

Chapter 8: Process Control

fork(2): create a new process

exit(3): exit a process

Waiting:

```
pid_t wait(int *status);
```

```
pid_t waitpid(pid_t wpid, int *status, int options);
```

```
#include <sys/resource.h>
```

```
pid_t wait3(int *status, int options, struct rusage *rusage);
```

```
pid_t wait4(pid_t wpid, int *status, int options, struct rusage *rusage);
```

zombie process -- exited & not waited on

(example: zombie.c)

How to "kill" the zombies?

Wait on them!

Killing Zombies (e.g. waiting!)

`pid_t waitpid(pid_t wpid, int *status, int options);`

`wpid`

- `-1` waits for any child process.
- `0` waits for any child process in the process group of the caller.
- `>0` waits for the process with process id `wpid`.
- `<-1` waits for any process whose process group id equals the absolute value of `wpid`.

`status`

- exit value, other information about exit status.
- see man page

`options`

- `WNOHANG` -- This option is used to indicate that the call should not block if there are no stopped or exited children. `wait*()` call returns 0 if no stopped or exited children.

Exit Status ... macros

WIFEXITED(status)

true if process called `_exit(2)` or `exit(3)`

WEXITSTATUS(status)

The low-order 8 bits of the argument passed to `_exit(2)`

WIFSIGNALED(status)

True if the process terminated due to receipt of a signal.

WTERMSIG(status)

The number of the signal that caused the termination.

WCOREDUMP(status)

True if a core file was created.

WIFSTOPPED(status)

True if the process has not terminated, but has stopped and can be restarted.

WSTOPSIG(status)

Number of signal that stopped process.

Race Conditions

- Multiple processes working together
- Results depend on the order of the processes running.

(Example race.c)

- Example -- character at a time output
- Accessing a file, "lock file"

More on the exec functions ...

System Call:

□ `int exece (char *path, char * argv[], char * envp[]);`

Library Calls:

□ `int execl (char *path, char *arg, ...);`

□ `int execlp (char *file, char *arg, ...);`

□ `int execl (char *path, char *arg, ..., char *envp[]);`

□ `int execv(char *path, char *argv[]);`

□ `int execvp(char *file, char *argv[]);`

Use:

□ `*p` -- search the path for the file named

□ others require full file path.

Example program `exec.c`

Things that remain the same across an exec

- process ID (pid), parent process ID (ppid)
- real user ID (uid), real group ID (gid)
- supplementary groups IDs
- process group ID
- session ID
- controlling terminal
- time left until alarm clock
- current working directory
- file mode creation mask (umask)
- file locks
- process signal mask
- pending signals
- resource limits
- time accounting values

Open files:

- file will remain open unless set to close.
- `r = fcntl (fd, F_SETFD, FD_CLOEXEC);`

Changing User IDs

Kinds of UIDs

- real user ID
- effective user ID (set by exec if setuid bit is set)
- saved set-user-ID (set by exec if setuid bit is set)

`int setuid(uid_t newuid);`

- POSIX (and Linux)
 - effective uid == 0 => sets all three
 - real uid == newuid => sets effective uid
 - saved uid == newuid => sets effective uid
 - otherwise error
- BSD (NetBSD)
 - effective uid == 0 => sets all three
 - real uid == newuid => sets all three
 - otherwise error

Changing User IDs (page 2)

`int seteuid(uid_t euid);`

POSIX -- no such call

BSD (NetBSD)

set effective to either real or saved UID

`int setgid(gid_t gid);`

`int setegid(gid_t egid);`

Same rules for these.

Use?

Interpreter files

Script files can be run directly from command line

```
#!/name [opt parameter]
```

```
contents
```

Uses:

shells

perl

python

