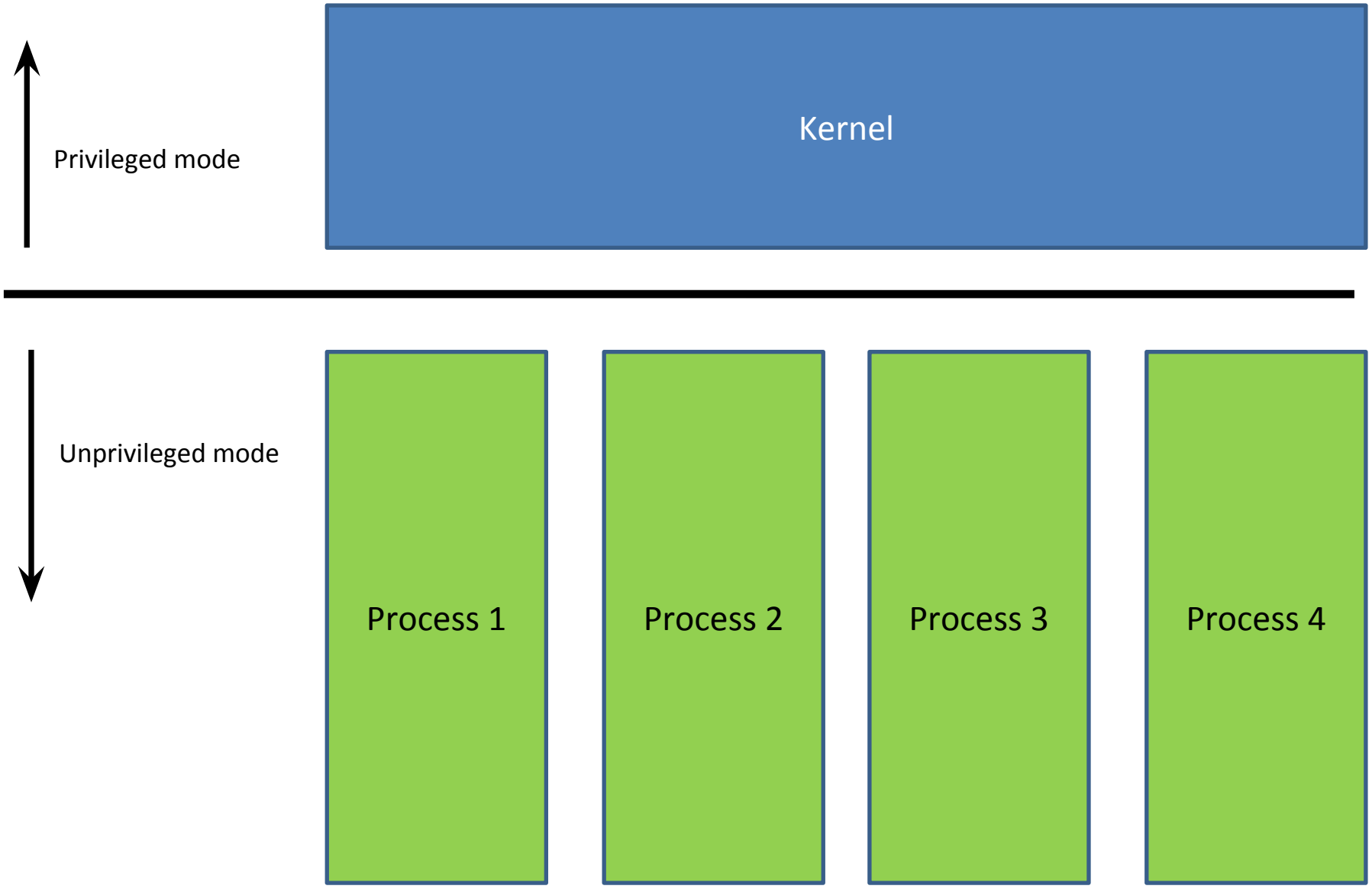
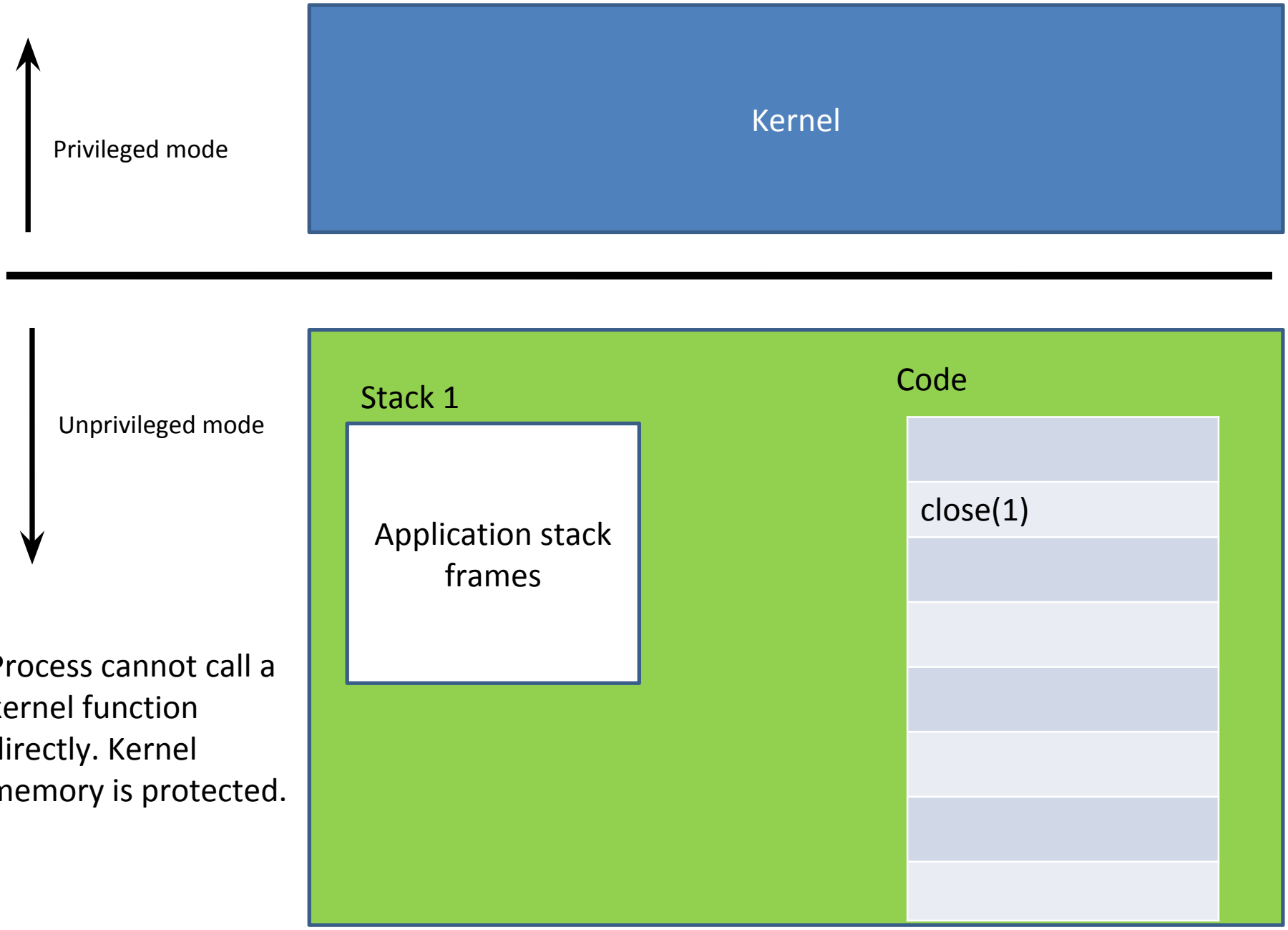
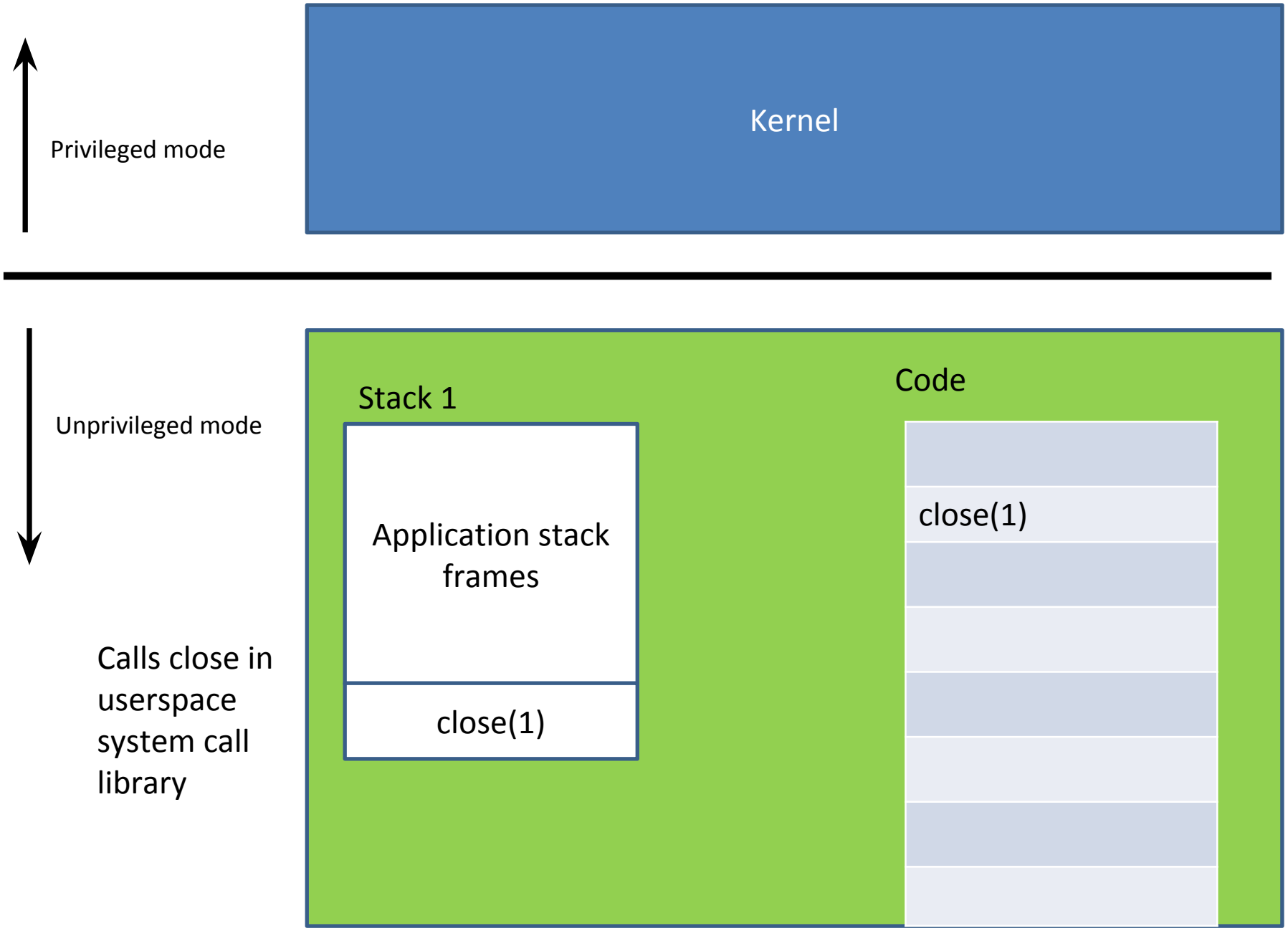
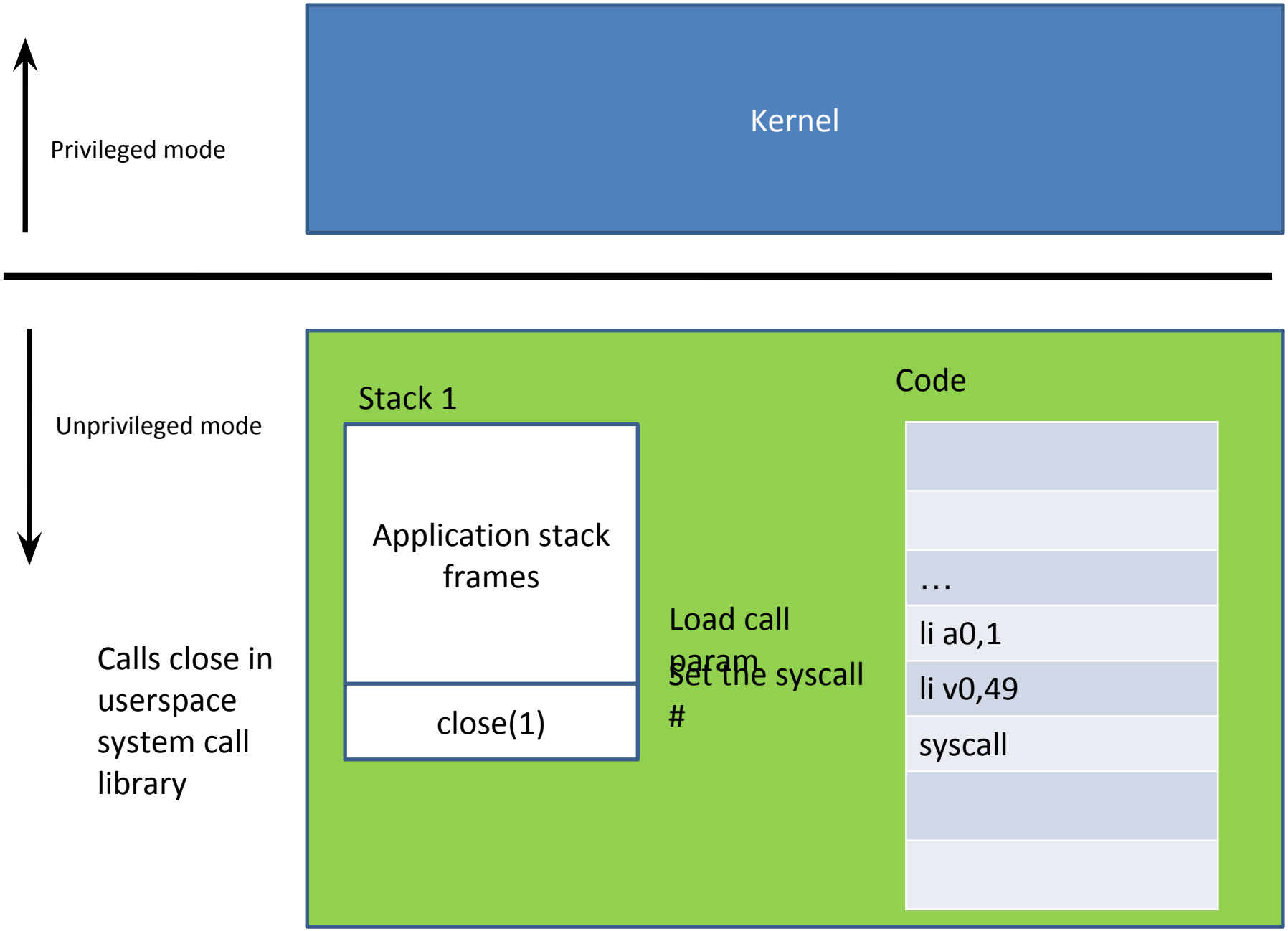
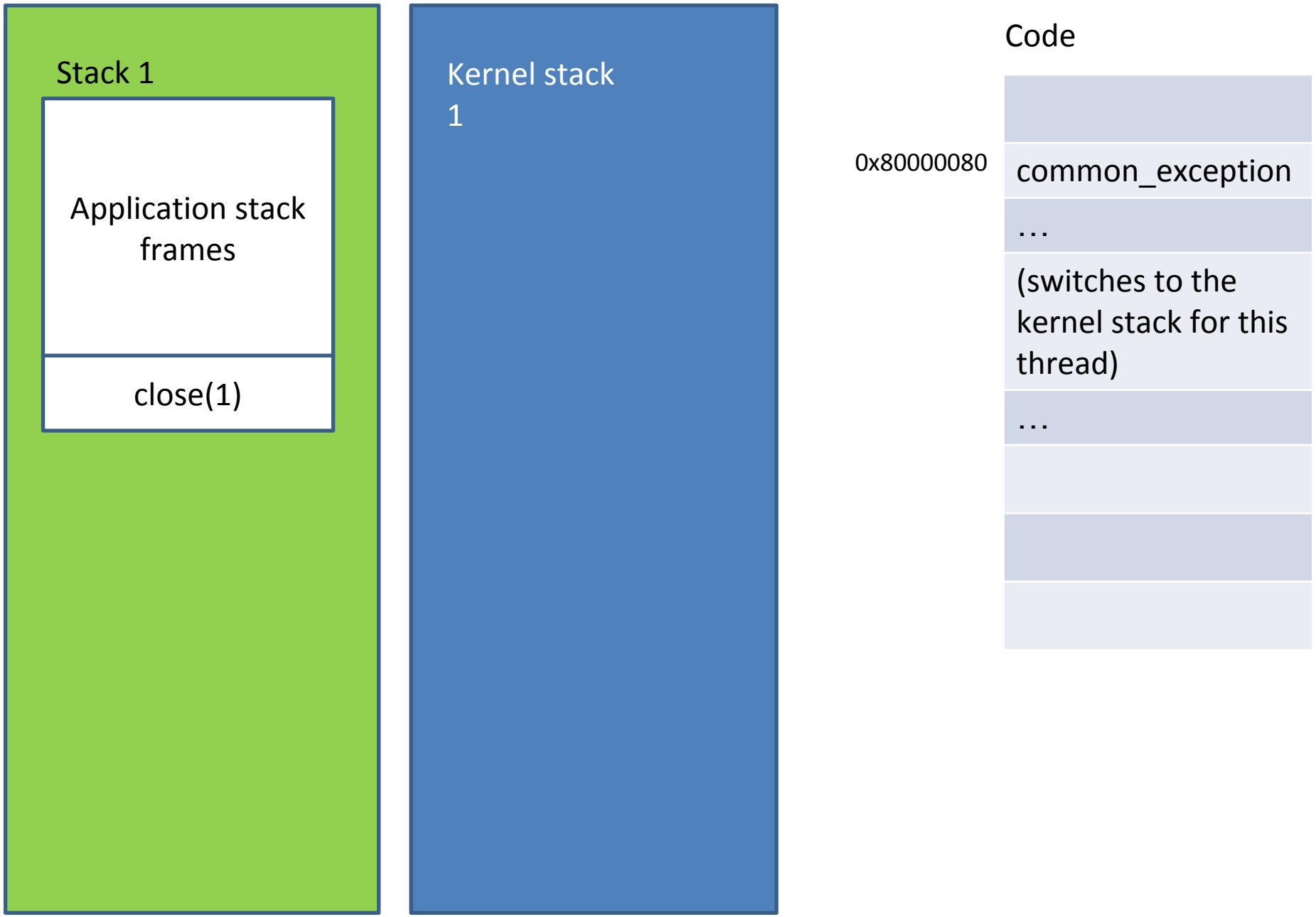

Privileged mode
Kernel
Unprivileged mode
Process 1
Process 2
Process 3
Process 4

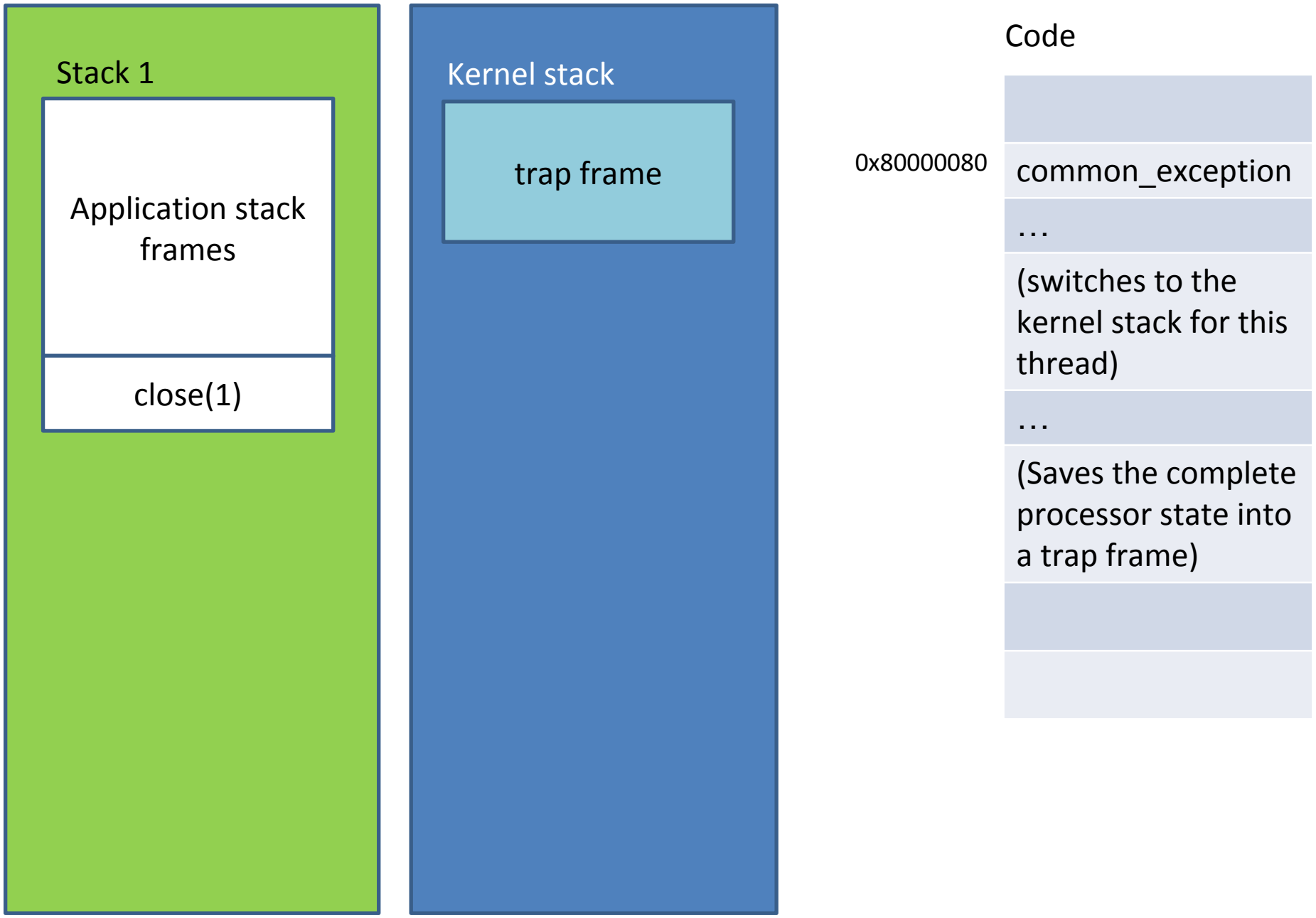


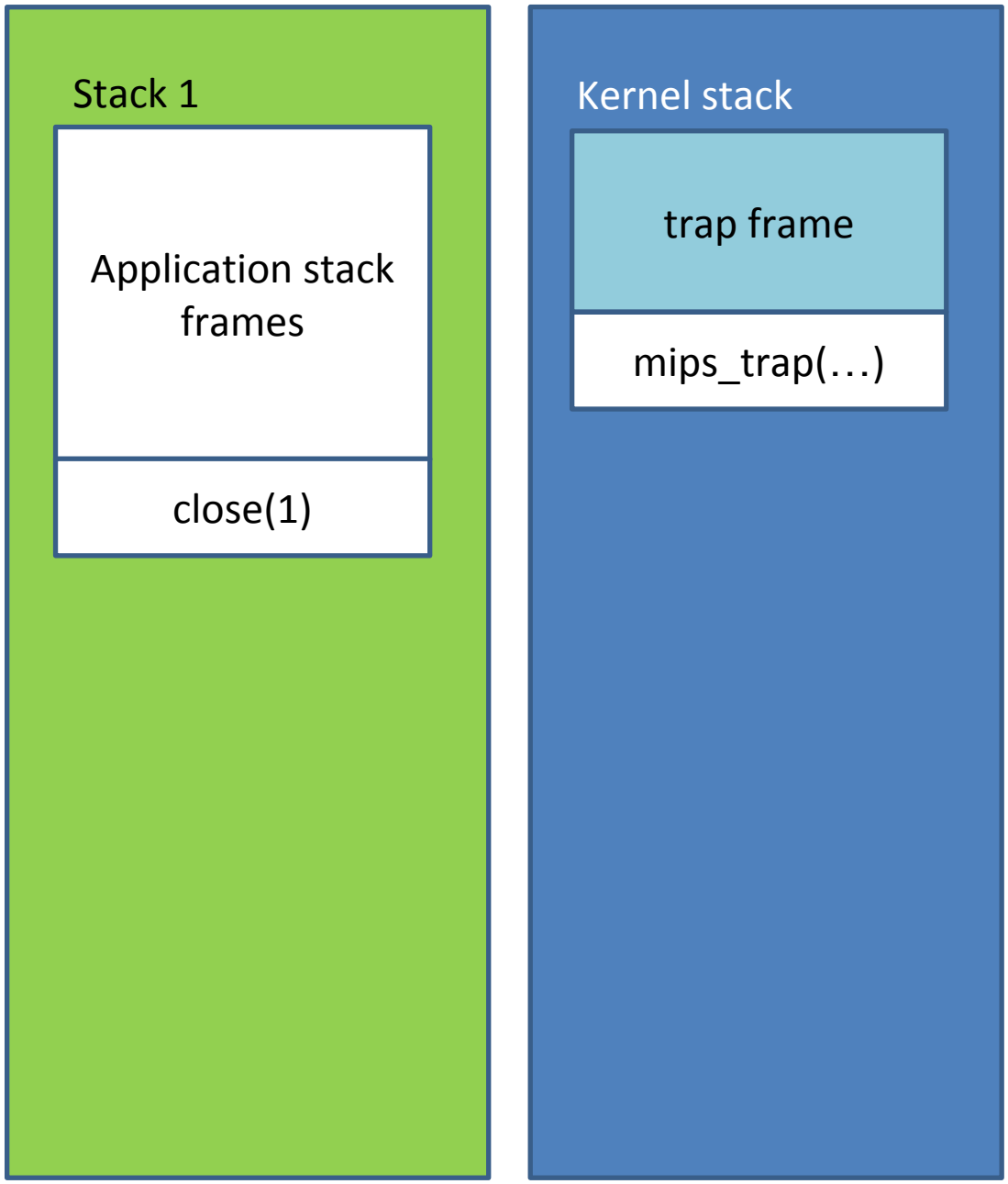
Process cannot call a kernel function directly. Kernel memory is protected.


Privileged mode
Kernel
Unprivileged mode
Stack 1
Application stack frames
close(1)
Code
close(1)
Calls close in userspace system call library

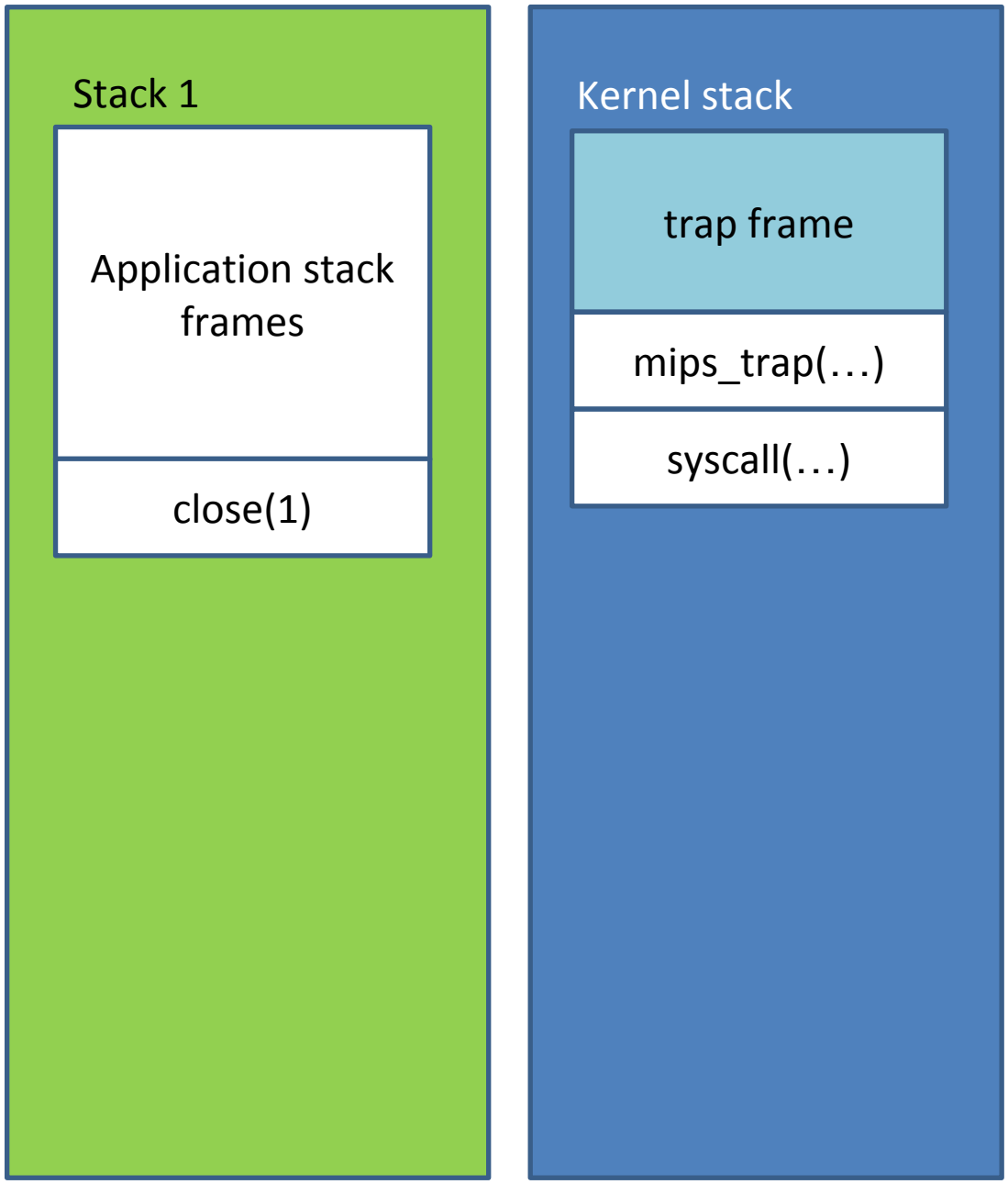

Privileged mode
Kernel
Unprivileged mode
Stack 1
Application stack frames
close(1)
Calls close in userspace system call library
Load call param
Set the syscall #
Code
…
li a0,1
li v0,49
syscall

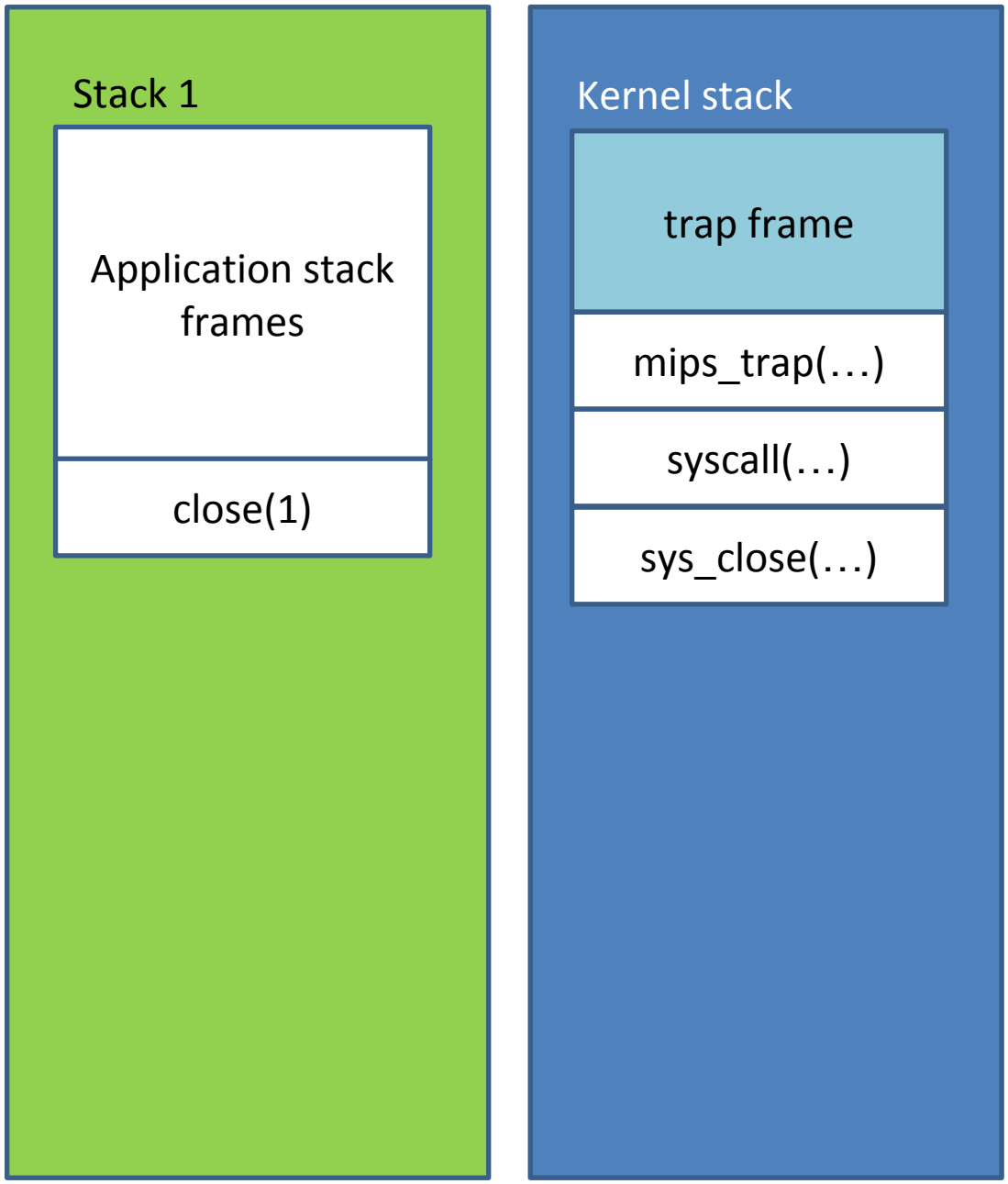

Stack 1
Application stack frames
close(1)
Kernel stack 1
Code
0x80000080
common_exception
…
(switches to the kernel stack for this thread)
…

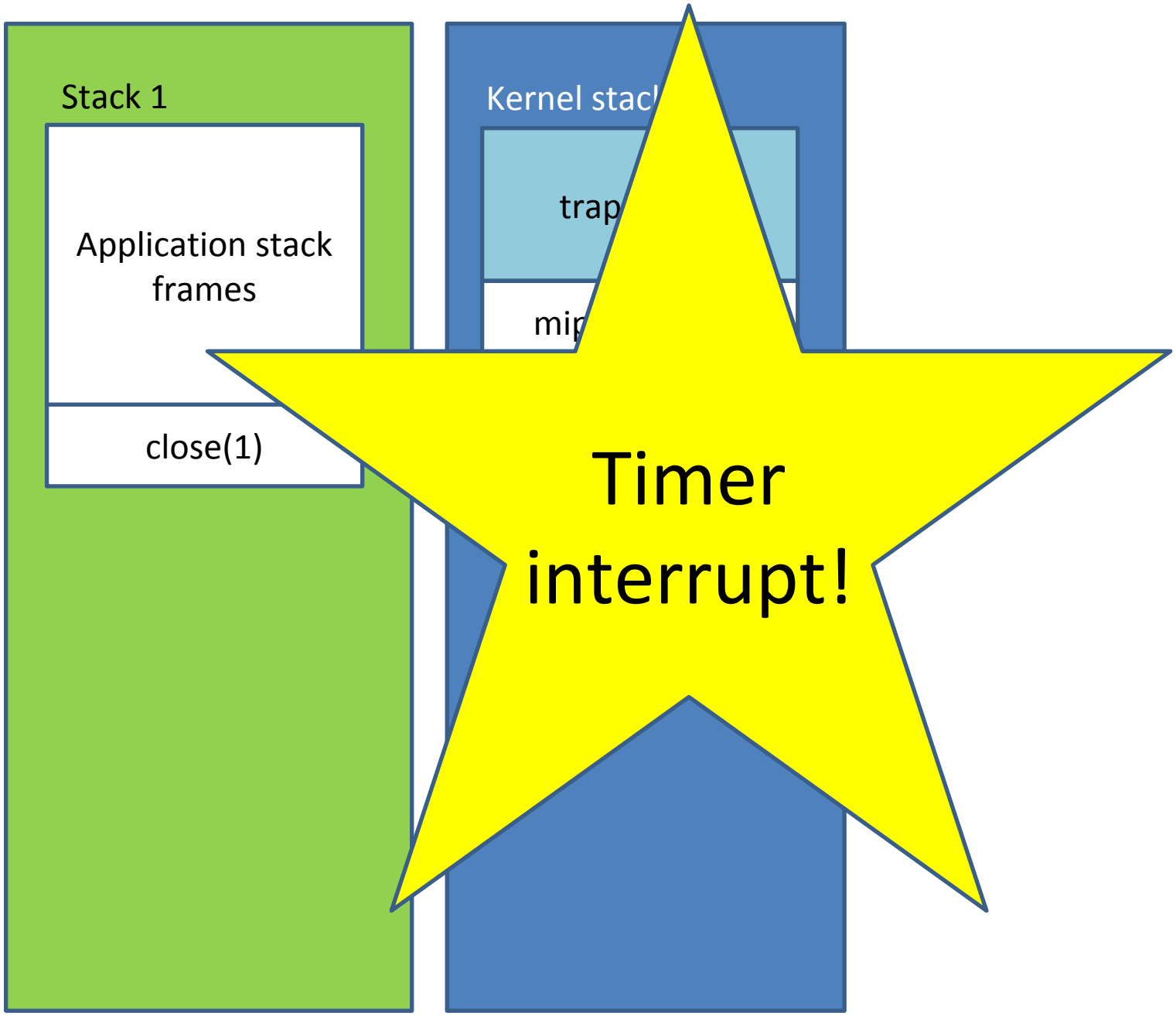

Stack 1
Application stack frames
close(1)
Kernel stack
trap frame
Code
0x80000080
common_exception
…
(switches to the kernel stack for this thread)
…
(Saves the complete processor state into a trap frame)

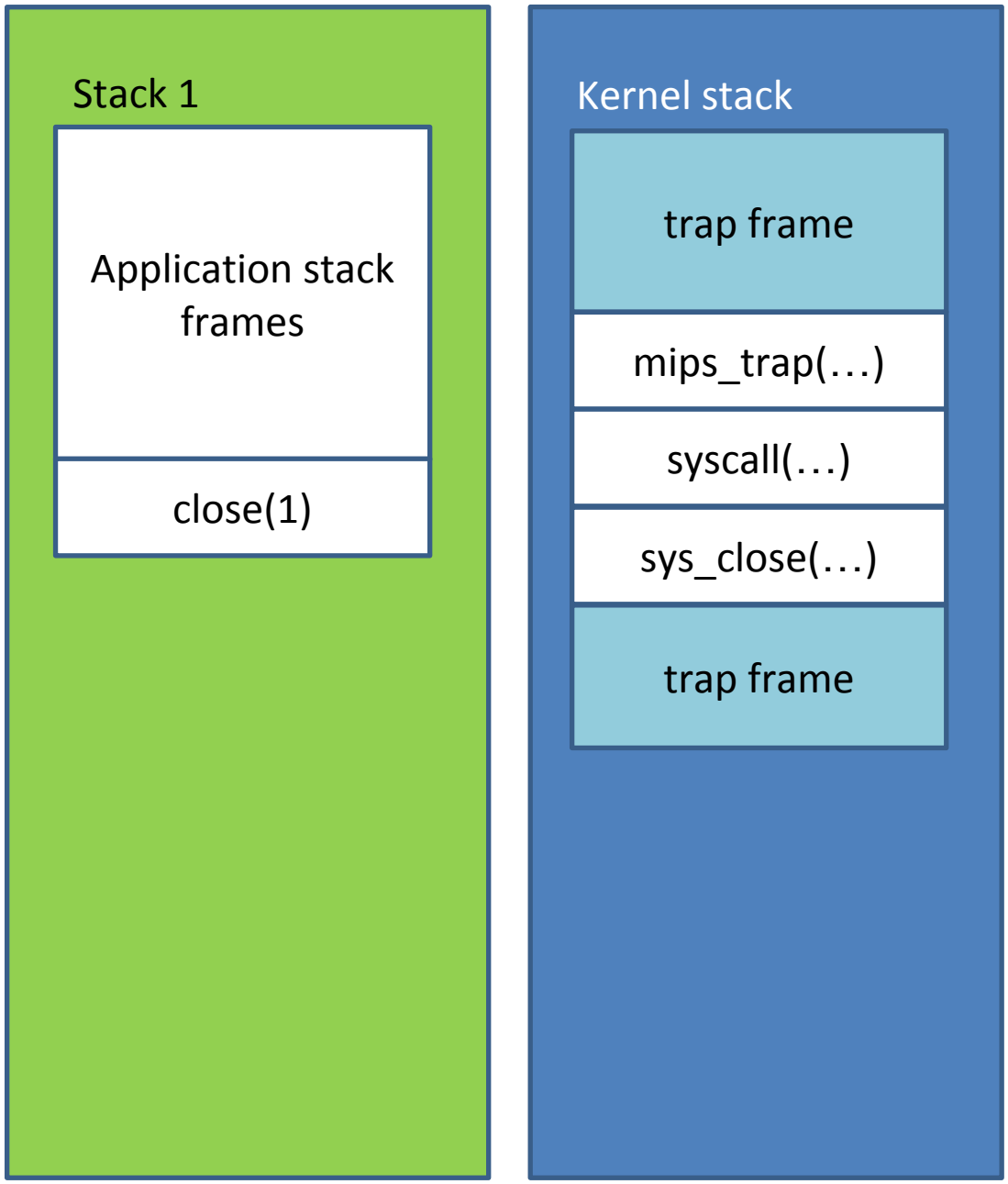


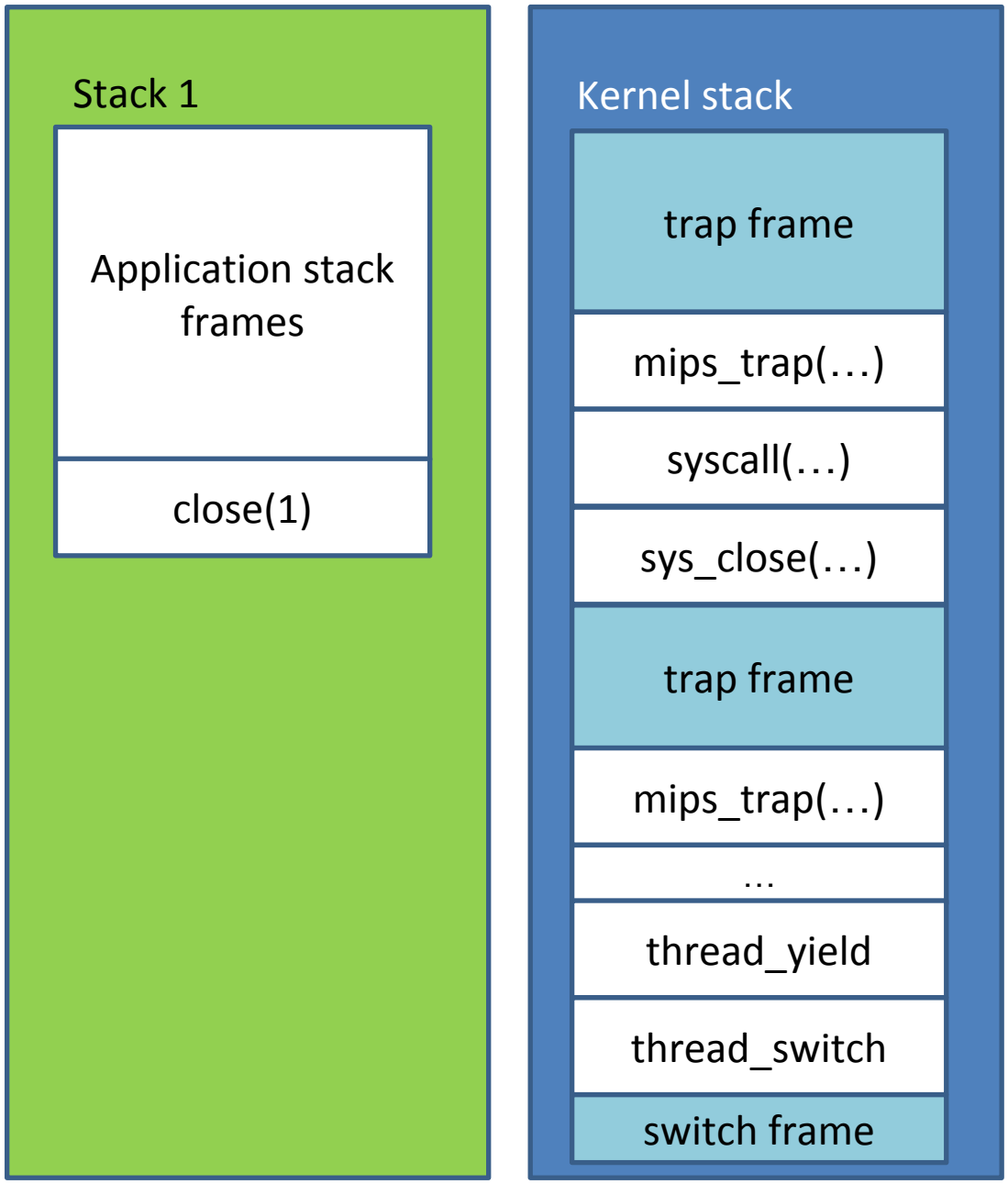
- Check whether this is an exception, interrupt, or system call (all handled by mips_trap).
- If it is not an interrupt, turn interrupts back on.

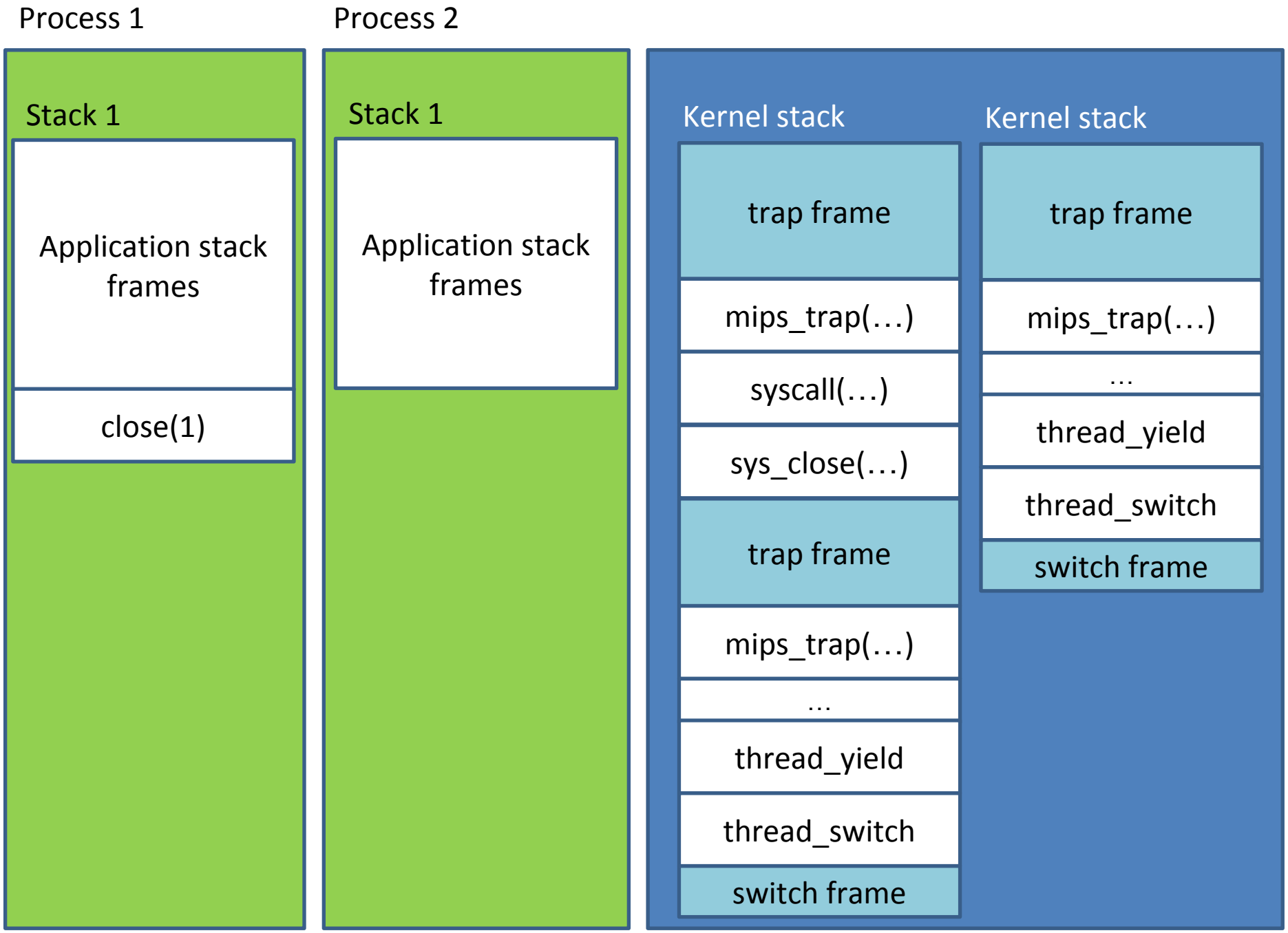

Stack 1
Application stack frames
close(1)
Kernel stack
trap frame
mips_trap(…)
syscall(…)

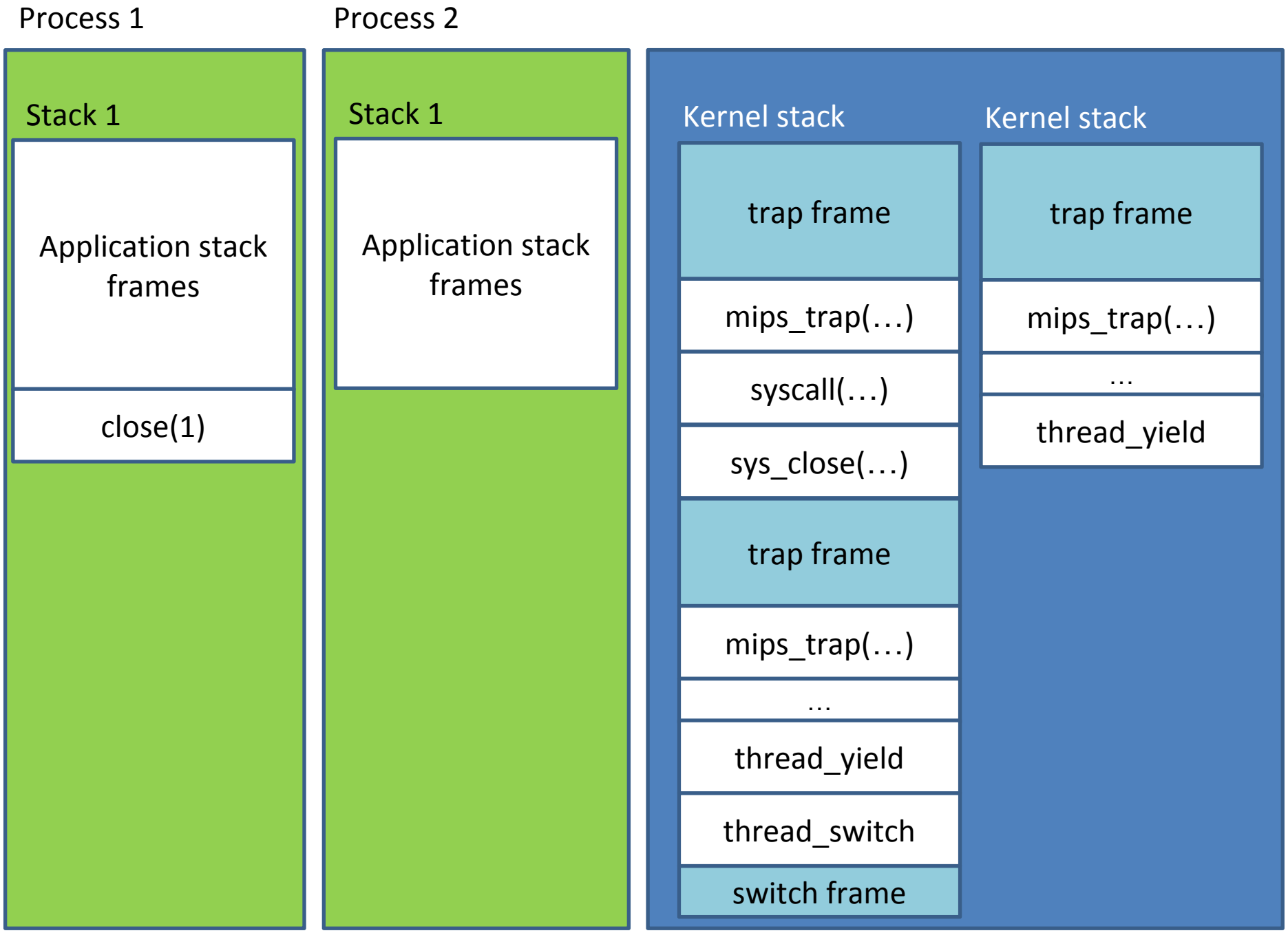

Stack 1
Application stack frames
close(1)
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)

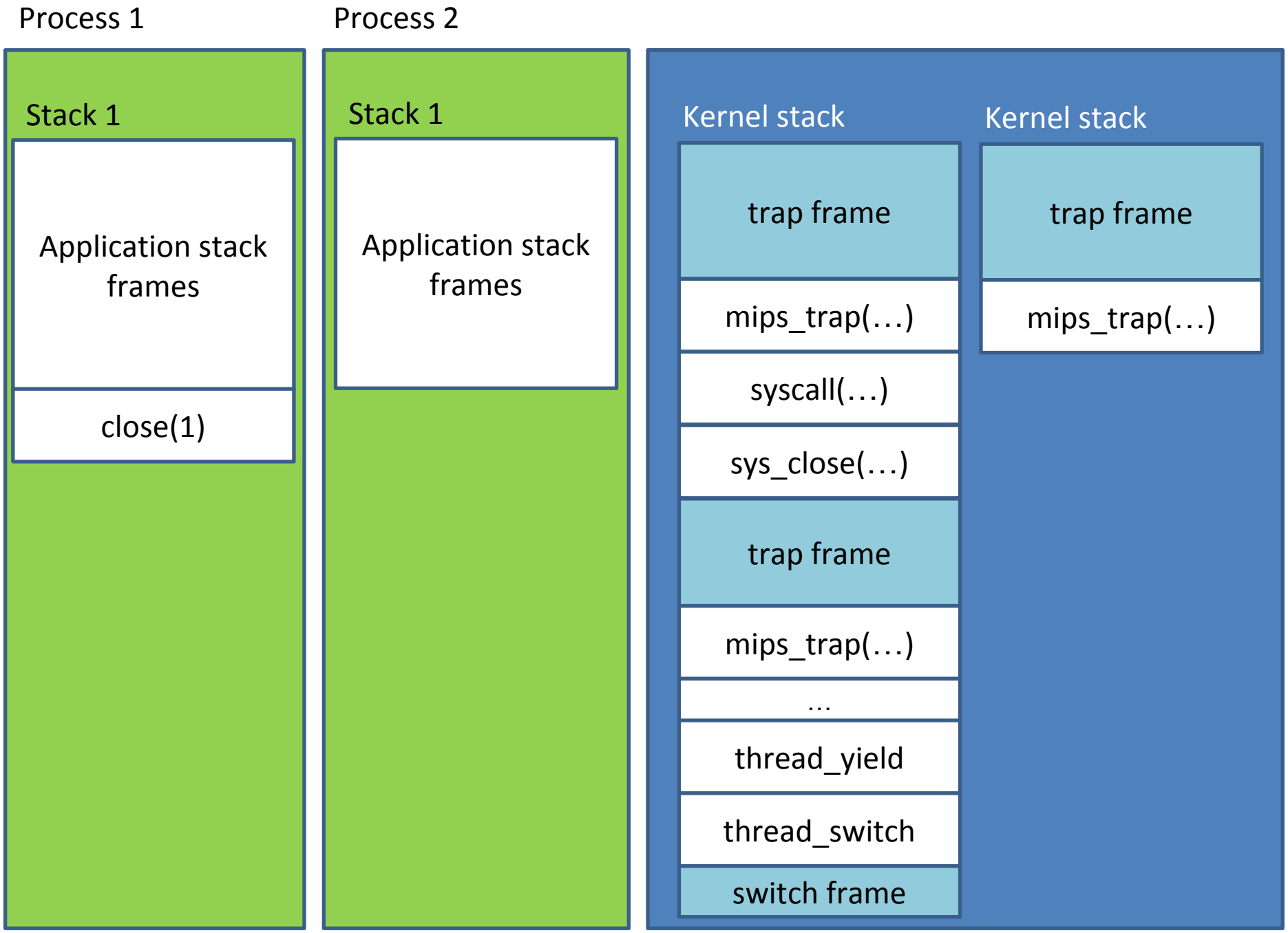

Stack 1
Application stack frames
close(1)
Kernel stac
trap
mip
Timer interrupt!

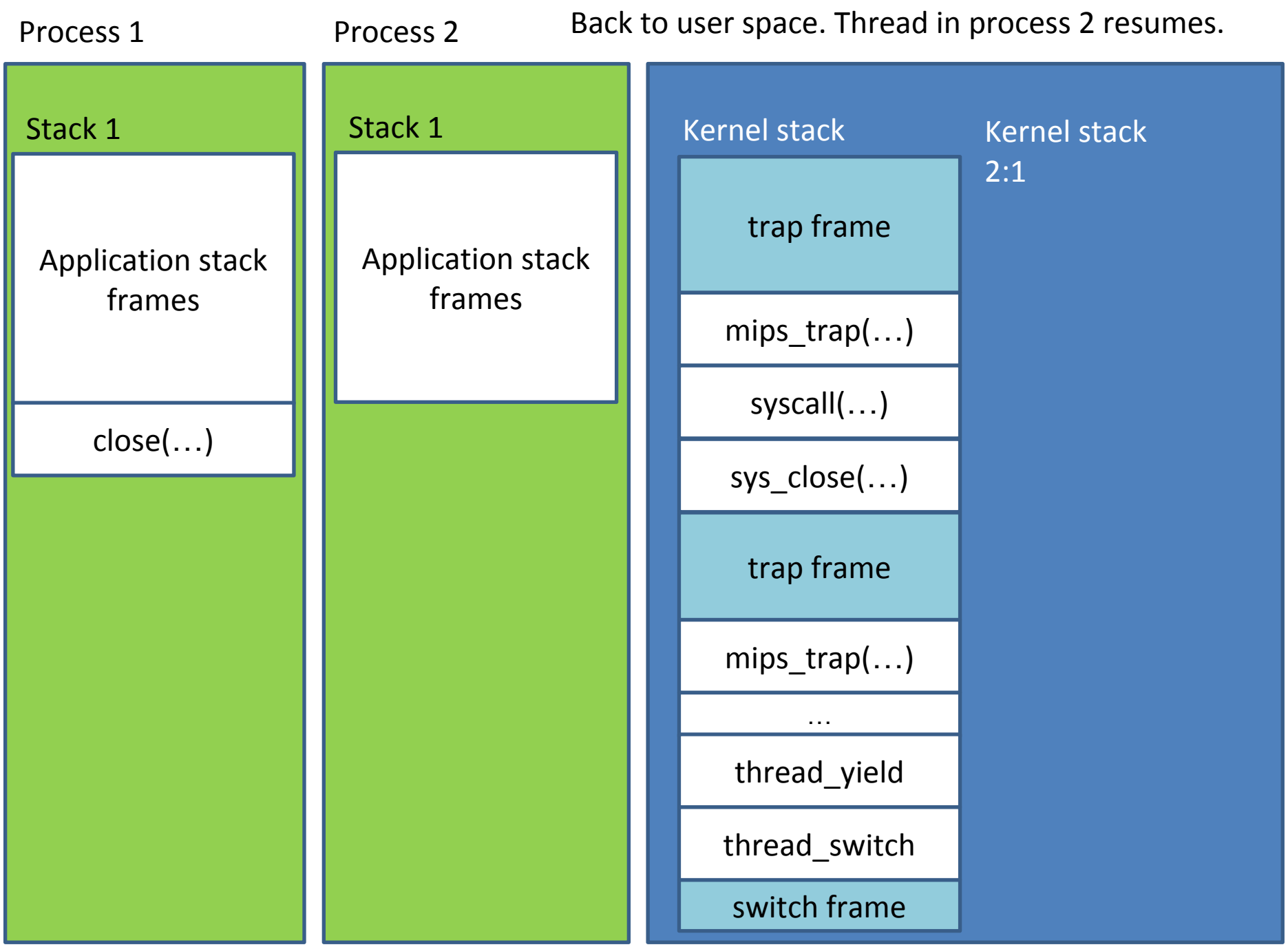

Stack 1
Application stack frames
close(1)
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame


Stack 1
Application stack frames
close(1)
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame

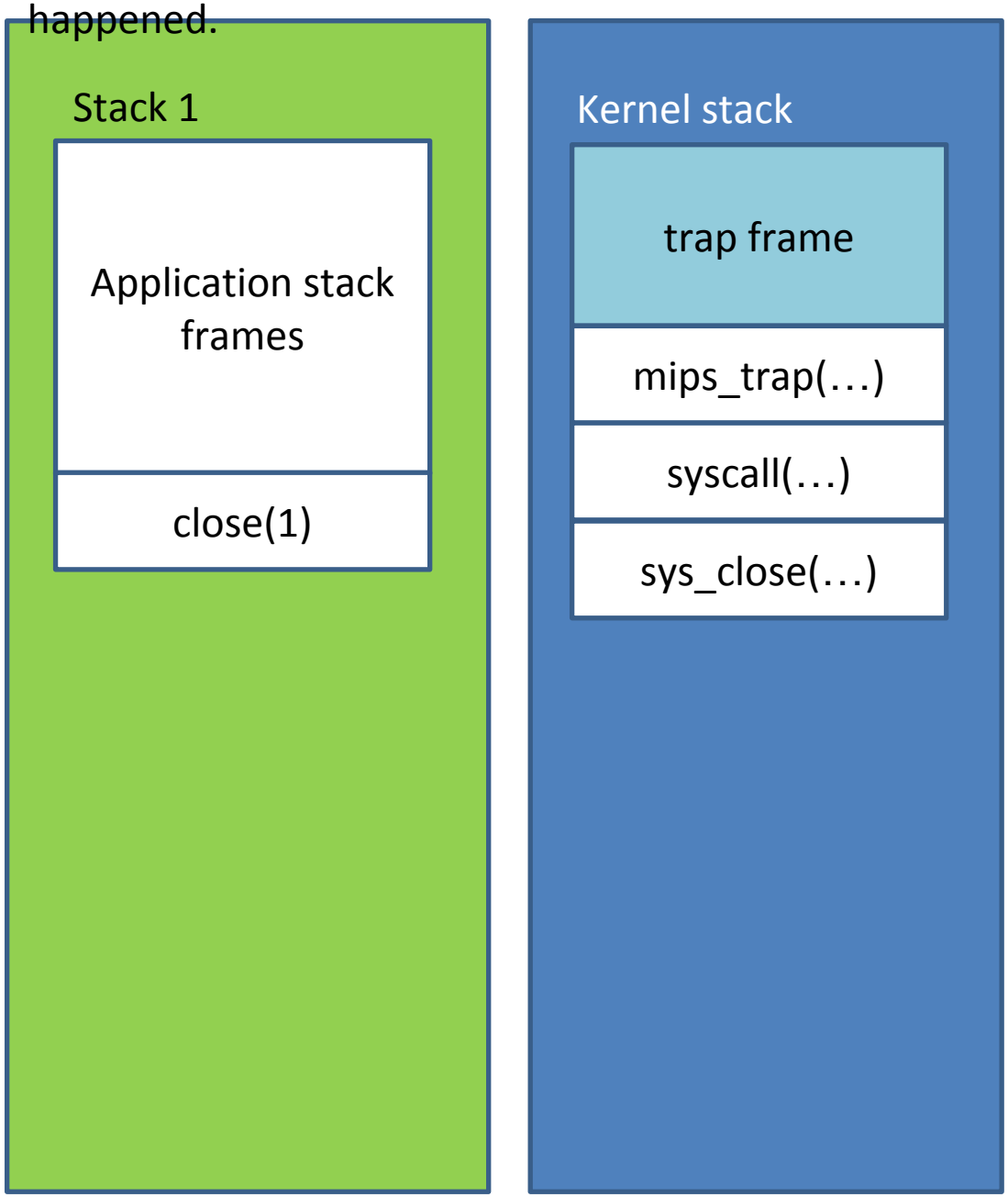

Process 1
Process 2
Stack 1
Application stack frames
close(1)
Stack 1
Application stack frames
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame
Kernel stack
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame


Process 1
Process 2
Stack 1
Application stack frames
close(1)
Stack 1
Application stack frames
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame
Kernel stack
trap frame
mips_trap(…)
…
thread_yield

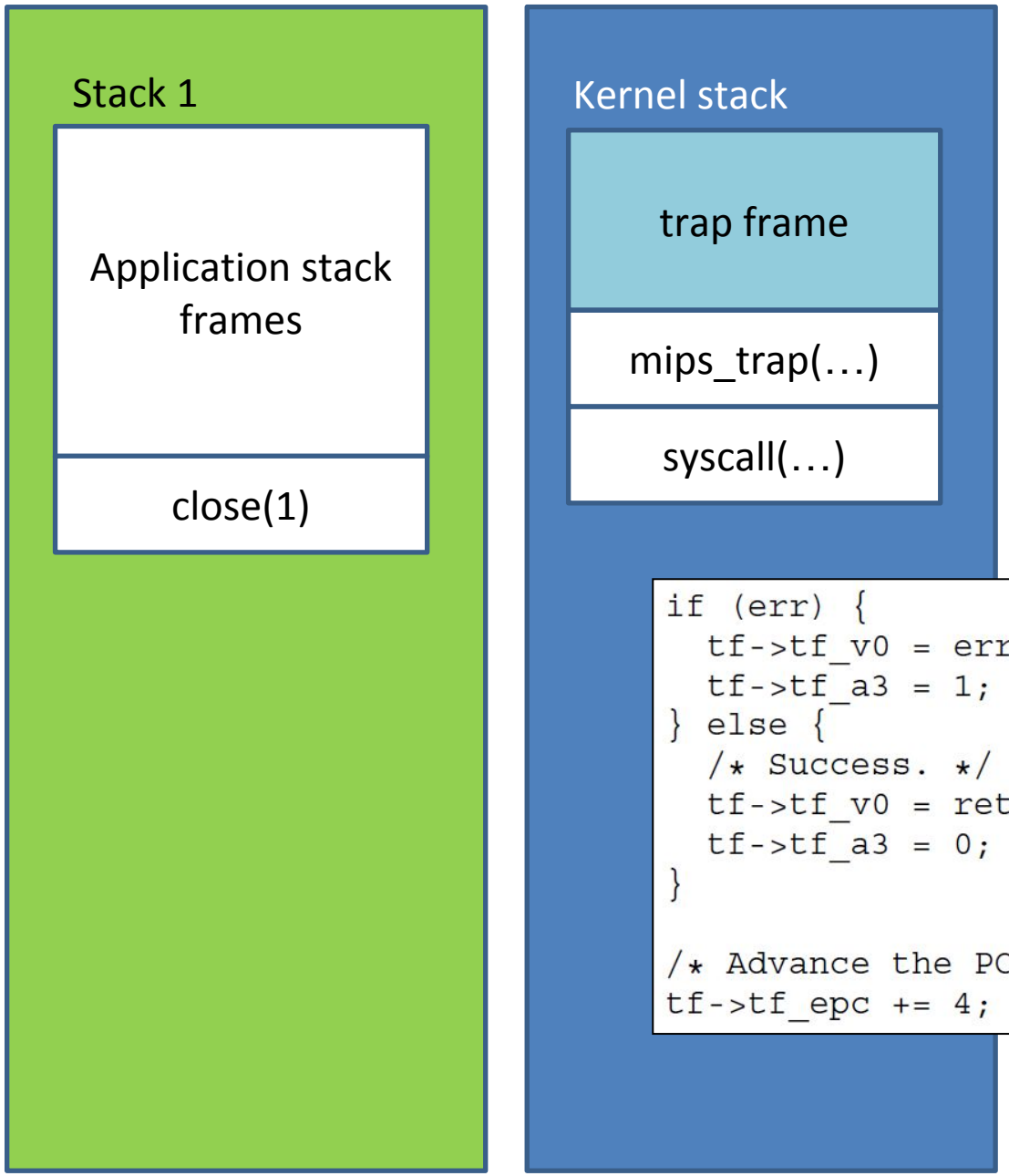

Process 1
Process 2
Stack 1
Application stack frames
close(1)
Stack 1
Application stack frames
Kernel stack
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame
Kernel stack
trap frame
mips_trap(…)


Process 1
Process 2
Back to user space. Thread in process 2 resumes.
Stack 1
Application stack frames
close(…)
Stack 1
Application stack frames
Kernel stack
Kernel stack 2:1
trap frame
mips_trap(…)
syscall(…)
sys_close(…)
trap frame
mips_trap(…)
…
thread_yield
thread_switch
switch frame

Let’s go back and assume the interrupt never happened.



When syscall returns, it modifies register values stored in the trap_frame.

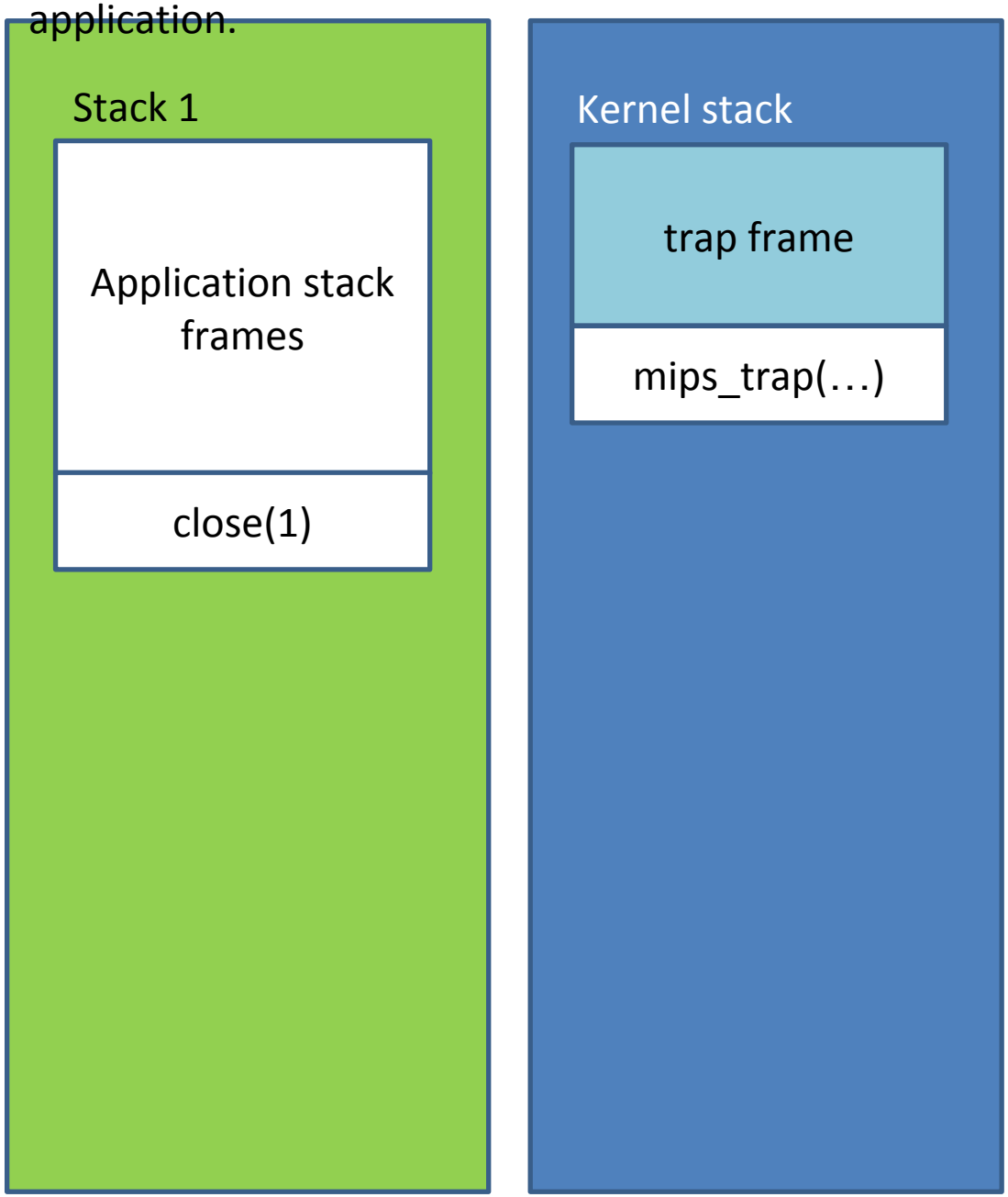


Stores success flag in a3 and return value/error code in v0

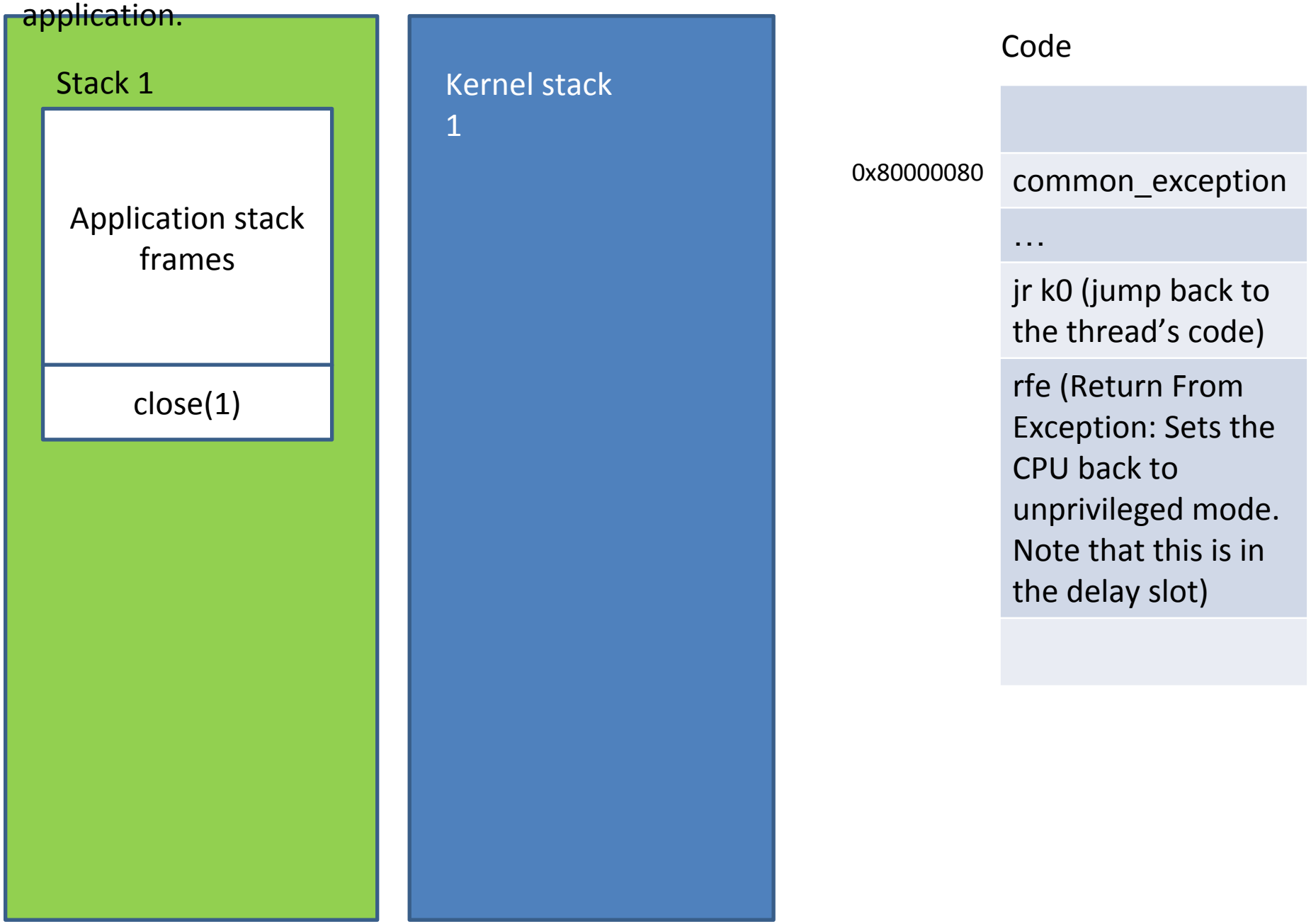
```
if (err) {
  tf->tf_v0 = err;
  tf->tf_a3 = 1;       /* signal an error */
} else {
  /* Success. */
  tf->tf_v0 = retval;
  tf->tf_a3 = 0;       /* signal no error */
}

/* Advance the PC, to avoid the syscall again. */
tf->tf_epc += 4;
```

Eventually returns control to the user-space application.



Eventually returns control to the user-space application.



Returns from the user-space system call library back to the application code.