Lab 2 Report

Christina Pavlopoulou
cpavl001@ucr.edu

Niloufar Hosseini Pour
nhoss003@ucr.edu

Andres Calderon
acald013@ucr.edu

February 23, 2016

1 Null pointer at user space.

In xv6, user code is loaded into the first part of the address space. Accordingly, when we dereference a null pointer, because we start from the first page, it is accessible for us so we will not get an exception, instead, we see the first bit of code as the content of the dereferenced variable.

For resolving this problem, we changed 3 files (exec.c, vm.c and Makefile) in order to start from second page in the page table instead of first page.

1. exec.c: In exec.c file, we changed size instead of 0 to 4096 (PGSIZE), so address space will get filled from second page. We make the change at line 39 of listing 1 (sz=PGSIZE instead of sz=0).
2. vm.c: In copyuvm function, where a copy of the parent process's page table is given to the child, we start the for loop from second page (PGSIZE) instead of 0. See line 319 at listing 2.
3. Makefile: In Makefile, entry point of user programs is set. So, we have to make the first page invalid, meaning where the first instruction is set to 0, and change the entry point to the next page at "0x1000". So we set init and forktest to start from second page (0x1000). See lines 140 and 147 at listing 3.

After changing all these, we tested our user code (a code that tries to access a null pointer) shown in listing 4, and now we see that the process has been trapped and killed (figure 1).

```
38  // Load program into memory.
39  sz = PGSIZE;
40  for(i=0, off=elf.phoff; i<elf.phnum; i++, off+=sizeof(ph)){
41    if(readi(ip, (char*)&ph, off, sizeof(ph)) != sizeof(ph))
42      goto bad;
43    if(ph.type != ELF_PROG_LOAD)
44      continue;
45    if(ph.memsz < ph.filesz)
46      goto bad;
47    if((sz = allocuvm(pgdir, sz, ph.vaddr + ph.memsz)) == 0)
48      goto bad;
49    if(loaduvm(pgdir, (char*)ph.vaddr, ip, ph.off, ph.filesz) < 0)
50      goto bad;
51  }
```

Listing 1: Changes in exec.c file. The sz variable start at PGSIZE now (line 39).

```
307 // Given a parent process’s page table, create a copy
308 // of it for a child.
309 pde_t*
310 copyuvm(pde_t *pgdir, uint sz)
311 {
312   pde_t *d;
313   pte_t *pte;
314   uint pa, i, flags;
315   char *mem;
316
317   if((d = setupkvm()) == 0)
318     return 0;
319   for(i = PGSIZE; i < sz; i += PGSIZE){
320     if((pte = walkpgdir(pgdir, (void *) i, 0)) == 0)
321       panic("copyuvm: pte should exist");
322     if(!(*pte & PTE_P))
323       panic("copyuvm: page not present");
324     pa = PTE_ADDR(*pte);
325     flags = PTE_FLAGS(*pte);
326     if((mem = kalloc()) == 0)
327       goto bad;
328     memmove(mem, (char*)p2v(pa), PGSIZE);
329     if(mappages(d, (void*)i, PGSIZE, v2p(mem), flags) < 0)
330       goto bad;
331   }
332   return d;
333
334 bad:
335   freevm(d);
336   return 0;
337 }
```

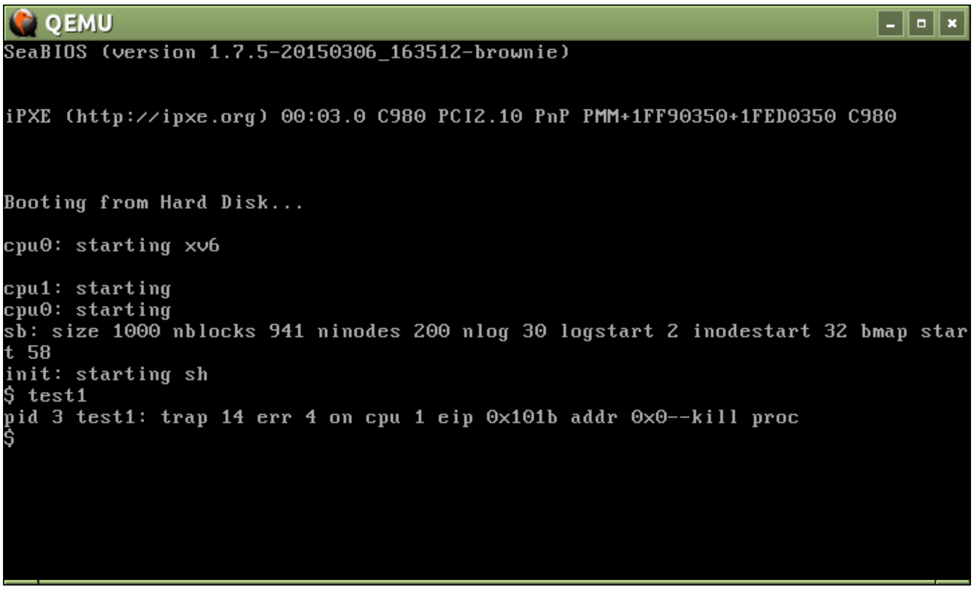
Listing 2: Changes in `vm.c` file. The `for loop` start at `PGSIZE` (line 319).

```
_%: %.o $(ULIB)
  $(LD) $(LDFLAGS) -N -e main -Ttext 0x1000 -o $@ $^
  $(OBJDUMP) -S $@ > $*.asm
  $(OBJDUMP) -t $@ | sed ’1,/SYMBOL TABLE/d; s/ .* / /; /^$$/d’ > $*.sym

_forktest: forktest.o $(ULIB)
  # forktest has less library code linked in - needs to be small
  # in order to be able to max out the proc table.
  $(LD) $(LDFLAGS) -N -e main -Ttext 0x1000 -o _forktest forktest.o ulib.o usys.o
  $(OBJDUMP) -S _forktest > forktest.asm
```

Listing 3: Changes in `Makefile`. We adjust the `ULIB` parameters accordingly to start at `PGSIZE` (`0x1000`)

```
#include "types.h"
#include "user.h"
#include "syscall.h"

int main(){
  int *p = 0;

  printf(1,"%d\n", *p);
  exit();
}
```

Listing 4: Test for null pointer catching at command line (`test1.c` file).



```
SeaBIOS (version 1.7.5-20150306_163512-brownie)


iPXE (http://ipxe.org) 00:03.0 C980 PCI2.10 PnP PMM+1FF90350+1FED0350 C980



Booting from Hard Disk...

cpu0: starting xv6

cpu1: starting
cpu0: starting
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap star
t 58
init: starting sh
$ test1
pid 3 test1: trap 14 err 4 on cpu 1 eip 0x101b addr 0x0--kill proc
$
```

Figure 1: Output of test 1.

2 Null pointer at system call.

For the second part of lab 2, we made some changes in `syscall.c` file. Specifically, we added an `if` clause in function `argptr` to check if we point at `0`. If this is true, then we have an exception. The change is shown between lines 64 and 67 at listing 5.

The reason that we make these changes is that now that we changed `xv6` so that each process does not start from the zero address, we, also, need to ensure that we pass to kernel a correct pointer via system calls. Without the changes, `xv6` checks only if the pointer lies between the process address space. However, we should add a check that returns an exception if the pointer points to `0`.

We tested our implementation by executing a system call that passes a pointer to `0`, using the code in listing 6, and we got an exception. We add the `null` system call at the end of `sysproc.c` file in a similar fashion as it was done in the past lab (see listing 7). The output can be seen in figure 2. However, when we pass the pointer to somewhere else (inside the process address space) the system call is executed normally.

```
51  // Fetch the nth word-sized system call argument as a pointer
52  // to a block of memory of size n bytes.  Check that the pointer
53  // lies within the process address space.
54  int
55  argptr(int n, char **pp, int size)
56  {
57    int i;
58
59    if(argint(n, &i) < 0)
60      return -1;
61    if((uint)i >= proc->sz || (uint)i+size > proc->sz)
62      return -1;
63    *pp = (char*)i;
64    if(*pp == 0){
65      cprintf("Null Pointer Exception!!!\n");
66      return -1;
67    }
68    return 0;
69  }
```

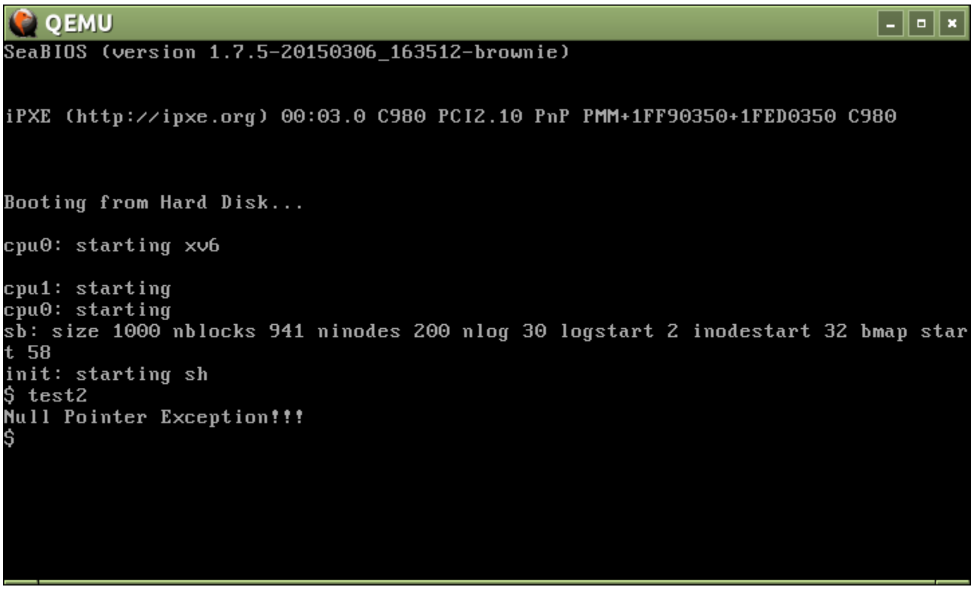
Listing 5: Checking a null pointer in `syscall.c` file.

```
#include "types.h"
#include "user.h"
#include "syscall.h"

int main(){
  int *p = 0;

  null(p);
  exit();
}
```

Listing 6: Test for null pointer catching at system call (`test2.c` file).

```
int sys_null(){
  int *f;

  argptr(0, (void*)&f, 2*sizeof(f[0]));
  return 0;
}
```

Listing 7: Adding the `null` system call in `sysproc.c` file.



```
SeaBIOS (version 1.7.5-20150306_163512-brownie)


iPXE (http://ipxe.org) 00:03.0 C980 PCI2.10 PnP PMM+1FF90350+1FED0350 C980



Booting from Hard Disk...

cpu0: starting xv6

cpu1: starting
cpu0: starting
sb: size 1000 nblocks 941 ninodes 200 nlog 30 logstart 2 inodestart 32 bmap star
t 58
init: starting sh
$ test2
Null Pointer Exception!!!
$
```

Figure 2: Output of test 2.