OS 161 - Adding System Calls

(Detailed Version)

Overview

1. Kernel-level steps
2. User-level steps
3. Testing the new system call

Kernel-level steps

1. Add the prototype of the system-call function to the header file: **`kern/include/syscall.h`**

2. The kernel-level implementation (e.g., **`newsyscall.c`**) goes into **`kern/syscall/`**

3. Add a new ID number for the system call. The new entry goes in the file **`kern/include/kern/syscall.h`**

4. Add a new branch in the switch-case statement in: **`kern/arch/mips/syscall/syscall.c`**

5. Add *file entry* definition for **`syscall/newsyscall.c`** in **`kern/conf/conf.kern`**

User-level steps

1. Add the user-level prototype of the system call to: `user/include/unistd.h`

2. Add the user-level test function. For this, create a new subdirectory directory `user/testbin/testnewsyscall/` and inside it add the test function (e.g., `testnewsyscall.c`).

3. Create a *Makefile* inside this subdirectory for building the test function. You can use one of the subdirectories as a template.

4. Add an entry to the new function to the top-level *Makefile* in `user/testbin`

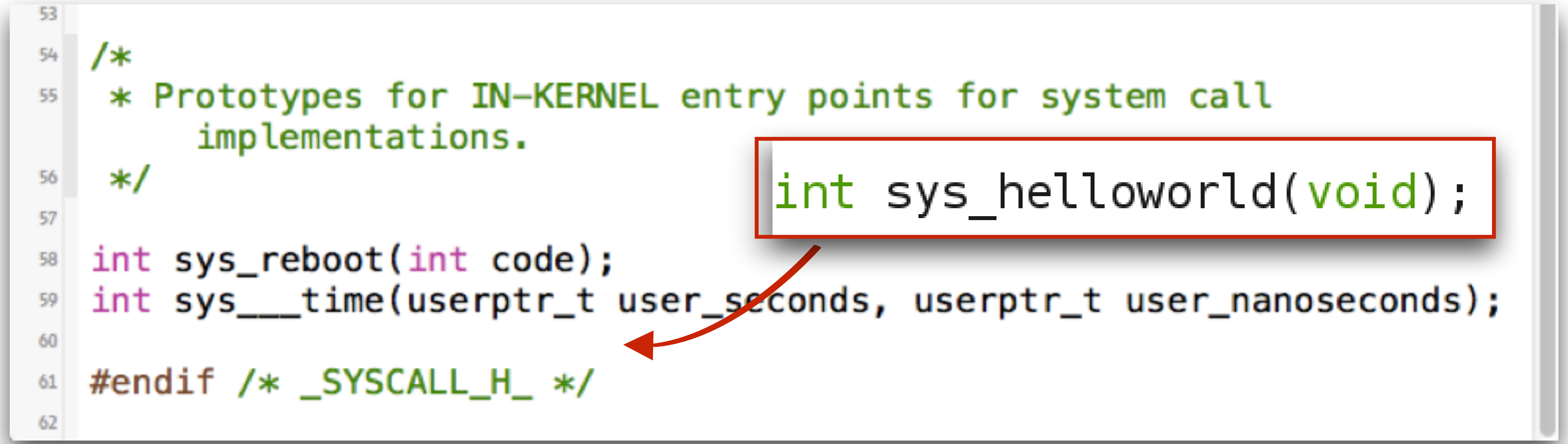
Testing the new system call

1. Re-build the kernel
2. Start the new kernel (i.e., run **`sys161 kernel`** in the root directory)
3. At the OS161 prompt, use the *p option* (from OS161 menu) to run the test program, i.e., **`p testbin/testnewsyscall`**

1. **Kernel-level steps**
2. User-level steps
3. Testing the new system call

1 Prototype of the system call

- Add the prototype of the system call to the header file: `kern/include/syscall.h`
- In the end of the file, you will find prototypes for `sys_reboot()` and `sys__time()`.



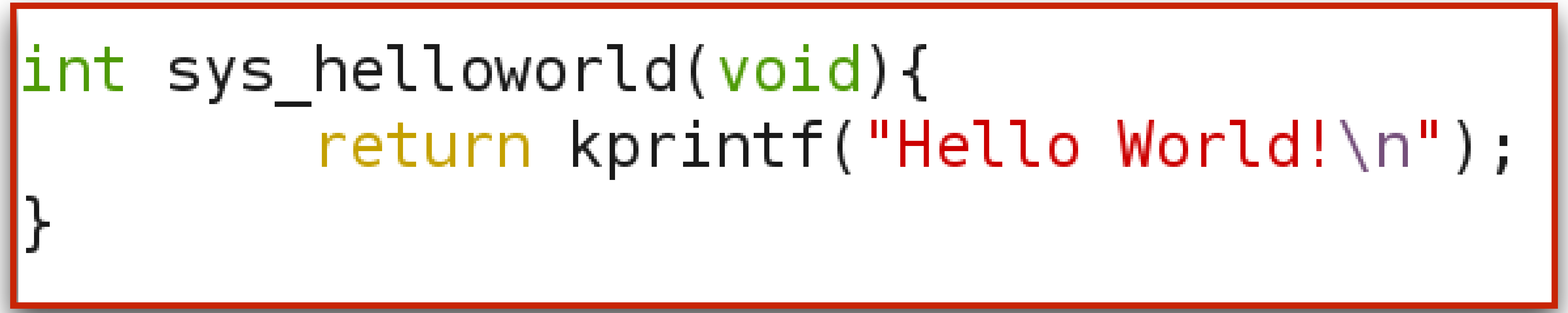
```
/*
 * Prototypes for IN-KERNEL entry points for system call
      implementations.
 */

int sys_reboot(int code);
int sys___time(userptr_t user_seconds, userptr_t user_nanoseconds);

#endif /* _SYSCALL_H_ */
```

```
int sys_helloworld(void);
```

2 Kernel-level implementation

- The kernel-level implementation goes into **`kern/syscall`**. This directory contains an example of a system call, i.e., **`time_syscalls.c`**.

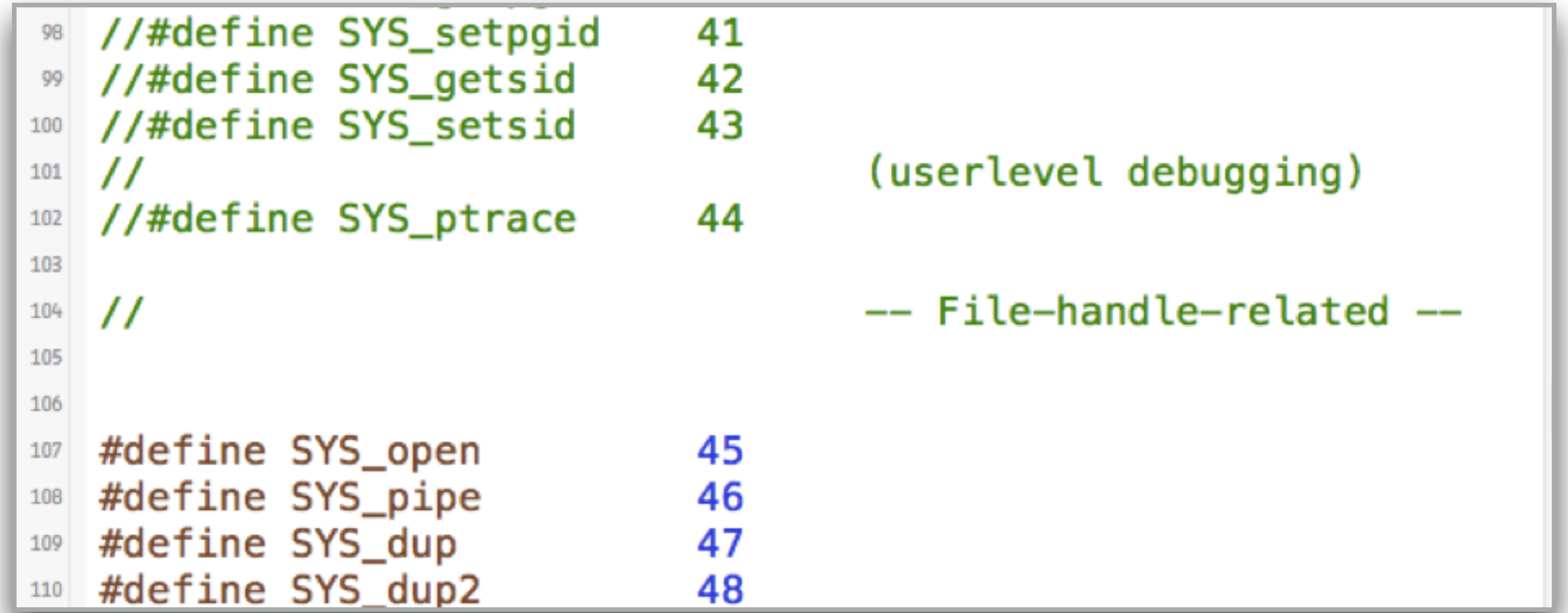
- Here, create a program called **`simple_syscall.c`**, and implement your system call in it.



```
int sys_helloworld(void){
        return kprintf("Hello World!\n");
}
```

3 Create the ID number for the new system call

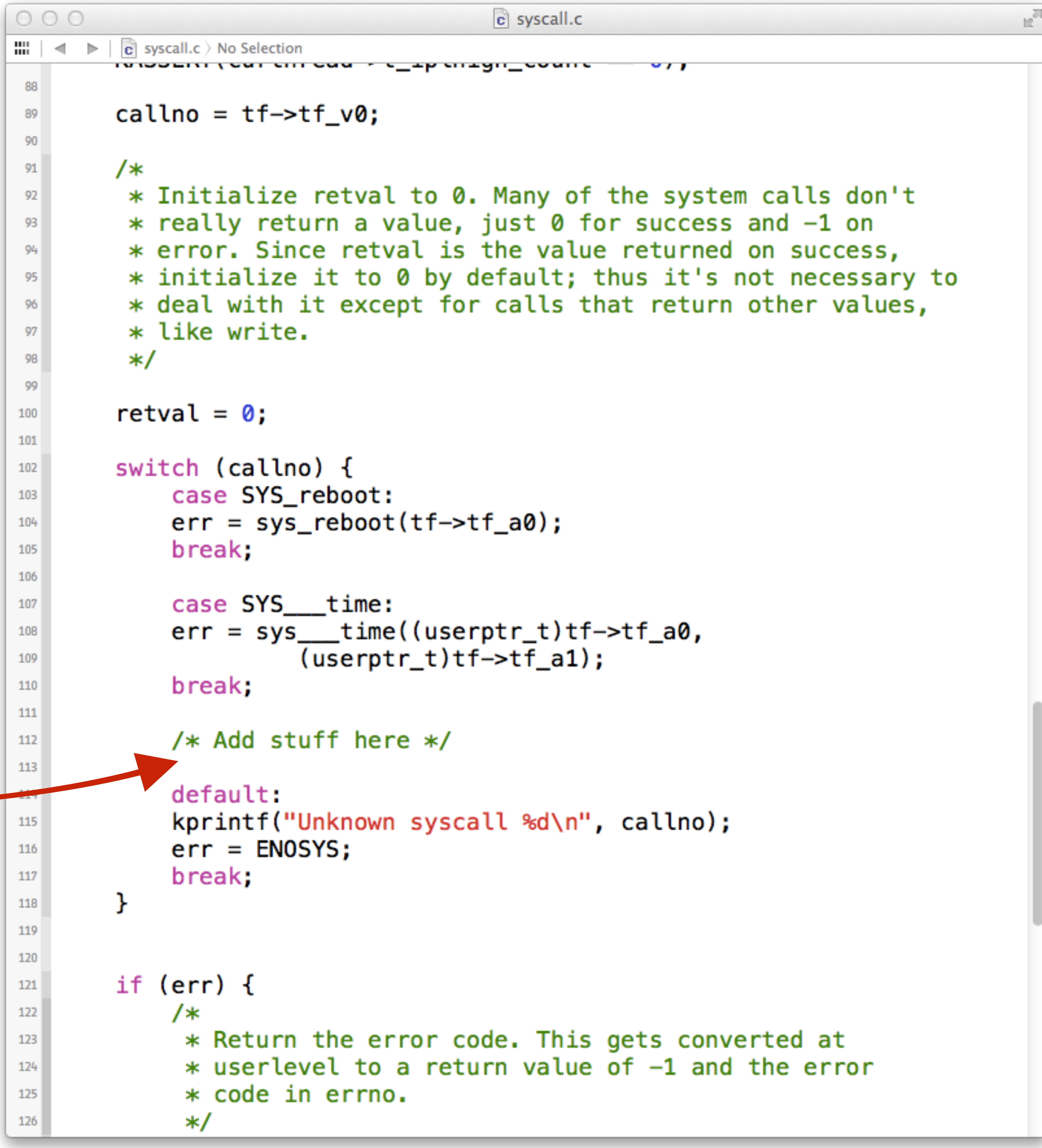
- The OS needs to know the ID number of the system call
- Add a new entry to the file **`kern/include/kern/syscall.h`**



```
//#define SYS_setpgid    41
//#define SYS_getsid     42
//#define SYS_setsid     43
//                              (userlevel debugging)
//#define SYS_ptrace     44

//                              -- File-handle-related --


#define SYS_open         45
#define SYS_pipe         46
#define SYS_dup          47
#define SYS_dup2         48
```

4 Add a new branch in the switch-case statement in: `kern/arch/mips/syscall/syscall.c`

```
case SYS_helloworld:
    err = sys_helloworld();
    break;
```

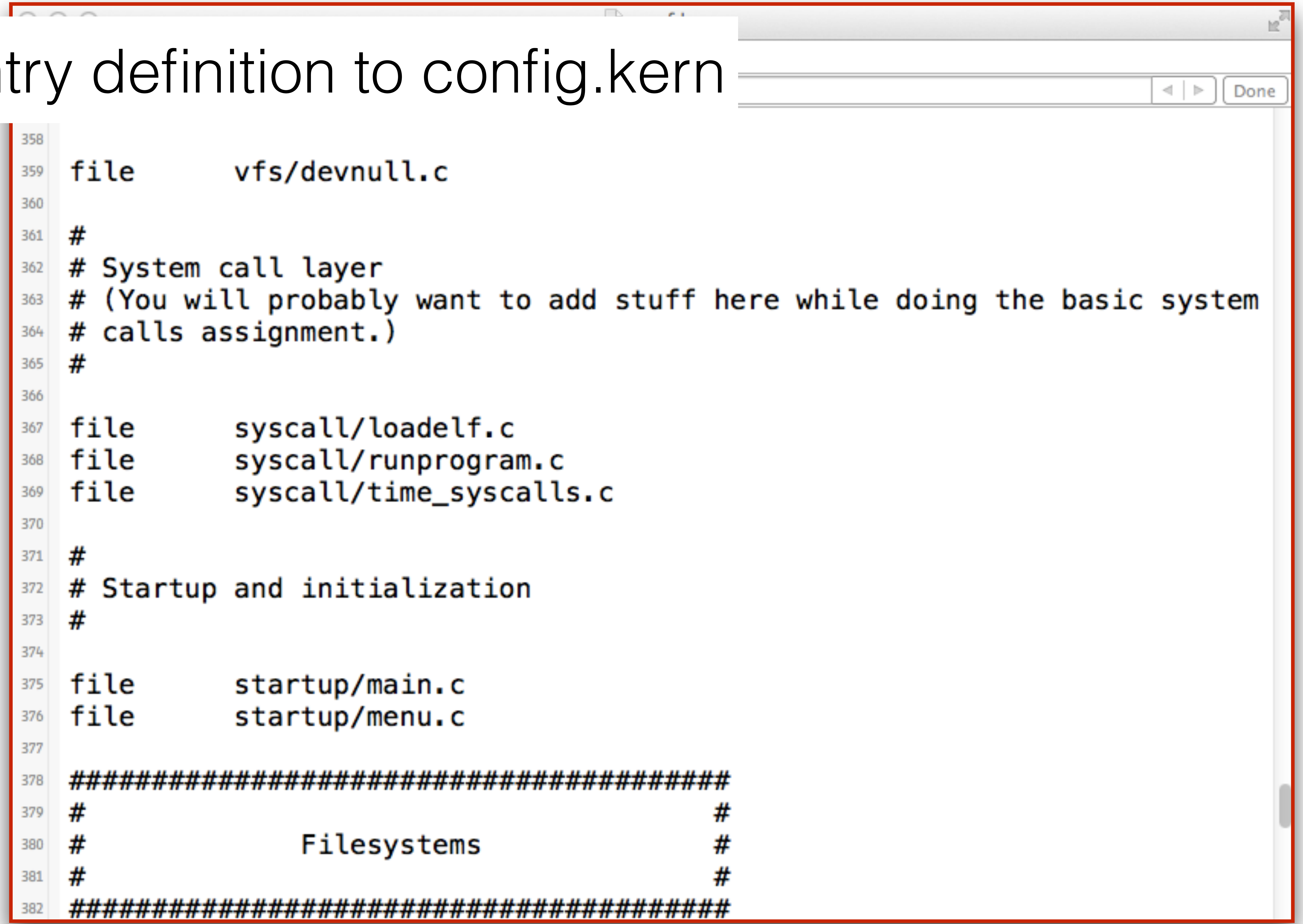


syscall.c

syscall.c 〉 No Selection

```
	callno = tf->tf_v0;

	/*
	 * Initialize retval to 0. Many of the system calls don't
	 * really return a value, just 0 for success and -1 on
	 * error. Since retval is the value returned on success,
	 * initialize it to 0 by default; thus it's not necessary to
	 * deal with it except for calls that return other values,
	 * like write.
	 */

	retval = 0;

	switch (callno) {
	    case SYS_reboot:
		err = sys_reboot(tf->tf_a0);
		break;

	    case SYS___time:
		err = sys___time((userptr_t)tf->tf_a0,
				 (userptr_t)tf->tf_a1);
		break;

	    /* Add stuff here */

	    default:
		kprintf("Unknown syscall %d\n", callno);
		err = ENOSYS;
		break;
	}


	if (err) {
		/*
		 * Return the error code. This gets converted at
		 * userlevel to a return value of -1 and the error
		 * code in errno.
		 */
```

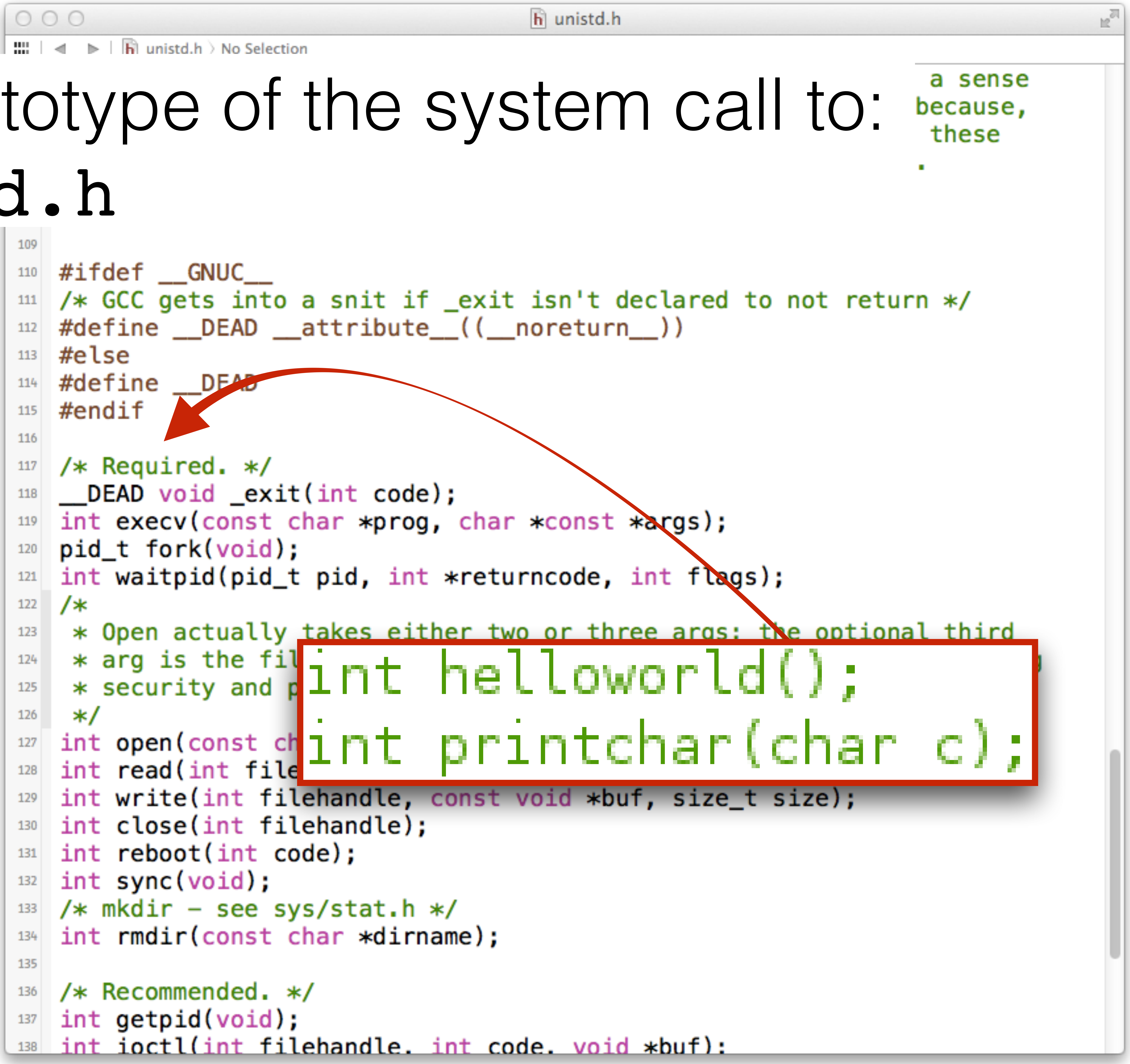
5 Add file-entry definition to config.kern



```
file      vfs/devnull.c

#
# System call layer
# (You will probably want to add stuff here while doing the basic system
# calls assignment.)
#

file      syscall/loadelf.c
file      syscall/runprogram.c
file      syscall/time_syscalls.c

#
# Startup and initialization
#

file      startup/main.c
file      startup/menu.c

########################################
#                                      #
#             Filesystems              #
#                                      #
########################################
```

1. Kernel-level steps
2. **User-level steps**
3. Testing the new system call

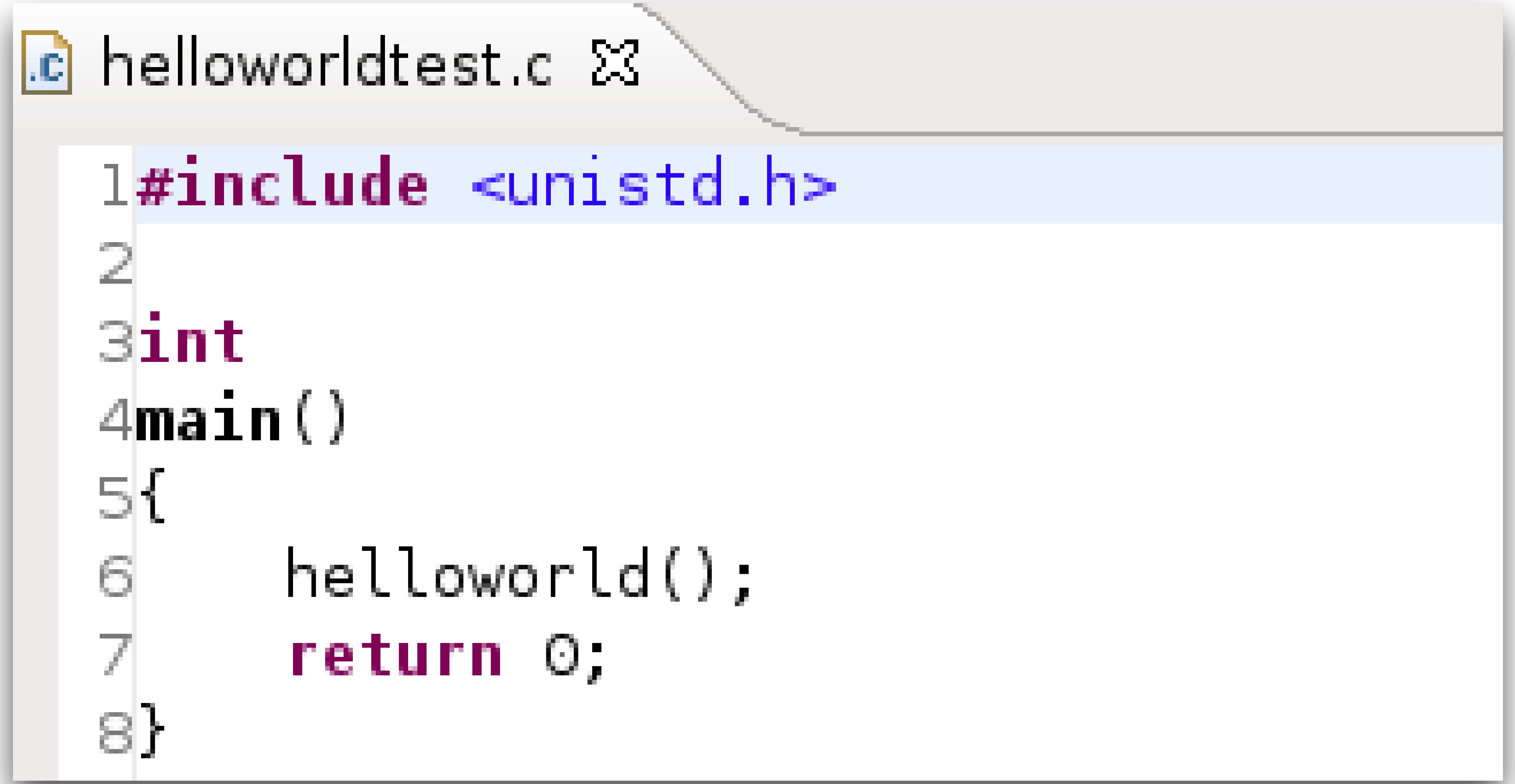
1. Add the user-level prototype of the system call to: `user/include/unistd.h`



```
a sense
because,
these
.

#ifdef __GNUC__
/* GCC gets into a snit if _exit isn't declared to not return */
#define __DEAD __attribute__((__noreturn__))
#else
#define __DEAD
#endif

/* Required. */
__DEAD void _exit(int code);
int execv(const char *prog, char *const *args);
pid_t fork(void);
int waitpid(pid_t pid, int *returncode, int flags);
/*
 * Open actually takes either two or three args: the optional third
 * arg is the fil
 * security and p
 */
int open(const ch
int read(int file
int write(int filehandle, const void *buf, size_t size);
int close(int filehandle);
int reboot(int code);
int sync(void);
/* mkdir - see sys/stat.h */
int rmdir(const char *dirname);

/* Recommended. */
int getpid(void);
int ioctl(int filehandle, int code, void *buf);
```

```
int helloworld();
int printchar(char c);
```

2. Add the user-level test function. For this, create a new subdirectory directory `user/testbin/`

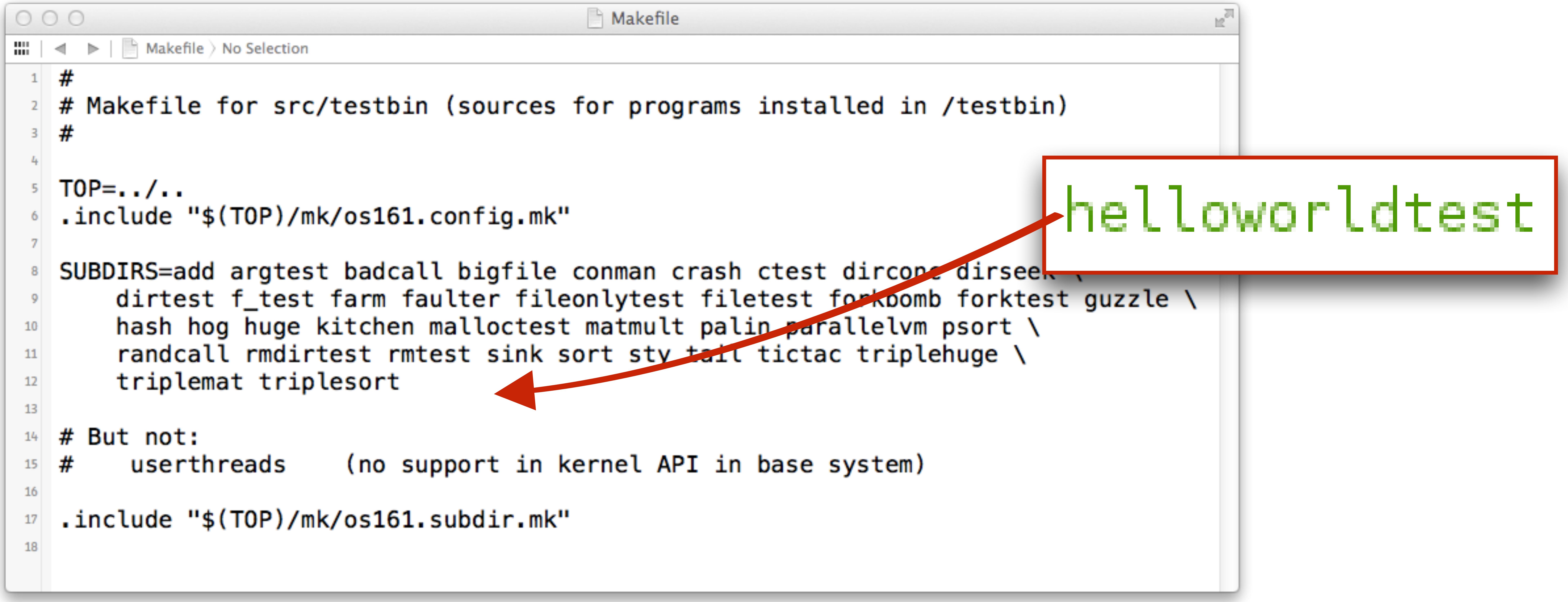


helloworldtest.c

```c
#include <unistd.h>

int
main()
{
	helloworld();
	return 0;
}
```

```
# Makefile for helloworldtest

TOP=../../..
.include "$(TOP)/mk/os161.config.mk"

PROG=helloworldtest
SRCS=helloworldtest.c
BINDIR=/testbin

.include "$(TOP)/mk/os161.prog.mk"
```

3. Add an entry to the new function to the top-level *Makefile* in **`user/testbin/`** and inside it add the



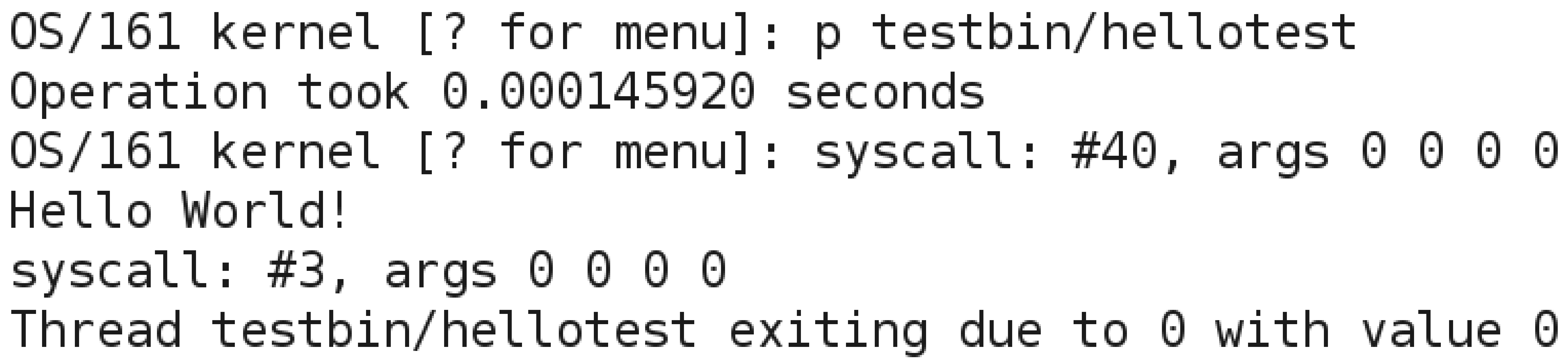
```
#
# Makefile for src/testbin (sources for programs installed in /testbin)
#

TOP=../..
.include "$(TOP)/mk/os161.config.mk"

SUBDIRS=add argtest badcall bigfile conman crash ctest dircone dirseek \
	dirtest f_test farm faulter fileonlytest filetest forkbomb forktest guzzle \
	hash hog huge kitchen malloctest matmult palin parallelvm psort \
	randcall rmdirtest rmtest sink sort sty tail tictac triplehuge \
	triplemat triplesort

# But not:
#    userthreads    (no support in kernel API in base system)

.include "$(TOP)/mk/os161.subdir.mk"
```

1. Kernel-level steps
2. User-level steps
3. **Testing the new system call**

Testing User Programs:

- Inside the root folder, run the command “sys161 kernel”
- In the os161 terminal, run the command “p testbin/<name>” where name is the name of your program

Hellotest Program:



```
OS/161 kernel [? for menu]: p testbin/hellotest
Operation took 0.000145920 seconds
OS/161 kernel [? for menu]: syscall: #40, args 0 0 0 0
Hello World!
syscall: #3, args 0 0 0 0
Thread testbin/hellotest exiting due to 0 with value 0
```

Thanks to Troshchenko and Manzotti