

NAME

new system call – How to add a new system call to libexplain

DESCRIPTION

Adding a new system call to libexplain is both simple and tedious.

In this example, the system call is called *example*, and takes two arguments, *pathname* and *flags*.

```
example(const char *pathname, int flags);
```

The libexplain library presents a C interface to the user, and explains the C system calls. It tries to avoid dynamic memory, and has several helper functions and structures to make this simpler.

Naming Conventions

In general, one function per file. This gives the static linker more opportunity to leave things out, thus producing smaller executables. Exceptions to make use of `static` common functions are acceptable. No savings for shared libraries, of course.

Functions that write their output into a *explain_string_buffer_t* via the `explain_string_buffer_*` functions, all have a filename of `libexplain/buffer/something`.

Functions that write their output to a *message*, *message_size* pair have a message path component in their file name.

Functions that accept an *errno* value as an argument have an `errno` path component in their file name, called `errnum`. If a function has both a buffer and an `errno`, the buffer comes first, both in the argument list, and the file's name. If a function has both a message+size and an `errno`, the message comes first, both in the argument list, and the file's name.

MODIFIED FILES

Note that the *codegen* command does most of the work for you. Pass it the function prototype (in single quotes) and it will do most of the work.

```
$ bin/codegen 'example(const char *pathname, int flags);'
creating catalogue/example
$
```

then you must edit the `catalogue/example` file to make any adjustment necessary. This file is then used to do the boring stuff:

```
$ bin/codegen example
creating explain/syscall/example.c
creating explain/syscall/example.h
creating libexplain/buffer/errno/example.c
creating libexplain/buffer/errno/example.h
creating libexplain/example.c
creating libexplain/example.h
creating libexplain/example_or_die.c
creating man/man3/explain_example.3
creating man/man3/explain_example_or_die.3
creating test_example/main.c
modify explain/syscall.c
modify libexplain/libexplain.h
modify man/man1/explain.1
modify man/man3/explain.3
$
```

All of these files have been added to the Aegis change set. Edit the last 4 to place the appended line in their correct positions within the files, respecting the symbol sort ordering of each file.

libexplain/libexplain.h

The `libexplain/libexplain.h` include file defines the user API. It, and any files it includes, are installed into `$(prefix)/include` by *make install*.

This file needs another include line. This means that the entire API is available to the user as a single

include directive.

```
#include <libexplain/example.h>
```

This file is also used to decide which files are installed by the *make install* command.

Take care that none of those files, directly or indirectly, wind up including `libexplain/config.h` which is generated by the *configure* script, and has **no** namespace protection.

This means you can't `#include <stddef.h>`, or use any of the types it defines, because on older systems *configure* works quite hard to cope with its absence. Ditto `<unistd.h>` and `<sys/types.h>`.

explain/main.c

Include the include file for the new function, and add the function to the table.

man/man1/explain.1

Add a description of the new system call.

man/man3/libexplain.3

Add your new man pages, `man/man3/explain_example.3` and `man/man3/explain_example_or_die.3`, to the list. Keep the list sorted.

NEW FILES

Note that the *codegen* command does most of the work for you. Pass it the function prototype (in single quotes) and it will do most of the work.

libexplain/buffer/errno/example.c

The central file for adding a new example is `libexplain/buffer/errno/example.c` Which defines a function

```
void explain_buffer_errno_example(explain_string_buffer_t *buffer,
int errnum, const char *pathname, int flags);
```

The `errnum` argument holds the *errno* value. Note that calling *errno* usually has problems because many systems have *errno* as a macro, which makes the compiler barf, and because there are times you want access to the global *errno*, and having it shadowed by the argument is a nuisance.

This function writes its output into the buffer via the `explain_string_buffer_printf`, *etc*, functions. First the argument list is reprinted.

The `explain_string_buffer_puts_quoted` function should be used to print pathnames, because it uses full C quoting and escape sequences.

If an argument is a file descriptor, it should be called *fildes*, short for “file descriptor”. On systems capable of it, the file descriptor can be mapped to a pathname using the `explain_buffer_fildes_to_pathname` function. This makes explanations for system calls like *read* and *write* much more informative.

Next comes a switch on the `errnum` value, and additional explanation is given for each `errno` value documented (or sometimes undocumented) for that system call. Copy-and-paste of the man page is often useful as a basis for the text of the explanation, but be sure it is open source documentation, and not Copyright proprietary text.

Don't forget to check the existing `libexplain/buffer/e*.h` files for pre-canned explanations for common errors. Some pre-canned explanations include

| | |
|--------------|---|
| EACCES | <code>explain_buffer_eaccess</code> |
| EADDRINUSE | <code>explain_buffer_eaddrinuse</code> |
| EAFNOSUPPORT | <code>explain_buffer_eafnosupport</code> |
| EBADF | <code>explain_buffer_ebadf</code> |
| EFAULT | <code>explain_buffer_efault</code> |
| EFBIG | <code>explain_buffer_efbig</code> |
| EINTR | <code>explain_buffer_eintr</code> |
| EINVAL | <code>explain_buffer_einval_vague, etc</code> |

| | |
|--------------|-----------------------------|
| EIO | explain_buffer_eio |
| ELOOP | explain_buffer_eloop |
| EMFILE | explain_buffer_emfile |
| EMLINK | explain_buffer_emlink |
| ENAMETOOLONG | explain_buffer_enametoolong |
| ENFILE | explain_buffer_enfile |
| ENOBUFFS | explain_buffer_enobufs |
| ENOENT | explain_buffer_enoent |
| ENOMEM | explain_buffer_enomem |
| ENOTCONN | explain_buffer_enotconn |
| ENOTDIR | explain_buffer_enotdir |
| ENOTSOCK | explain_buffer_enotsock |
| EROFS | explain_buffer_erofs |
| ETXTBSY | explain_buffer_etxtbsy |
| EXDEV | explain_buffer_exdev |

libexplain/buffer/errno/example.h

This file holds the function prototype for the above function definition.

libexplain/example.h

The file contains the user visible API for the *example* system call. There are five function prototypes declared in this file:

```
void explain_example_or_die(const char *pathname, int flags) ;
void explain_example( const char *pathname, int flags) ;
void explain_errno_example(int errnum, const char *pathname, int flags) ;
void explain_message_example(const char *message, int message_size,
const char *pathname, int flags) ;
void explain_message_errno_example(const char *message, int message_size, int errnum, const char *pathname, int flags) ;
```

The function prototypes for these appear in the libexplain/example.h include file.

Each function prototype shall be accompanied by thorough Doxygen style comments. These are extracted and placed on the web site.

The buffer functions are **never** part of the user visible API.

libexplain/example_or_die.c

One function per file, explain_example_or_die in this case. It simply calls *example* and then, if fails, explain_example to print why, and then exit(EXIT_FAILURE).

libexplain/example.c

One function per file, explain_example in this case. It simply calls explain_errno_example to pass in the global *errno* value.

libexplain/errno/example.c

One function per file, explain_errno_example in this case. It calls explain_message_errno_example, using the <libexplain/global_message_buffer.h> to hold the string.

libexplain/message/example.c

One function per file, explain_message_example in this case. It simply calls explain_message_errno_example to pass in the global *errno* value.

libexplain/message/errno/example.c

One function per file, explain_message_errno_example in this case. It declares and initializes a explain_string_buffer_t instance, which ensures that the message buffer will not be exceeded, and passes that buffer to the explain_buffer_errno_example function.

man/man3/explain_example.3

This file also documents the error explanations functions, except `explain_example_or_dir`. Use the same text as you did in `libexplain/example.h`

man/man3/explain_example_or_die.3

This file also documents the helper function. Use the same text as you did in `libexplain/example.h`

explain/example.c

Glue to turn the command line into arguments to a call to `explain_example`

explain/example.h

Function prototype for the above.

test_example/main.c

This program should call `explain_explain_or_die`.

NEW IOCTL REQUESTS

Each different `ioctl(2)` request is, in effect, yet another system call. Except that they all have appallingly bad type safety. I have seen fugly C++ classes with less overloading than `ioctl(2)`.

libexplain/iocontrol/request_by_number.c

This file has one include line for each `ioctl(2)` request. There is a `table` array that contains a pointer to the `explain_iocontrol_t` variable declared in the include file (see next). Keep both sets of lines sorted alphabetically, it makes it easier to detect duplicates.

libexplain/iocontrol/name.h

Where *name* is the name of the `ioctl(2)` request in lower case. This declares an global const variable describing how to handle it.

libexplain/iocontrol/name.c

This defines the above global variable, and defines any static glue functions necessary to print a representation of it. You will probably have to read the kernel source to discover the errors the `ioctl` can return, and what causes them, in order to write the explanation function; they are almost never described in the man pages.

TESTS

Write at least one separate test for each case in the `errno` switch.

Debian Notes

You can check that the Debian stuff builds by using

`apt-get install pbuilder`

`pbuilder create`

`pbuilder login`

now copy the files from `web-site/debian/` into the chroot

`cd libexplain-*`

`dpkg-checkbuilddeps`

`apt-get install what dpkg-checkbuilddeps said`

`apt-get install devscripts`

`debuild`

This should report success.

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libexplain version

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