# FUSE File System in User Space

https://www.kernel.org/doc/Documentation/filesystems/fuse.txt

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# FUSE Overview

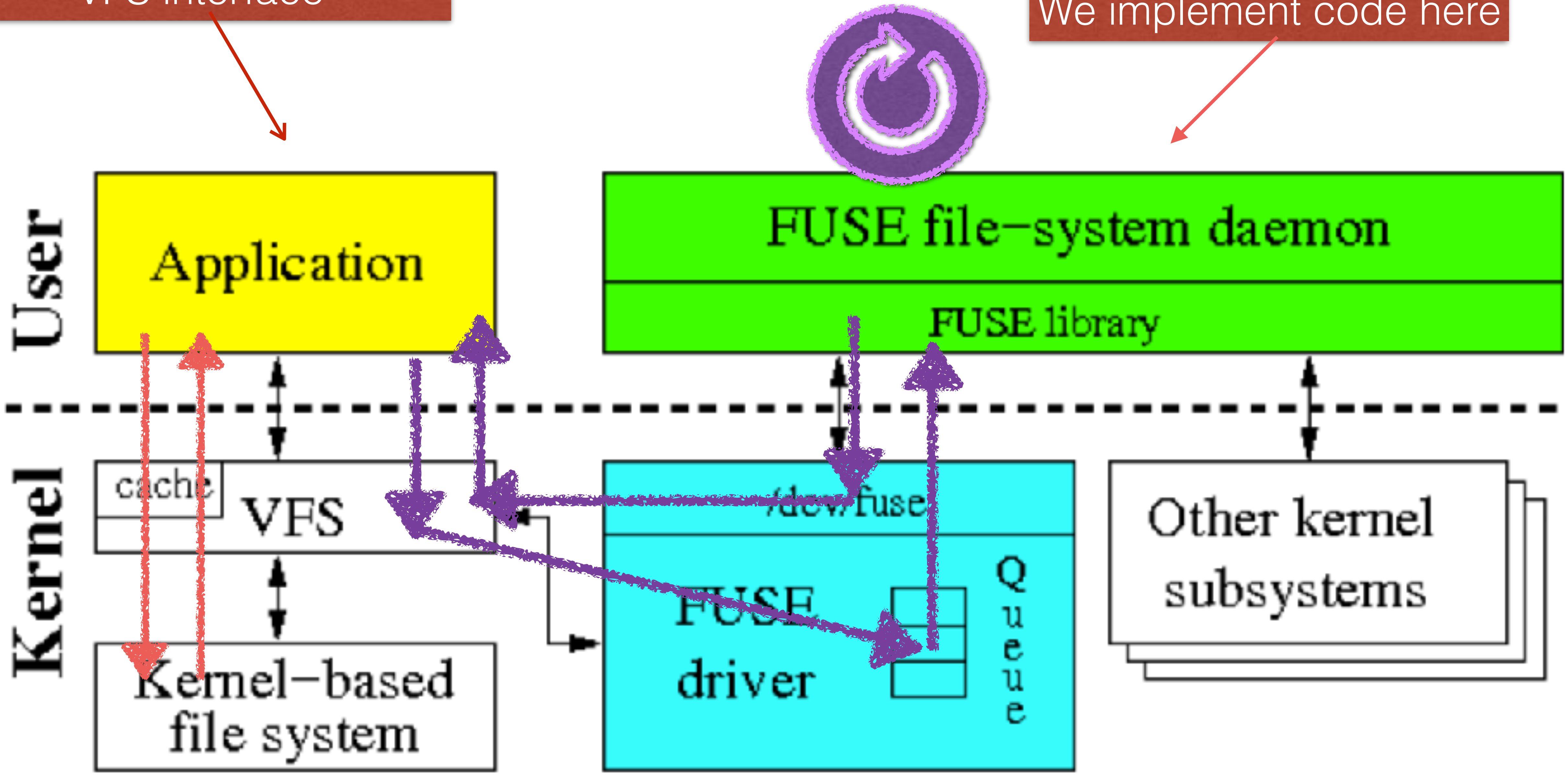
- The FUSE framework lets application writers create userspace file systems
  - + Faster and more convenient development
  - + Write and debug code using familiar tools
  - - Performance is often slower

- FUSE Consists of three parts:
  - FUSE kernel module
  - **`libfuse`**
  - **`fusermount`**

# Fuse Kernel Module

Applications use standard VFS interface

We implement code here



https://cdn-images-1.medium.com/max/1600/1*cExIHzPTy_RoRJalDui9pA.png

# “Userspace side” of FS Implementation

- `libfuse` provides an implementation of the FUSE interface for communicating with the FUSE kernel module.
  - `libfuse` v3 broke backwards compatibility;
    we’ll be using v2.9.5 (the default version on Ubuntu 20.04)
  - Look at appropriate “git tag” to see correct source code

- By following templates in the `examples/` directory, we can see what infrastructure “simple” file systems require

- ***General idea***: similar to implementing a “real” file system
  - implement well-defined functions
  - register a C struct that holds our function pointers so our code is called by FUSE daemon (hooks)

# Fusermount

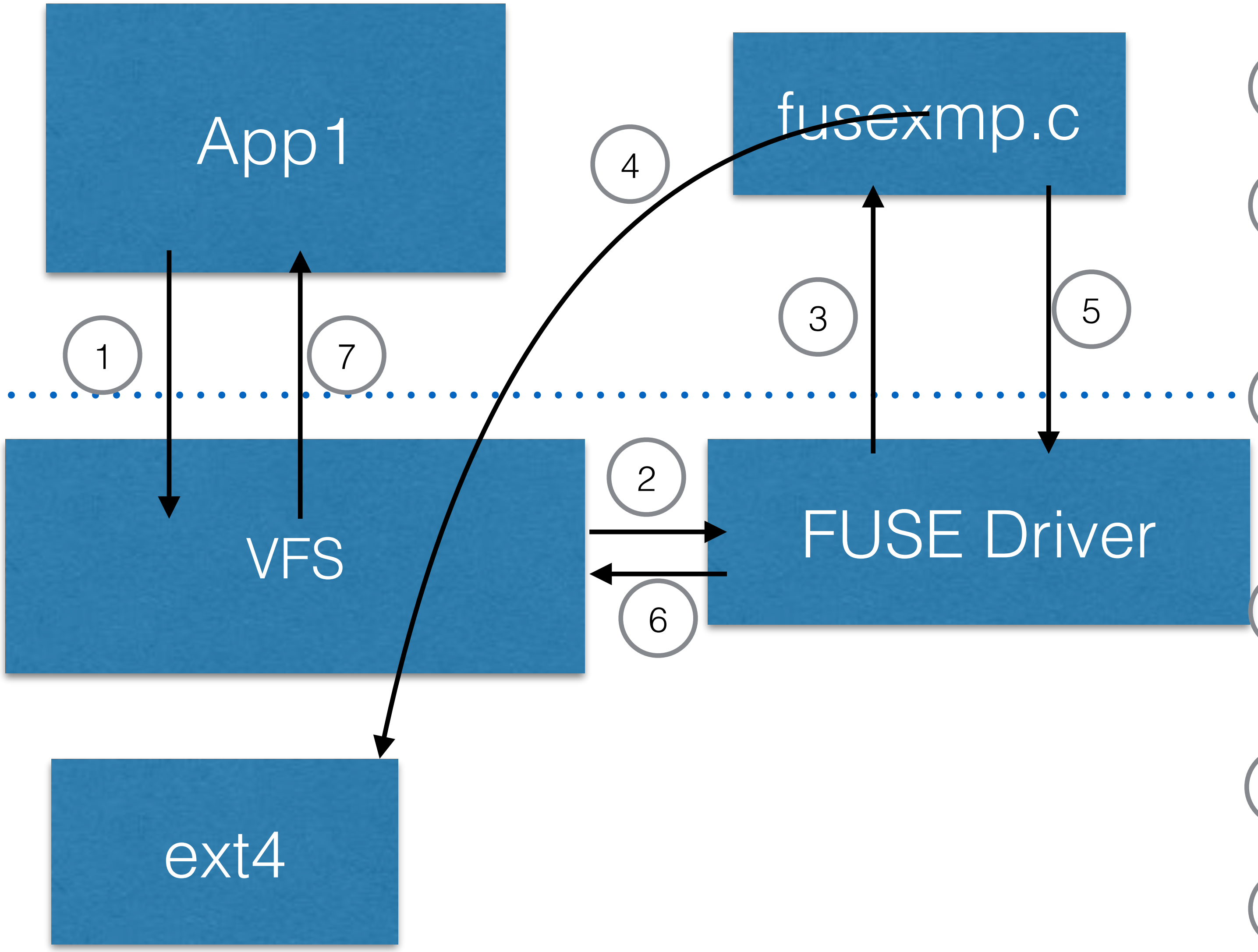
- Mounting a file system typically requires root privileges
- Users can mount/unmount their own FUSE filesystems.
  - The **`fusermount`** program is installed ***`setuid root`***.
- However, there are restrictions:
    - You can only mount a FUSE FS on a mountpoint where your user has write permission
- Notes on general workflow:
  - Running your compiled FUSE FS program will mount it
  - Using the standard **`mount`** utility lists all mounted file systems, including FUSE file systems
  - **`fusermount -u mntpnt`** can unmount your FUSE FS

# Common Uses for FUSE FSes

- “Pass-through” file system
  - fusexmp.c
- “Pseudo” file system
  - hello.c
- Prototypes/proof-of-concept designs
  - TokuFS
- Adding functionality that would be hard to provide inside the kernel
  - E.g., FS that relies on user-space libraries or APIs

# Example: “fusexmp.c” Pass-through FS

**Goal**: pass operations through to lower FS, (ext4) as if the FUSE FS was not there



1 App1 performs an operation on a file

2 The request is sent to the FUSE driver

3 The FUSE driver calls the corresponding function in fusexmp.c

4 fusexmp performs the requested operation on the underlying file system (here, ext4).

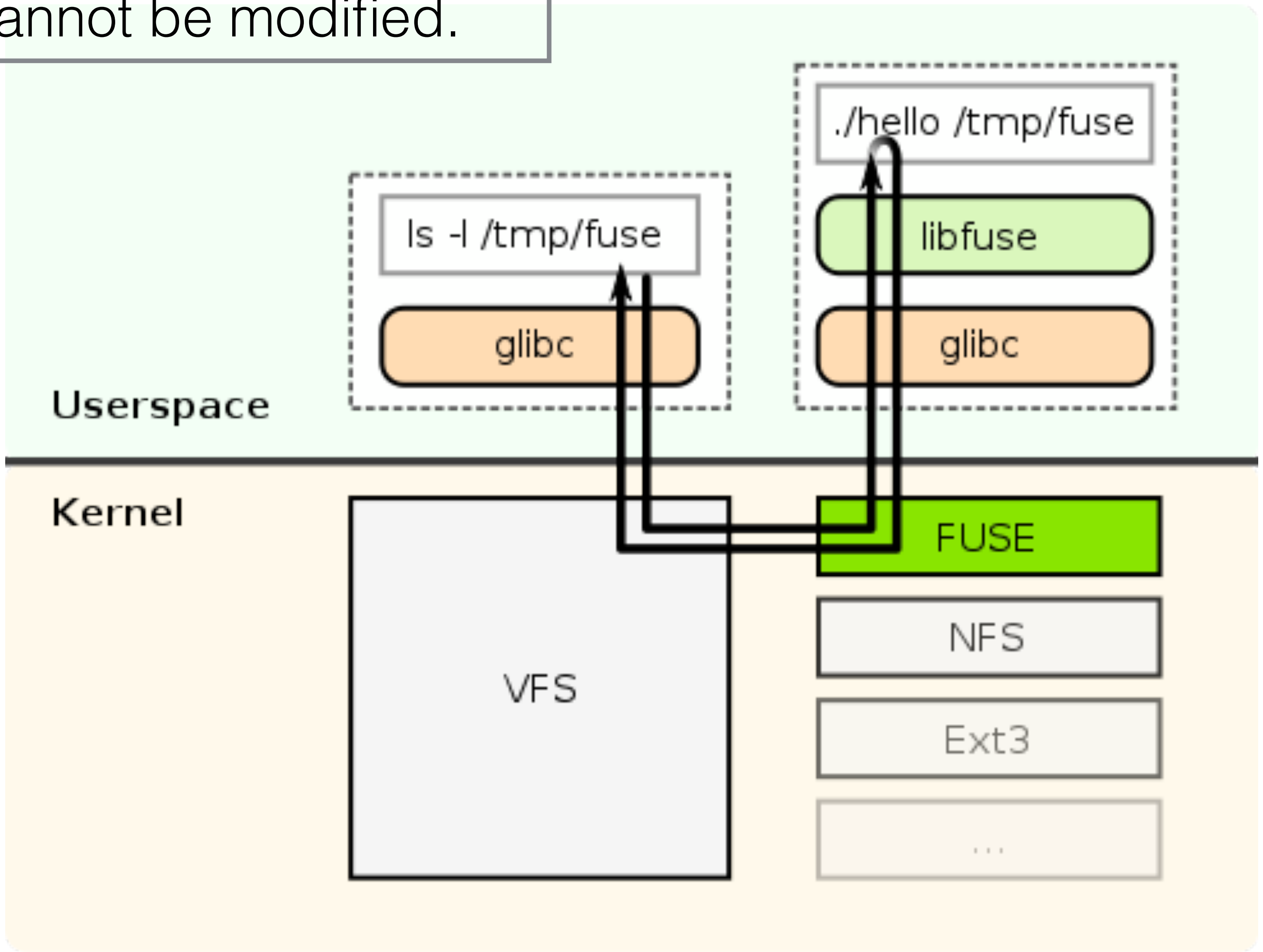
5 When fusexmp is done, it returns from the FUSE function to the FUSE Driver

6 The FUSE driver returns back to the VFS

7 The VFS returns back to the application

# Example: “hello.c” In-memory FS

**Goal**: simulate a single read-only file. The file is called “hello”; it does not exist on disk and it cannot be modified.



https://msreekan.com/2012/05/22/fuse-file-system-port-for-embedded-linux/

# FUSE Demo

- Compile a FUSE FS

  Remember to use appropriate gcc flags

- Run the FS to mount it

  In example, the argument is the mount point

- Example usage

  Operations on your file system are translated into calls to your FUSE functions

- Unmount using `fusermount`

  Use the `-u` flag