Università della Svizzera italiana

Facoltà di scienze informatiche

Operating Systems **Spring - 2022**

Prof. Fernando Pedone, Eliã Rafael L Batista, Nenad Milosevic

Project 5 - User programs II PintOS

In this project you are asked to implement two system calls: *wait* and *exec*. To implement *exec*, you need synchronization and also you need to check the pointers passed by the user which requires some understanding of memory paging.

The *wait()* system call

The calling process blocks until its child p, which has id pid, has finished. Here is the syscalls declaration:

- *int wait (pid_t pid)*

The return value must be:

- the exit status of p, if all was fine (even if p finished before $wait$ was called!);
- -1 if p was killed;
- -1 if p is not a direct child of the caller (this makes it easier);
- -1 if the calling process already waited for that pid before.

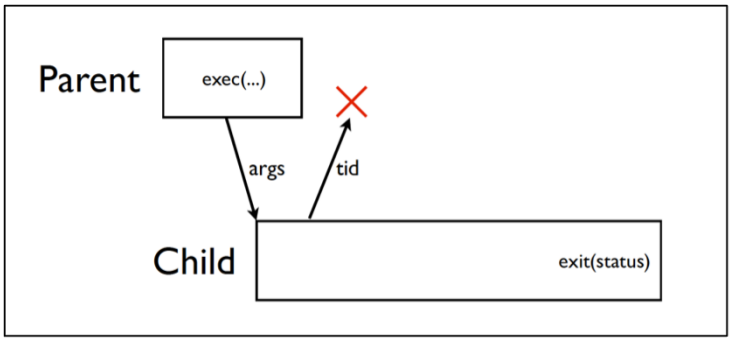
The *exec()* system call

A user program can use this system call to execute a command by creating a child process. Here is the systcall's declaration:

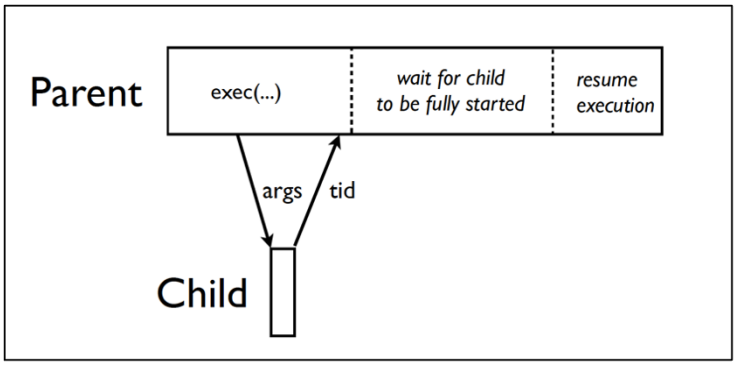
- *pid_t exec (const char *cmd_line)*

It tries to run the executable given in cmd_line. The return value is the pid (tid) of the child process (or -1 in case of error). A correct implementation synchronize between parent and child processes in order to prevent the following corner cases:

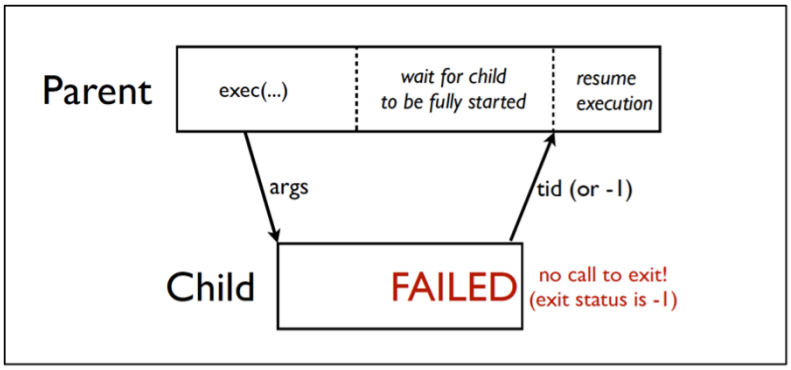
The parent thread must wait for the child creation:



The child thread may finish too fast:



The child thread may fail before telling some status:



Hints

The synchronization between parent and child process can be handled with *thread_block()*, or just a semaphore.

PintOS semaphore API

PintOS semaphore is a tool for synchronizing threads. It can solve the "wait for child" problem of the $exec$ syscall. The API is available in **"thread/synch.h"**.

- **struct semaphore** semaphore type; must be initialized with *sema_init*;
- **sema_init (struct semaphore * s, unsigned val)** initialize semaphore pointed by s with value val;
- **sema_down (struct semaphore * s)** if s is 0 (zero), block the calling thread and put it in a list waiting for s; otherwise, decrement s by 1;
- **sema_up (struct semaphore * s)** if s is 0 (zero) and there is some thread waiting for s, unblock one of the threads that are waiting for s; otherwise, increment s by 1;
- neither **sema_up** or **sema_down** can be interrupted (they're atomic)

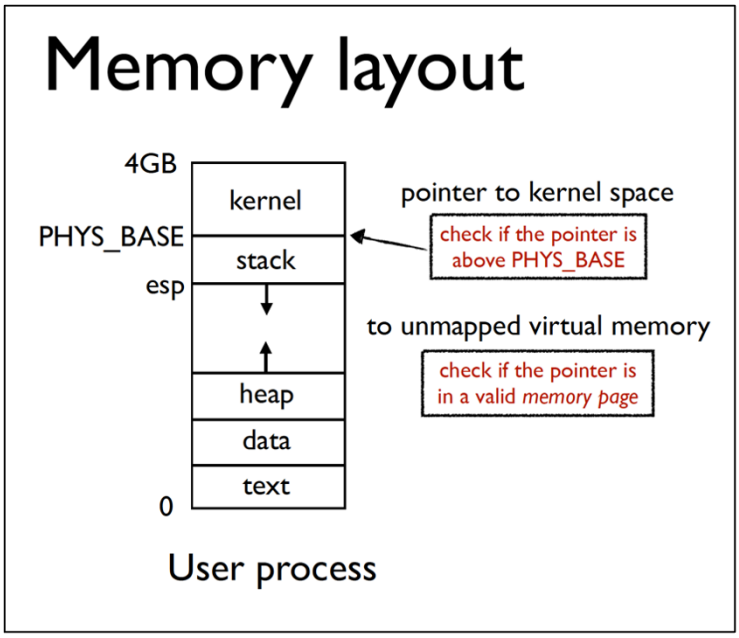
Memory Access

The user may provide an invalid pointer in a syscall. It is important to check the pointer before using it. You should check if the pointer is:

a. a null pointer;

b. a pointer to kernel address space;

c. a pointer to unmapped virtual memory; make sure user pointer is in a valid memory page (hints in **vaddr.h** and **pagedir.c**).



Tests

Your implementation should pass the tests:

- *exec-once*
- *exec-arg*
- *exec-multiple*
- *exec-missing*
- *exec-bad-ptr*
- *wait-simple*
- *wait-twice*
- *wait-bad-pid*

Readings

- PintOS documentation
  - Chapter 3 (Specially sections 3.1.4 and 3.3.4.)