Recitation 9: Tshlab + VM

Instructor: TAs
Outline

- Labs
- Signals
- IO
- Virtual Memory
TshLab and MallocLab

- TshLab due Tuesday

- MallocLab is released immediately after
  - Start early
  - Do the checkpoint first, don’t immediately go for the final
  - Expect a recitation next week
    - Working for several hours will improve the value significantly
Signals

- Parent process sends SIGINT to a child process. What is the behavior of the child?

- What is the default?

- What else could the child do?
More Signals

- Parent process sends SIGKILL to a child process. What is the behavior of the child?
- What is the default?
- What else could the child do?
Sending Signals

- Parent sends SIGKILL to a child process.

...  

```c
pid_t pid = ...; // child pid
kill(pid, SIGKILL);
// At this point, what has happened
// to the child process?
```
Signals

- How many times is Hi printed?

```c
int main(int argc, char** argv)
{
    pid_t ppid = getpid(), cpid, tpid;
    cpid = fork();
    if (cpid == 0) tpid = ppid;
    else tpid = cpid;
    kill(tpid, SIGINT);
    write(STDOUT_FILENO, "Hi", strlen("Hi"));
    return 0;
}
```
Blocking Signals

- The shell is currently running its handler for SIGCHLD.

- What signals can it receive?
- What signals can it not receive (i.e., blocked)?
Errno

- Included from <errno.h>
- Global integer variable – usually 0
- When a system call fails (usually indicated by returning -1), it also will set errno to a value describing what went wrong
- Example: let’s assume there is no “foo.txt” in our path
  ```
  int fd = open("foo.txt", O_RDONLY);
  if(fd < 0) printf("%d\n", errno);
  ```
- The code above will print 2 – in the man pages, we can see that 2 is ENOENT “No such file or directory”
- In shell lab, your signal handlers must preserve errno
IO functions

Needed for tshlab

- int open(const char *pathname, int flags);
  - Some important flags:
    - O_CREAT – creates file if needed, opens for read/write
    - O_RDWR – opens for read/write
    - O_RDONLY – opens for read only
- int close(int fd);
- int dup2(int oldfd, int newfd);

Needed for life

- ssize_t read(int fd, void *buf, size_t count);
- ssize_t write(int fd, const void *buf, size_t count);
- off_t lseek(int fd, off_t offset, int whence);
IO and Fork()

- File descriptor management can be tricky.
- How many file descriptors are open in the parent process at the indicated point?
- How many does each child have open at the call to execve?

```c
int main(int argc, char** argv)
{
    int i;
    for (i = 0; i < 4; i++)
    {
        int fd = open("foo", O_RDONLY);
        pid_t pid = fork();
        if (pid == 0)
        {
            int ofd = open("bar", O_RDONLY);
            execve(...);
        }
    }
    // How many file descriptors are open in the parent?
}
```
Redirecting IO

- File descriptors can be directed to identify different open files.

```c
int main(int argc, char** argv)
{
    int i;
    for (i = 0; i < 4; i++)
    {
        int fd = open("foo", O_RDONLY);
        pid_t pid = fork();
        if (pid == 0)
        {
            int ofd = open("bar", O_WRONLY);
            dup2(fd, STDIN_FILENO);
            dup2(ofd, STDOUT_FILENO);
            execve(...);
        }
    }

    // How many file descriptors are open in the parent?
```
Redirecting IO

- At the two points (A and B) in main, how many file descriptors are open?

```c
int main(int argc, char** argv)
{
    int i, fd;
    fd = open("foo", O_WRONLY);
    dup2(fd, STDOUT_FILENO);
    // Point A
    close(fd);
    // Point B
    ...
```
Memory Access

- The processor tries to write to a memory address.
- List different steps that are required to complete this operation.
Memory Access

- The processor tries to write to a memory address.
- List different steps that are required to complete this operation. (non exhaustive list)
  - Virtual to physical address conversion (TLB lookup)
  - TLB miss
  - Page fault, page loaded from disk
  - TLB updated, check permissions
  - L1 Cache miss (and L2 ... and)
  - Request sent to memory
  - Memory sends data to processor
  - Cache updated
Address Translation with TLB

- Translate 0x15213, given the contents of the TLB and the first 32 entries of the page table below.

- 1MB Virtual Memory
  256KB Physical Memory
  4KB page size

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- 2-way set associative

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If you get stuck on TshLab

- Read the writeup!
- Do manual unit testing before `runtrace` and `sdriver`!
- Post private questions on piazza!

- Read the man pages on the syscalls.
  - Especially the error conditions
  - What errors should terminate the shell?
  - What errors should be reported?