representation of needs for a secure product build environment. Thus we are adjusting our processes and tooling to meet the requirements of the highest assurance level 4. The main controls which are covering the highest assurance level 4 for our SUSE Linux Enterprise product offering include:

SOURCE CODE MANAGEMENT

Keeping source code integrity is the key aspect of supply chain integrity. Source code integrity needs to be defended against all threats originating from insider or outsider attacks.

- **Source threats:** Typical source code threats include bad code that introduces vulnerabilities or a compromised source control system. To address bad code injection, SLSA mandates two-person reviews. To prevent source code from getting compromised, SLSA mandates strong measures to secure the source control systems.
- **Build threats** Build threats include code commits to the build that were not tracked by the source control system, a compromised build platform, bypassing the CI/CD system, a compromised package repository, and injecting bad packages. Most build threats are mitigated by maintaining a controlled build environment, where each build is also fully encapsulated on its own, not influenceable from outside, or even reproducible. To prove this to the outside, detailed provenance data can be generated, which allows for the external inspection of the builds. Strong security controls ensure that the build platform is not easily compromised.
- **Dependency threats** Dependency threats come into play where risky dependencies are used. SLSA addresses this kind of threat by mandating provenance for all artifacts (files, Git commits, directories of files, container images, ...). That way one would have an indication that this dependency was not built from the proper builder or out of the designated GitHub repository.
- **Version-controlled source** Our Open Build Service complies with this requirement as it assigns numeric identifiers to commits. The commit stores information about the author, the commit time, a comment describing the commit, and other information. The commit also contains an identification of the source content, like the tree object in git.
- **Verified revision history:** Each commit stores information about the author and commit time. It also contains a comment describing the commit and other information. Identities of all actors are verifiable and use two-factor authentication.
- **Revision and change history are retained indefinitely:** We retain all sources, but also any shipped binary indefinitely. A retraction of a shipped update from the customer's channels does not lead to its removal from the build system. Furthermore, all source references and binary shipments including bug tracker references (CVE, bugzilla) are tracked by the build system for each shipment channel.
- **Two-person reviewed:** The workflows for creating a new product and delivering maintenance updates involve multiple parties, like the core code review team and the maintenance or product release managers as a minimum. Furthermore, there are reviews by subject matter experts and additional checks for quality assurance and legal aspects. These reviews are enforced by the OBS, and a single decline rejects the entire release process.

BUILDING AND BUILD SYSTEM

The next part of the integrity chain is the actual build process that turns sources to binaries. The entire build process must be secured against any kind of unknown or outside influence to avoid possible tampering with the builds. Builds must be reproducible to allow verification and checking of build results.

- **Scripted build:** This is achieved by the SUSE build script also used by the Open Build Service (OBS). Even the decision to invoke a build is made by OBS based on the submitted code changes or other builds.
- **Build service:** We are running our build service in a dedicated build cluster within the SUSE data center
- **Build as code:** The recipe files defining the build process are part of the sources of the individual packages, for example the RPM spec file, its sources and patches, or image and container description files. The build environment configuration (project config) is also under source control in OBS.
- **Isolated and Ephemeral environment** We are using an isolated KVM instance for each build. Access to the outside is not possible (no network), only the sources and binaries prepared by OBS can be used. OBS also decides which pieces of the build artifacts are used. This includes running Linux kernel in the VM.
- **Parameterless:** The build happens completely decoupled from any user interaction. Any parameter must be part of any source submission. No input is possible during the build, which is ensured by the KVM setup. The only output during the build is the build log.
- **Hermetic:** Our software builds in a KVM guest without network, and everything required for the build is injected before the build instance is brought up.
- **Reproducible:** Our OBS system tracks all used binaries for each build and can reproduce the build environment of any released binary. The binaries used are also referenced in in-toto provenance files and made available together with the sources starting from SUSE Linux Enterprise 15 SP4 builds. Older builds may have missing binaries because of the nature of the bootstrapping process. It is notable that the SUSE Linux Enterprise 15 code base is not enforcing binary identical reproducibility yet. Instead, builds are compared and known good differences are accepted (for example time stamps or build host name). This validation is done by the code in the build-compare package.

PROVENANCE

A key aspect of supply chain security is the ability to prove that a build has been completed / a package built according to all SLSA4-mandated requirements. This provenance is established by means of providing metadata that proves compliance to SLSA. The SLSA requirements for provenance include process requirements on provenance generation and consumption, and requirements on the contents of the provenance.

- **Source threats** Available
- **Source threats** Authenticated
- **Source threats** Service-generated
- **Source threats** Non-falsifiable
- **Source threats** Dependencies complete

SUSE is up to a great start with its effort to attain SLSA L4 compliance, as SLSA requirements partly overlap with the requirements of Common Criteria EAL4 + . This means that several SLSA criteria were met by SUSE's supply chain processes right from the start. The core part of this is our certified and proven build and integration process which uses the Open Build Service technology. Over the past few months, SUSE has been working on improving and tightening processes and technologies to be able to claim full SLSA L4 compliance.

For more information on our compliance with the Google SLSA Level 4 requirements, visit: <https://documentation.suse.com/sbp/server-linux/html/SBP-SLSA4/index.html> ↗

8 Adopting Sigstore for our Supply Chain Security

Sigstore is a recent initiative to enhance signing and cryptographic verification of open source deliveries. SUSE has adopted additional "cosign" style signing for its published container images including Base Container Images (BCI) containers. SUSE also started uploading cryptographic signatures to the global "rekor" transparency log for its containers and product repositories in February 2022. SUSE Linux Enterprise Base Container Images (SLE BCI) offer a platform for creating SUSE Linux Enterprise Server-based custom container images and containerized applications that can be distributed freely. SLE BCIs feature the same predictable enterprise lifecycle as SUSE Linux Enterprise Server. The SLE_BCI 15 SP3 and SP4 repository (which is a subset of the SUSE Linux Enterprise repository) gives SLE BCIs access to 4000 packages available for the

AMD64/Intel 64, AArch64, PowerPC, and IBM Z architectures. The packages in the repository have undergone quality assurance and security audits by SUSE. The container images are FIPS-compliant when running on a host in FIPS mode. In addition to that, SUSE can provide official support for SLE BCIs through SUSE subscription plans.

Security

Each package in the *SLE_BCI* repository undergoes security audits, and SLE BCIs benefit from the same mechanism of dealing with CVEs as SUSE Linux Enterprise Server. All discovered and fixed vulnerabilities are announced via e-mail, the dedicated CVE pages, and as OVAL and CVRF data. To ensure a secure supply chain, all container images are signed with Notary v1, Podman's GPG signatures, and Sigstore Cosign. We have also implemented support for cosign signatures on a rekor server, so you can also check BCI container images against rekor, the immutable tamper resistant ledger. All cosign signatures of containers and generated update repositories (GPG) are uploaded to the Linux Foundation's rekor transparency log.

Stability

Since SLE BCIs are based on SUSE Linux Enterprise Server, they feature the same level of stability and quality assurance. Similar to SUSE Linux Enterprise Server, SLE BCIs receive maintenance updates that provide bug fixes, improvements, and security patches. Tooling and integration SLE BCIs are designed to provide drop-in replacements for popular container images available on hub.docker.com. You can use the general-purpose SLE BCIs and the tools they put at your disposal to create custom container images, while the language stack SLE BCIs provide a foundation and the required tooling for building containerized applications.

Redistribution

SUSE Linux Enterprise Base Container Images are covered by a permissive EULA that allows you to redistribute custom container images based on such a SLE BCI.

9 Securing Our Product Portfolio

January 25th 2022

The Defense Information Systems Agency (DISA) has released the Security Content Automation Protocol (SCAP) for the SUSE Linux Enterprise Server 15 Security Technical Implementation Guide (STIG). The SCAP is available for download at https://dl.dod.cyber.mil/wp-content/uploads/stigs/zip/U_SLES_15_V1R1_STIG_SCAP_1-2_Benchmark.zip. DISA also released the automated benchmark for the SUSE Linux Enterprise Server 15 Security Technical Implementation Guide (STIG). The benchmark is also available on the Cyber Exchange public site at <https://public.cyber.mil/stigs/downloads>.

April 19th 2022

DISA released the SUSE Rancher Manager Security Technical Implementation Guide (STIG). The STIG is also available on the Cyber Exchange public site at https://dl.dod.cyber.mil/wp-content/uploads/stigs/zip/U_RGS_MCM_V1R1_STIG.zip

June 13th 2022

SUSE has translated its SUSE Security Situation Advisory Guide (SUSE S2 UAG) v. 1.1 into English. This guide provides an overview of possible immediate actions and approaches that can be taken with SUSE customer products. It can be accessed via https://links.imagerelay.com/cdn/3404/ql/0fb22d6c1aa740bf829f863d5841981a/SUSE_Security_Situation_Advisory_Guide__SUSE_S2UAG.pdf

June 29th 2022

SUSE became a collaborator with the National Institute of Standards and Technology (NIST) on the Automation of the Cryptographic Module Validation Program (ACMVP). "The National Cybersecurity Center of Excellence (NCCoE), a part of NIST, is a collaborative hub where industry organizations, government agencies, and academic institutions work together to address businesses' most pressing cybersecurity challenges. Through this collaboration, the NCCoE develops modular, easily adaptable example cybersecurity solutions using standards, best practices, and commercially available technology." SUSE looks forward to our joint activities with NIST and the other vendors in the program. You can read more at the NIST ACMVP Web site.

August 1st 2022

SUSE was awarded the Certificate of Software Quality Level 1 (Certificate #22-0353), also known as the Good Software (GS) Certification, by the Telecommunications Technology Association (TTA) of the Republic of Korea, for its SUSE Linux Enterprise Server 15. "The GS (Good Software) Certification certifies good quality software based on international standards, ISO/IEC 25023, 25051 and 25041 to improve the quality of software products and promote the spread of high quality products." Certificate can be viewed at https://sw.tta.or.kr/product/prod_gsce_view.jsp?num=7255&pa=2d56c77a3d1739509363eafd002e37bb

October 31st 2022

The Defense Information Systems Agency (DISA) released SUSE Rancher Kubernetes Engine 2 Security Technical Implementation Guide (STIG). This content is published as a resource to assist in the application of security guidance to systems. The STIG may be accessed at https://dl.dod.cyber.mil/wp-content/uploads/stigs/zip/U_RGS_RKE2_V1R1_STIG.zip

December 6th 2022

SUSE successfully implemented ISO 27001 and ISO 27701 in full scope and with all of the clauses and achieved certification of our Information Security Management System (ISMS) and the Privacy Information Management System (PIMS) to the respective standards, attesting to our commitment of secure innovation, with focus on privacy, rights and freedoms of individuals. In doing so, SUSE has obtained two certifications from NQA, the leading independent provider of environmental simulation testing, inspection and certification services. They span everything within SUSE and our entities, including all countries we operate in, subsidiaries and all processes. The ISMS & PIMS of SUSE (as PII Controller and Processor) applies to all client facing services, internal services, processed information including personal data related to employees, clients, openSUSE Community and other interested parties, related IT and non-IT supporting infrastructure as detailed in the latest Statement of Applicability version 1.0.

For additional information, you can download the certifications accessing the below links: ISO 27001: <https://www.suse.com/assets/GB235856-HO-ISMS.pdf> ISO 27701: <https://www.suse.com/assets/GB235856-HO-PIMS.pdf>

10 About SUSE

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