

# Creating a User Space Live Patch

## WHAT?

A guide on how to create a live patch on a system library.

## WHY?

You want to understand the entire process of patching a library using user space live patching.

## EFFORT

Approx. 5 minutes reading time.

## GOAL

You will be able to create your own live patch.

Publication Date: 05 Mar 2026

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# 1 Creating user space live patches

The following sections describe how to create live patches for libraries using the `libpulp`. The task comprises the following actions:

- creating the patch
- testing the patch
- packing the patch into an RPM
- deploying the patch

For more information regarding `libpulp`, refer to the [ULP documentation \(https://documentation.suse.com/sles/html/SLES-administration/#cha-ulp\)](https://documentation.suse.com/sles/html/SLES-administration/#cha-ulp).

## 2 Creating a live patch for a system library

In the procedure below, you will create a live patch for the `malloc` function. The patched function will initialize the memory allocated by the function with the string `glibc-livepatches`. To create the live patch, proceed as follows:

1. Create a test program that checks if a live patch has been applied. The program should just allocate a region in memory and check if the string is there. An example follows:

```
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <stdbool.h>
#include <string.h>

#define NUM_ATTEMPTS 30
#define LEN 32

static const char *const lp_string = "glibc-livepatch";

int main(int argc, char *argv[])
{
    for (int i = 0; i < NUM_ATTEMPTS; i++) {
        bool flag = false;
        char *m = malloc(LEN);
        m[LEN-1] = '\0';
```

```
fprintf(stderr, "%s\n", m);

if (m) {
    if (!strcmp(m, lp_string)) {
        flag = true;
    }
    free(m);
}

m = calloc(1, 32);
if (m) {
    free(m);
} else if (flag) {
    return 0;
}
sleep(1);
}

return 1;
}
```

2. Compile the program:

```
> gcc -o test test.c
```

3. Create a file containing the new `malloc` function, for example, `libc_livepatch1.c`. The code snippet shown below implements the new `malloc` function by using the `calloc` function to allocate memory and then overwrite its content with the `glibc-livepatch` string. The file is called `libc_livepatch1.c`.

```
#include <stdlib.h>
#include <string.h>

#define MIN(x, y) ((x) < (y) ? (x) : (y))

static const char *const lp_string = "glibc-livepatch";

void *malloc_lp(size_t s)
{
    char *block = calloc(1, s);
    if (block && s > 0) {
        int lp_string_len = strlen(lp_string);
        int copy_len = MIN(lp_string_len + 1, s);

        memcpy(block, lp_string, copy_len);
        block[s-1] = '\0';
    }
}
```

```
}  
return block;  
}
```

Compile the file for x86 as follows:

```
> gcc -fPIC -fpatchable-function-entry=16,14 -shared -o libc_livepatch1.so  
libc_livepatch1.c
```

4. Create a live patch description file. The file must contain the following information:

- A path to the live patch container, in this case the path to the `libc_livepatch1.so.6` file.
- A path to the target library— `/lib64/libc.so.6` in this case.
- The function name that will be patched and its replacement. You can also describe multiple replacements.
- The description file for the example live patch looks as follows:

```
libc_livepatch1.so  
@/lib64/libc.so.6  
__libc_malloc:malloc_lp
```

The patch is for the `__libc_malloc` function, not for `malloc`, because the `malloc` name is an indirect function, not a regular function, and in the end it calls the `__libc_malloc` function. For details about ifunc, refer to the [indirect function \(https://sourceware.org/glibc/wiki/GNU\\_IFUNC\)](https://sourceware.org/glibc/wiki/GNU_IFUNC) description.

5. Build the live patch container:

```
> gcc -fPIC -fpatchable-function-entry=16,14 -shared -o libc_livepatch1.so  
libc_livepatch1.c
```

6. Embed the description file into the live patch container:

```
> ulp packer libc_livepatch1.dsc
```

## 3 Testing the live patch

After you prepare the live patch and its test program as described in [Section 2, “Creating a live patch for a system library”](#), you can test if the live patch works:

1. Launch the test program:

```
> LD_PRELOAD=/usr/lib64/libpulp.so.0 ./test
```

2. Install the live patch:

```
> ulp trigger libc_livepatch.so
```

If the installation was successful, the ULP tool displays the message `SUCCESS`. You should also see the `glibc-livepatch` message from the test program.

## 4 Files required in a live patch package

To prepare a live patch package, use the `glibc-livepatches` (<https://build.opensuse.org/package/show/home:gbelinassi/glibc-livepatches>)<sup>7</sup> as a reference source. The package contains the following files:

- `glibc-livepatches.spec`; for details, refer to [Section 4.1, “The `glibc-livepatches.spec` file”](#).
- `glibc-livepatches-VERSION.tar.xz`; for details, refer to [Section 4.2, “The `glibc-livepatches.tar.xz` file”](#).

### 4.1 The `glibc-livepatches.spec` file

The `glibc-livepatches.spec` file contains instructions on how to prepare, build, install and apply the live patch.

The file also calls the `ulp_post_hook` script. The script calls the ULP trigger with extracted boilerplate code to avoid adding such a code to every package. To check the code, view the file `/usr/lib/userspace-livepatch/rpm-helper`. The call to the ULP trigger is performed with the `-revert-all` command that reverts all already installed patches. Make sure that your patch is cumulative and contains fixes for the previous versions of the patch.

## 4.2 The `glibc-livepatches.tar.xz` file

The `glibc-livepatches.tar.xz` file contains the actual source code of the live patch. The archive must also contain information about all `glibc` versions issued for the particular SLES version.

## 5 Making an RPM from the live patch

To prepare a live patch package, follow the steps below:

1. Extract the `glibc-livepatches` package.
2. Add the live patch source files.
3. Run the following command to update the package so that it includes all `glibc` versions released for the particular SLES version.

```
> make download
```

4. Run the following command to check if the live patch is buildable.

```
> make
```

If the process is successfully completed, one `.so` file is created for each `glibc` version. For example, `libc_2.31-150300.26.5_livepatch1.so`.

5. To ensure that your package does not contain any of your temporary build files, run the command:

```
> make clean
```

6. To create a new `.tar.xz`, run the command:

```
> make dist
```

7. Build the package with [OSC](https://github.com/openSUSE/osc) (<https://github.com/openSUSE/osc>).
8. If the build is successful, you can upload the package to a repository.

## 6 Deploying the live patch package

If you have the `RPM` package ready and tested, you can submit a merge request to the `glibc-livepatches` SLES16.0 update repository.

```
> osc -A https://api.suse.de mr YOUR_HOME glibc-livepatches SUSE:SLE-15-SP5:GA
```

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