SUSE

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: 08 Oct 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).

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— `/usr/lib64/libc.so` 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
     @/usr/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) 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) 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/user-space-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).
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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