Kernel Live Patching on SUSE Linux Enterprise Server for NVIDIA

Kernel Live Patching in SUSE Linux Enterprise Server for NVIDIA makes it possible to apply critical security updates and stability fixes to the running Linux kernel without rebooting. By redirecting execution to updated code in memory, Kernel Live Patching eliminates planned downtime, maintains compliance and ensures continuous availability for mission-critical enterprise workloads.

Prerequisites

- Working knowledge of Linux system administration
- An active subscription with access to live patching update channels

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1 Introduction to Kernel Live Patching

Kernel Live Patching (KLP) makes it possible to apply the latest security updates to Linux kernels without rebooting. This maximizes system uptime and availability, which is particularly important for mission-critical systems. As such, KLP offers several benefits.

- Keeping a large number of servers automatically up-to-date is essential for organizations obtaining or maintaining certain compliance certifications. KLP can help achieve compliance, while reducing the need for maintenance windows.
- Companies that work with service-level agreement contracts must guarantee a certain level of the system accessibility and uptime. Live patching makes it possible to patch systems without incurring downtime.
- Since KLP is part of the standard system update mechanism, there is no need for specialized training or introduction of additional maintenance routines.

1.1 Kernel Live Patching scope

The scope of SLE for NVIDIA Live Patching includes fixes for SUSE Common Vulnerability Scoring System (CVSS) level 7+ vulnerabilities and bug fixes related to system stability or data corruption. However, it may not be technically feasible to create live patches for all fixes that fall under the specified categories. SUSE therefore reserves the right to skip fixes in situations where creating a kernel live patch is not possible for technical reasons. Currently, over 95% of qualifying fixes are released as live patches. SUSE CVSS is based on the CVSS v3.0 system. For more information on CVSS, see Common Vulnerability Scoring System SIG (https://www.first.org/cvss/).

1.2 Kernel Live Patching limitations

KLP involves replacing functions and gracefully handling replacement of interdependent function sets. This is done by redirecting calls to old code to updated code in a different memory location. Changes in data structures make the situation more complicated, as the data remain in place and cannot be extended or reinterpreted. While there are techniques that allow indirect alteration of data structures, certain fixes cannot be converted to live patches. In this situation, a system restart is the only way to apply the fixes.

2 Understanding kernel live patches

Kernel live patches are installed as part of regular system updates. Kernel live patches are delivered as packages with modified code that are separate from the main kernel package. The live patches are cumulative, so the latest patch contains all fixes from the previous ones for the kernel package. Each kernel live package is tied to the exact kernel revision for which it is issued. The live patch package version number increases with every addition of fixes. To determine the kernel patching status, use the **`klp -v patches`** command.

Live patches contain only critical fixes, and they do not replace regular kernel updates that require a reboot. Consider live patches as temporary measures that protect the kernel until a proper kernel update and a reboot are performed.

The diagram below illustrates the overall relationship between live patches and kernel updates. The list of CVEs and defect reports addressed by the currently active live patch can be viewed using the **`klp -v patches`** command.

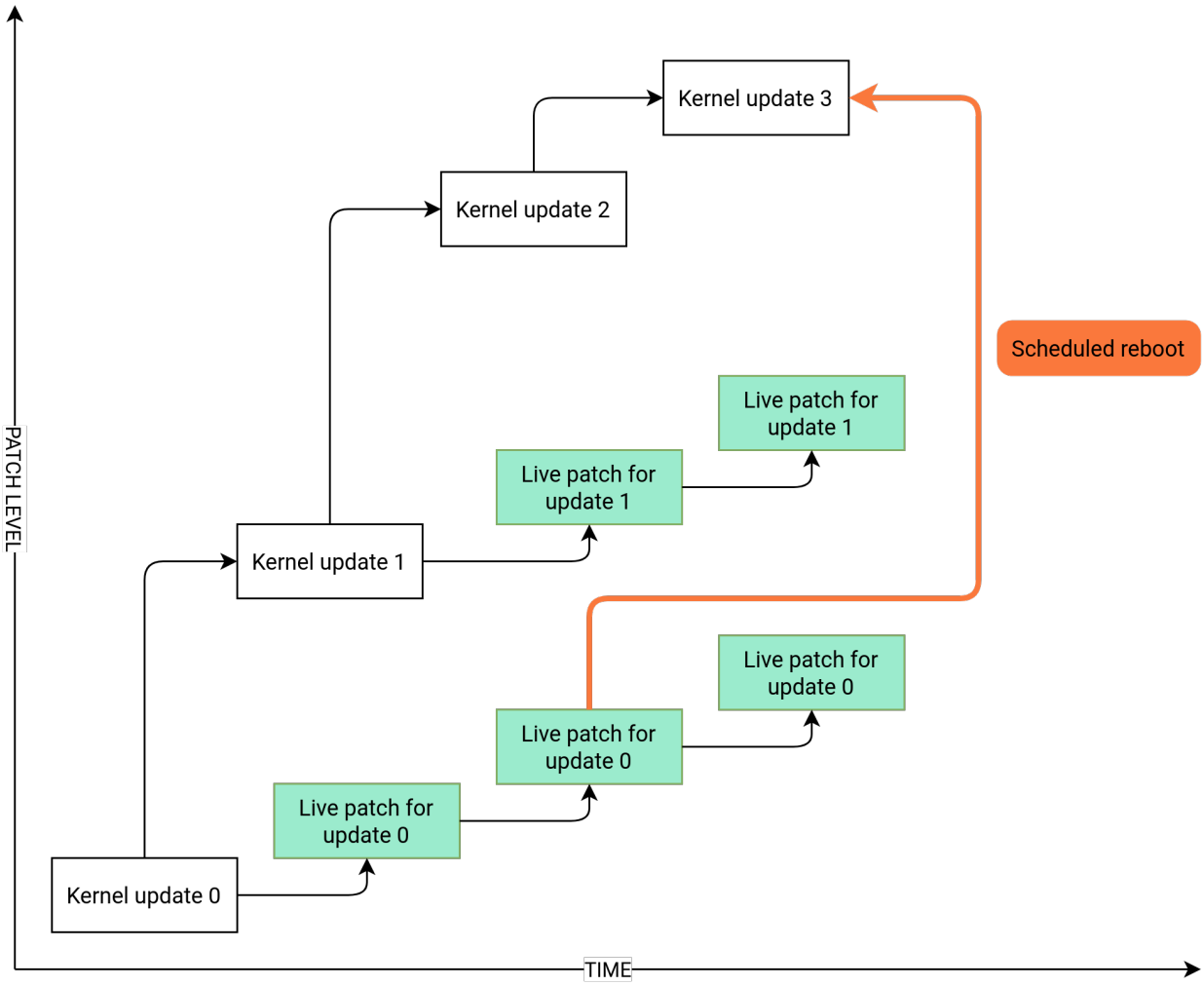


FIGURE 1: RELATIONSHIP BETWEEN LIVE PATCHES AND KERNEL UPDATES

It is possible to have multiple versions of the kernel package installed along with their live patches. These packages do not conflict. You can install updated kernel packages along with live patches for the running kernel. In this case, you may be prompted to reboot the system. Users with SLE for NVIDIA Live Patching subscriptions are eligible for technical support as long as there are live patch updates for the running kernel.

With KLP activated, every kernel update comes with a live patch package. This live patch does not contain any fixes and serves as a seed for future live patches for the corresponding kernel. These empty seed patches are called `initial patches`.

Keep in mind that while there may be multiple kernel packages installed on the system, only one of them is running at any given time. Similarly, there may be multiple live patch packages installed, but only one live patch is loaded into the kernel.

The active live patch is included in the `initrd`. This means that in case of an unexpected reboot, the system comes up with the live patch fixes applied, so there is no need to perform patching again.

3 Activating Kernel Live Patching from the command line

Kernel Live Patching is included in the standard SLE for NVIDIA subscription. To use it, you need to install the following pattern:

```
# zypper install -t pattern kernel_livepatching
```

At this point, the system has already been live-patched.

Here is how the process works behind the scenes: when the package installation system detects that there is an installed kernel that can be live-patched, and that there is a live patch for it in the software channel, the system selects the live patch for installation. The kernel then receives the live patch fixes *as part of the package installation*. The kernel gets live-patched even before the product installation is complete.

4 Troubleshooting Kernel Live Patching issues

4.1 Checking expiration date of the live patch

Make sure that the `lifecycle-data-sle-module-live-patching` is installed, then run the **`zypper lifecycle`** command. You should see expiration dates for live patches in the `Package end of support if different from product` section of the output.

Every live patch receives updates for 13 months from the release of the underlying kernel package. The Maintained kernels, patch updates and lifecycle (https://www.suse.com/products/live-patching/current-patches/) page allows you to check expiration dates based on the running kernel version without installing the product extension.

4.2 Checking what kernel live patch packages are installed

The kernel is live-patched if a `kernel-livepatch-*` package has been installed for the running kernel. You can use the command **`zypper se --details kernel-livepatch-*`** to check what kernel live patch packages are installed on your system.

4.3 Preventing reboot

When the `kernel-default` package is installed, the update manager prompts you to reboot the system. To prevent this message from appearing, you can filter out kernel updates from the patching operation. This can be done by adding package locks with Zypper.

4.4 Check patching status

You can check patching status using the **`klp status`** command. To examine installed patches, run the **`klp -v patches`** command.

4.5 Downgrading a kernel patch

If you find the latest live patch problematic, you can downgrade the currently installed live patch back to its previous version. Keep in mind that a system with kernel warnings or kernel error traces in the system log may not be suitable for the patch downgrade procedure. If you are unsure whether the system meets the requirements for a patch downgrade, contact SUSE Technical Support for help.

To downgrade the latest kernel live patch, use the **`klp downgrade`** command. This command automatically detects the version of the latest live patch and installs the preceding one.

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