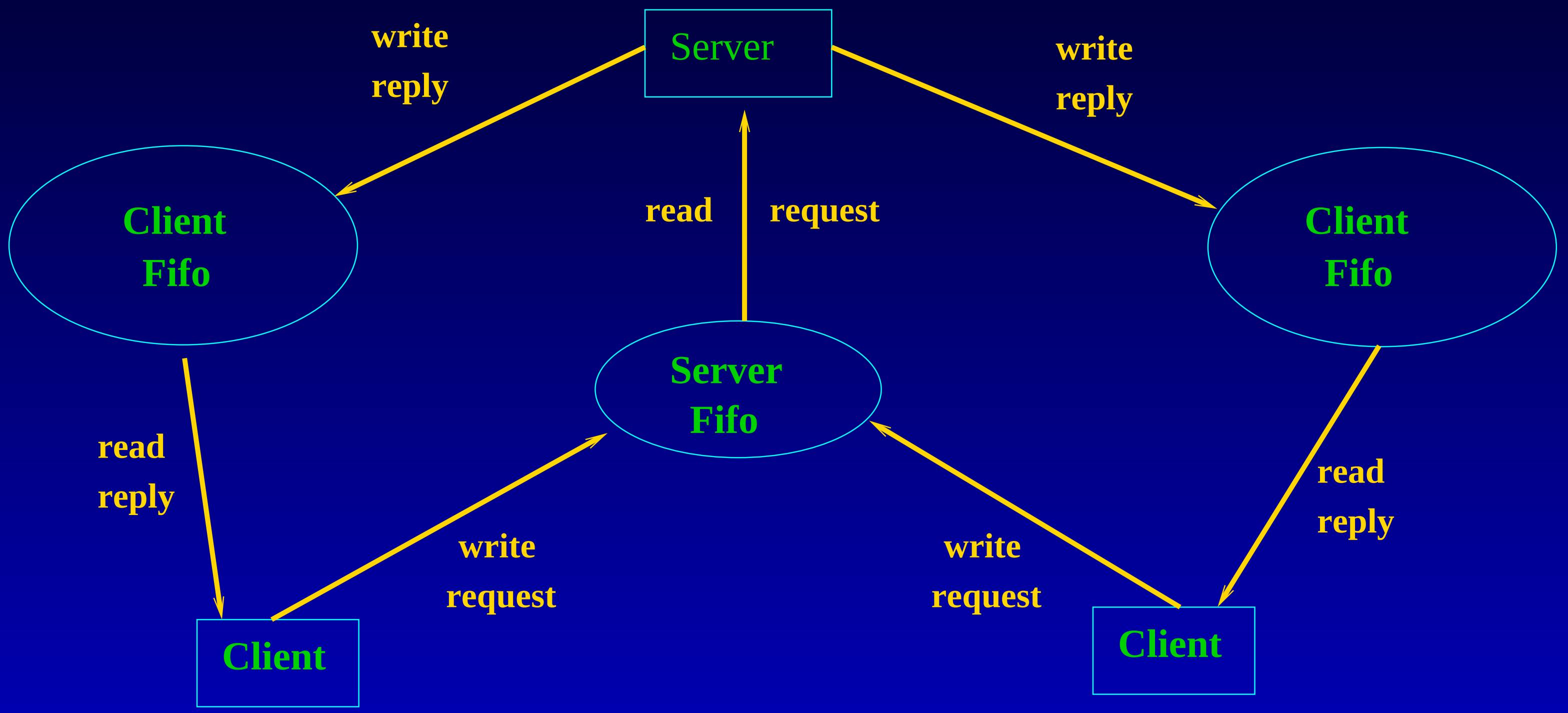
Client-Server Communications

with FIFOS



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To send a packet of information:

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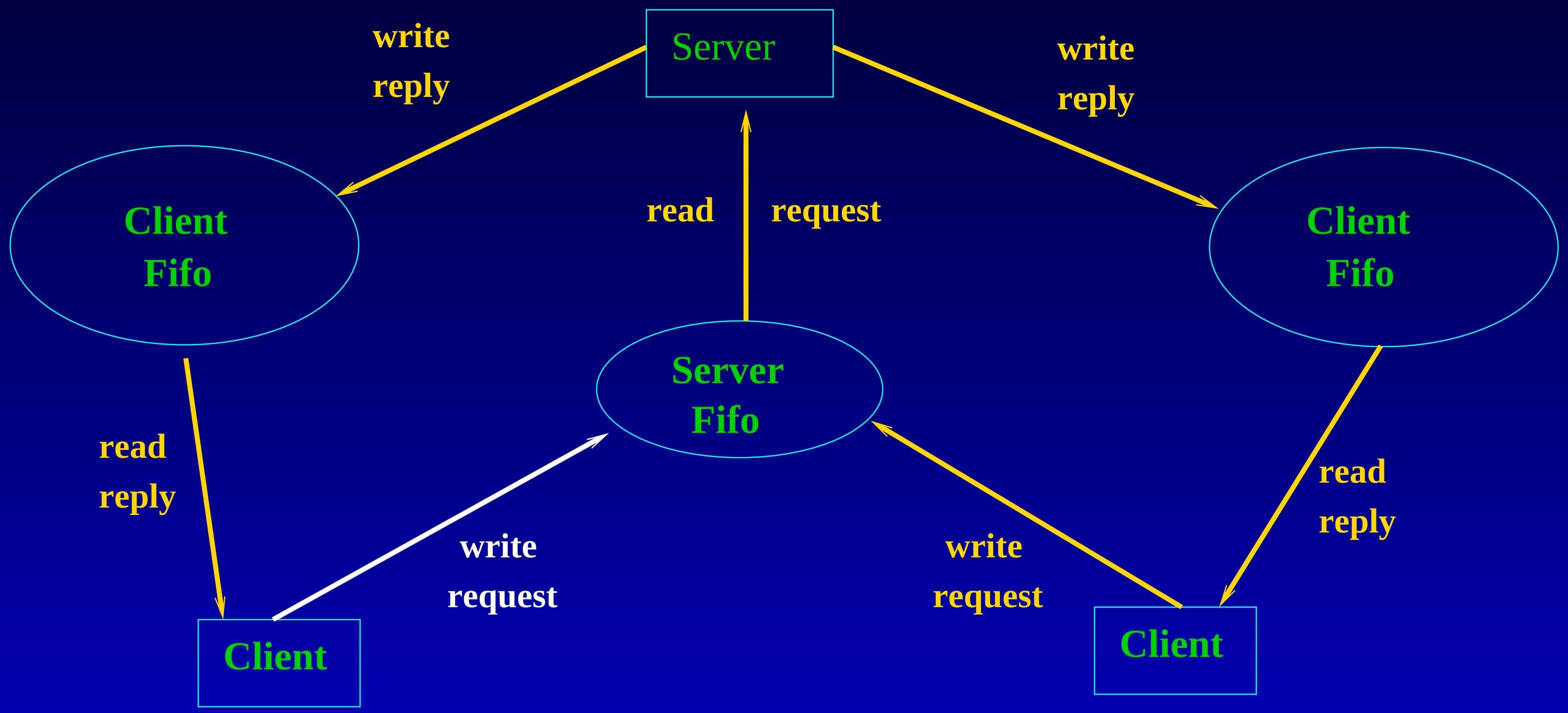

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Client writes to server FIFO: client pid, qty bytes, data

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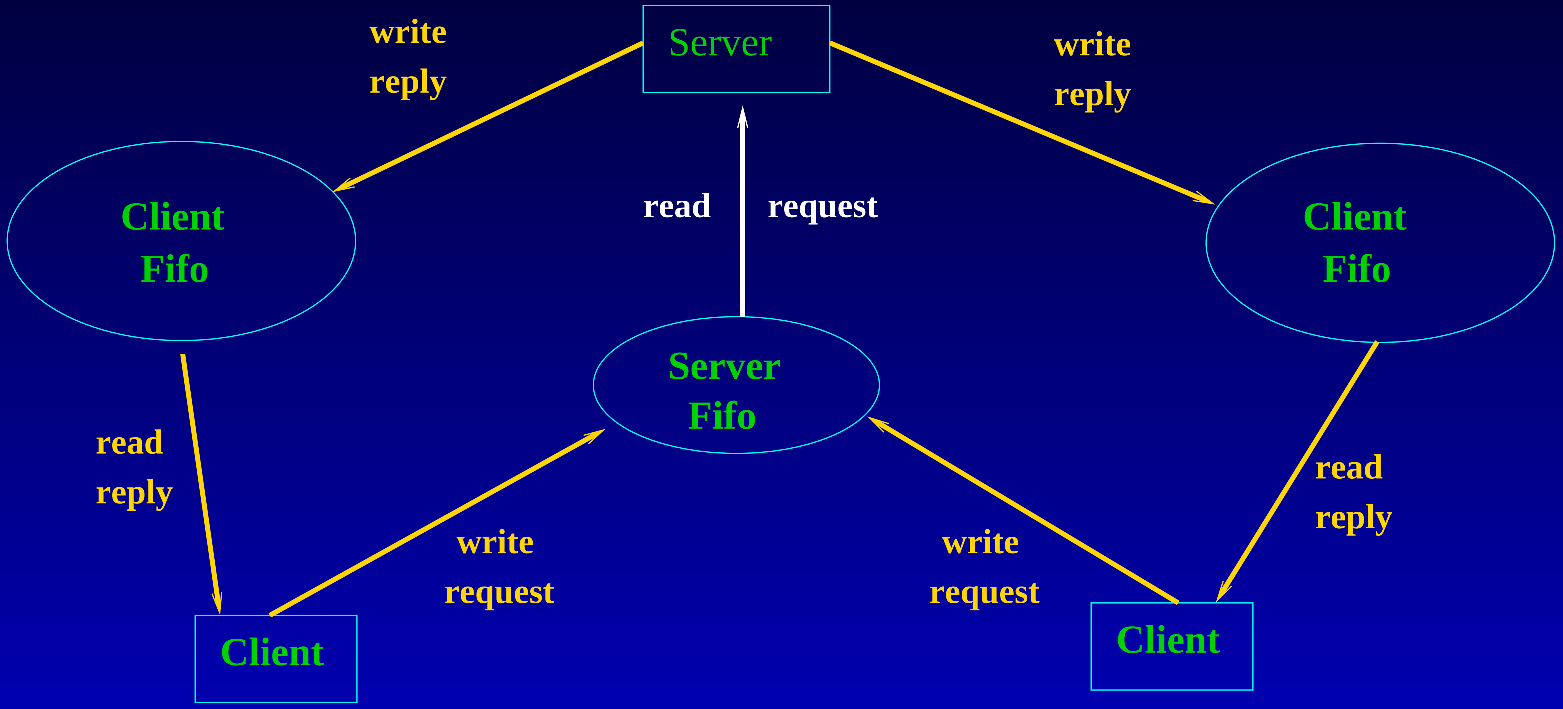

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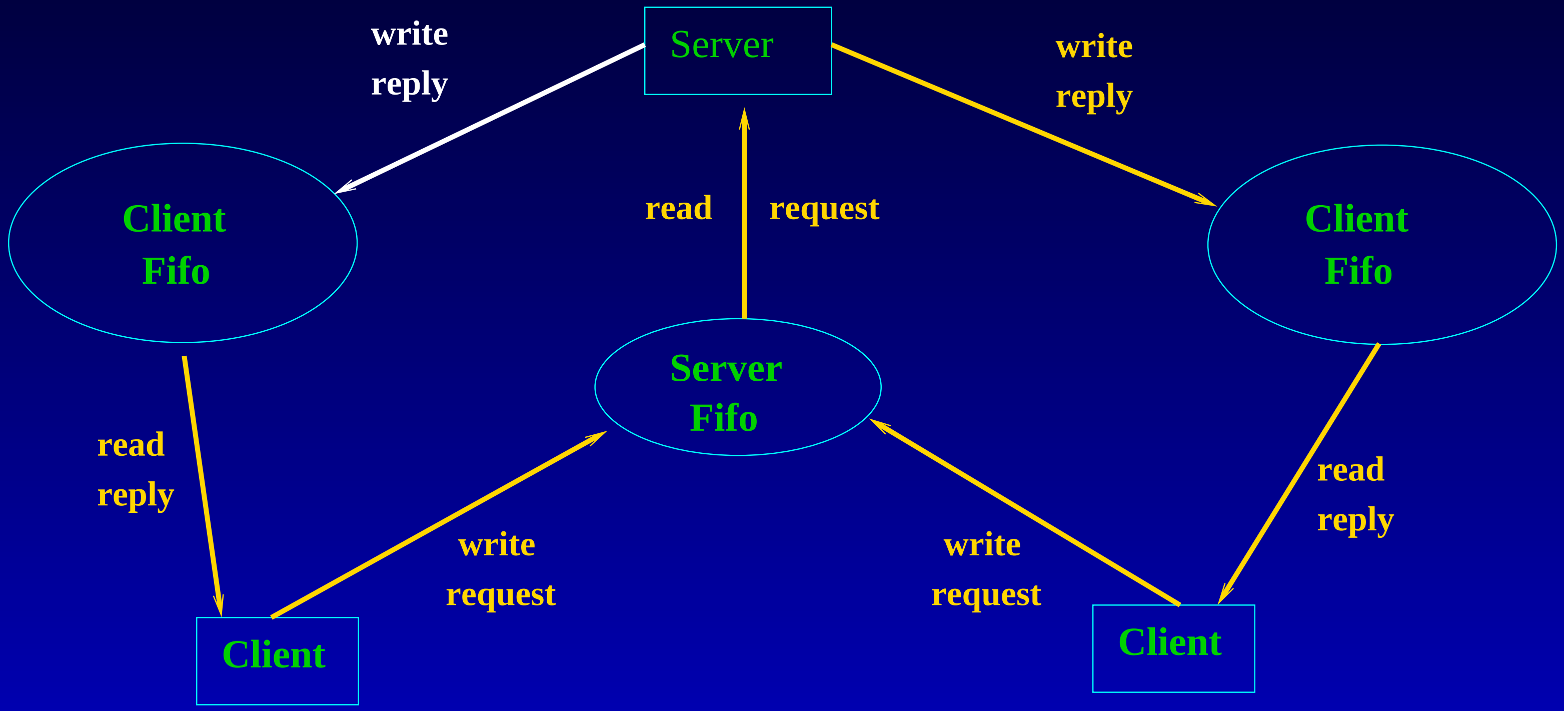

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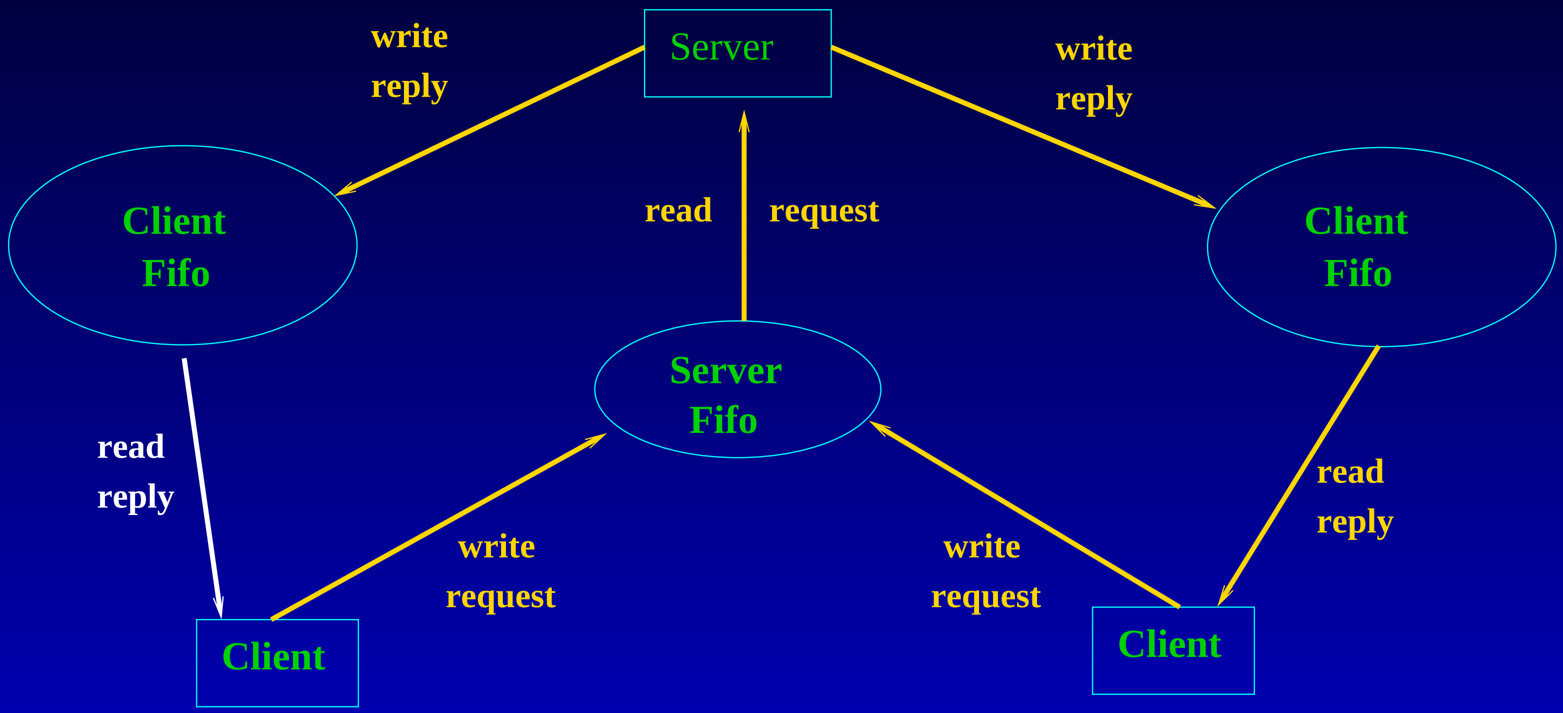

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Symbolic Link API

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#include <unistd.h>
int symlink(const char *reallink, const char *fakelink);
ssize_t readlink(const char *path, char *buf, size_t bufsiz);
int lstat(const char *path, struct stat *buf);
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symlink creates a symbolic link named fakelink which links to the file named by reallink. A symbolic link may point to an existing file or even a nonexistent one. In the latter case, its called a **dangling link**.

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lstat query file atttributes of the link file itself (as opposed to what its pointing to). Otherwise, its just like the stat() function.

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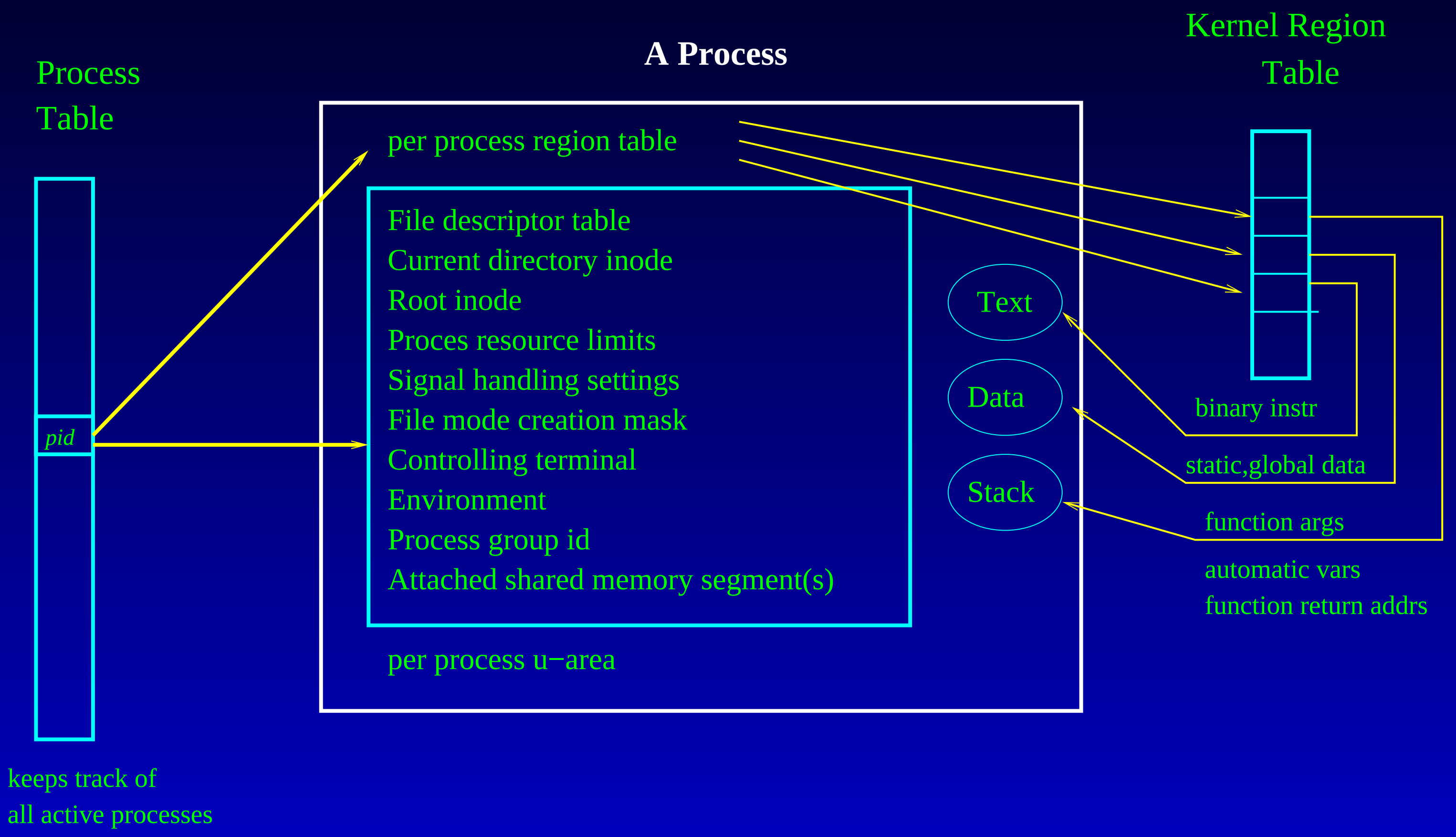

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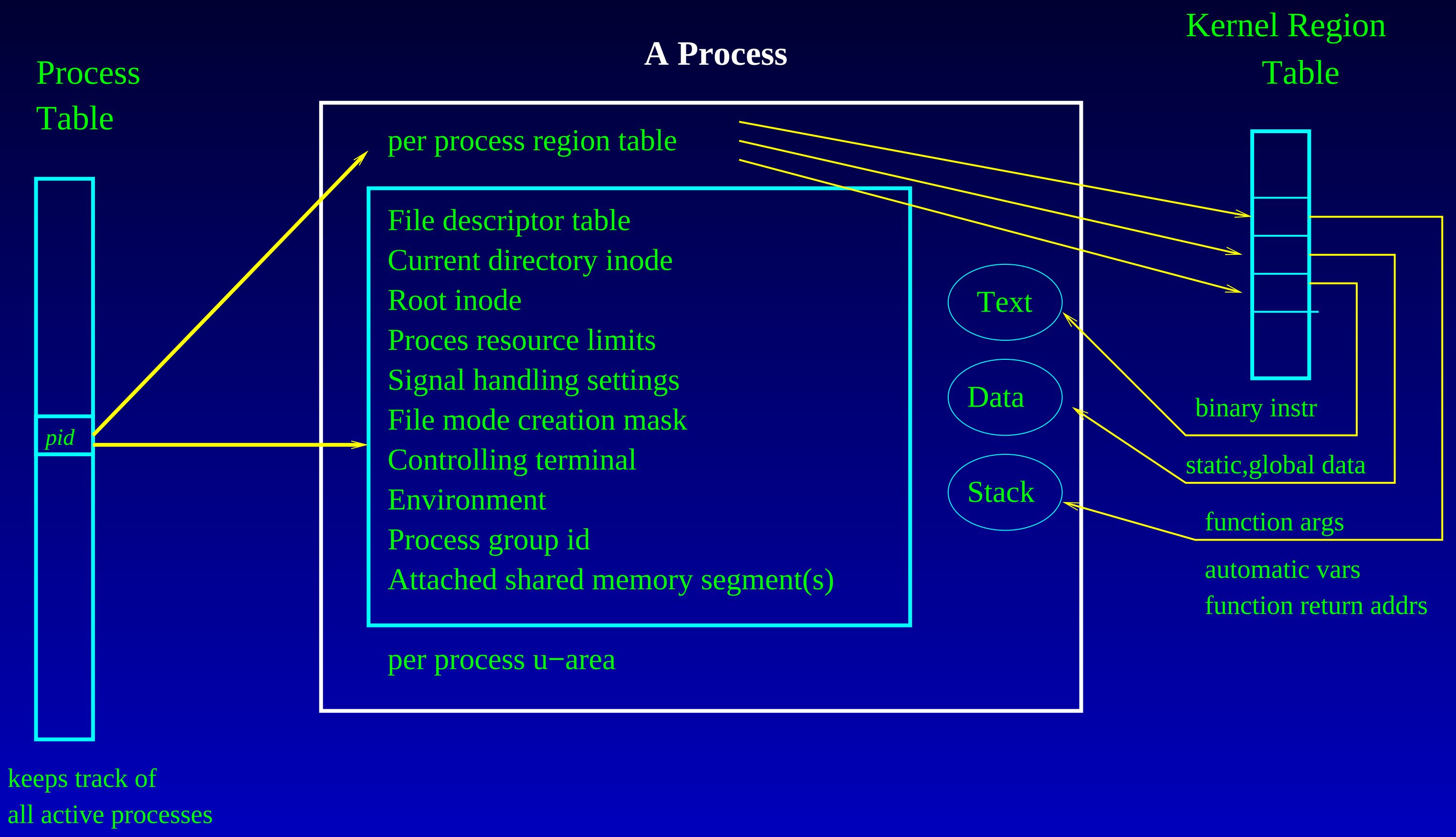

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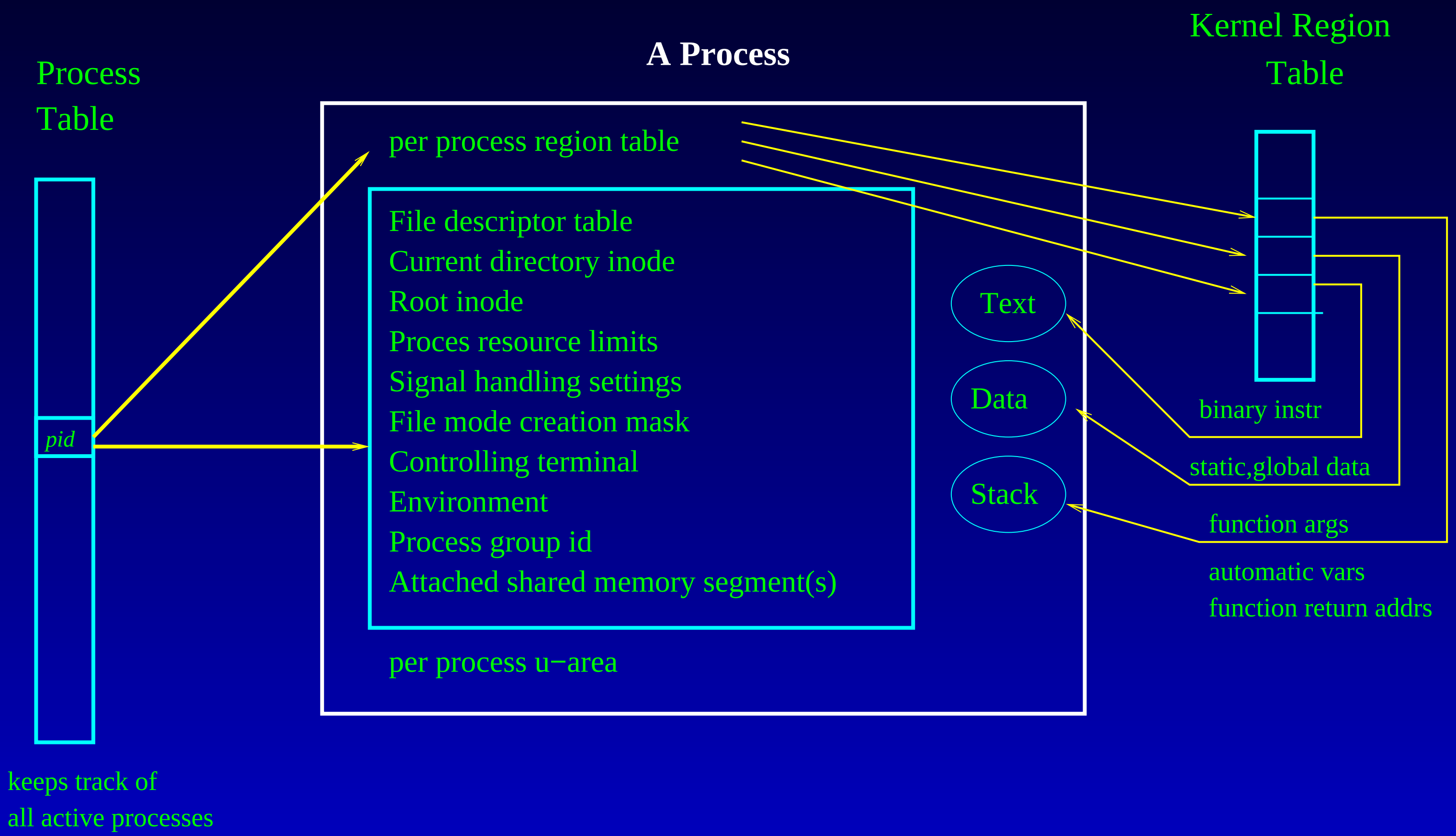

A Process

Process Table

pid

keeps track of
all active processes

per process region table

File descriptor table
Current directory inode
Root inode
Proces resource limits
Signal handling settings
File mode creation mask
Controlling terminal
Environment
Process group id
Attached shared memory segment(s)

per process u−area

Text

Data

Stack

Kernel Region Table

binary instr

static,global data

function args
automatic vars
function return addrs

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- PID=0: the *swapper*, a system process, part of the kernel
- PID=1: usually init (/etc/init or /sbin/init).

  Reads system files (/etc/rc*), starts daemons, etc.

  Normal user process, but supervisor privileged.

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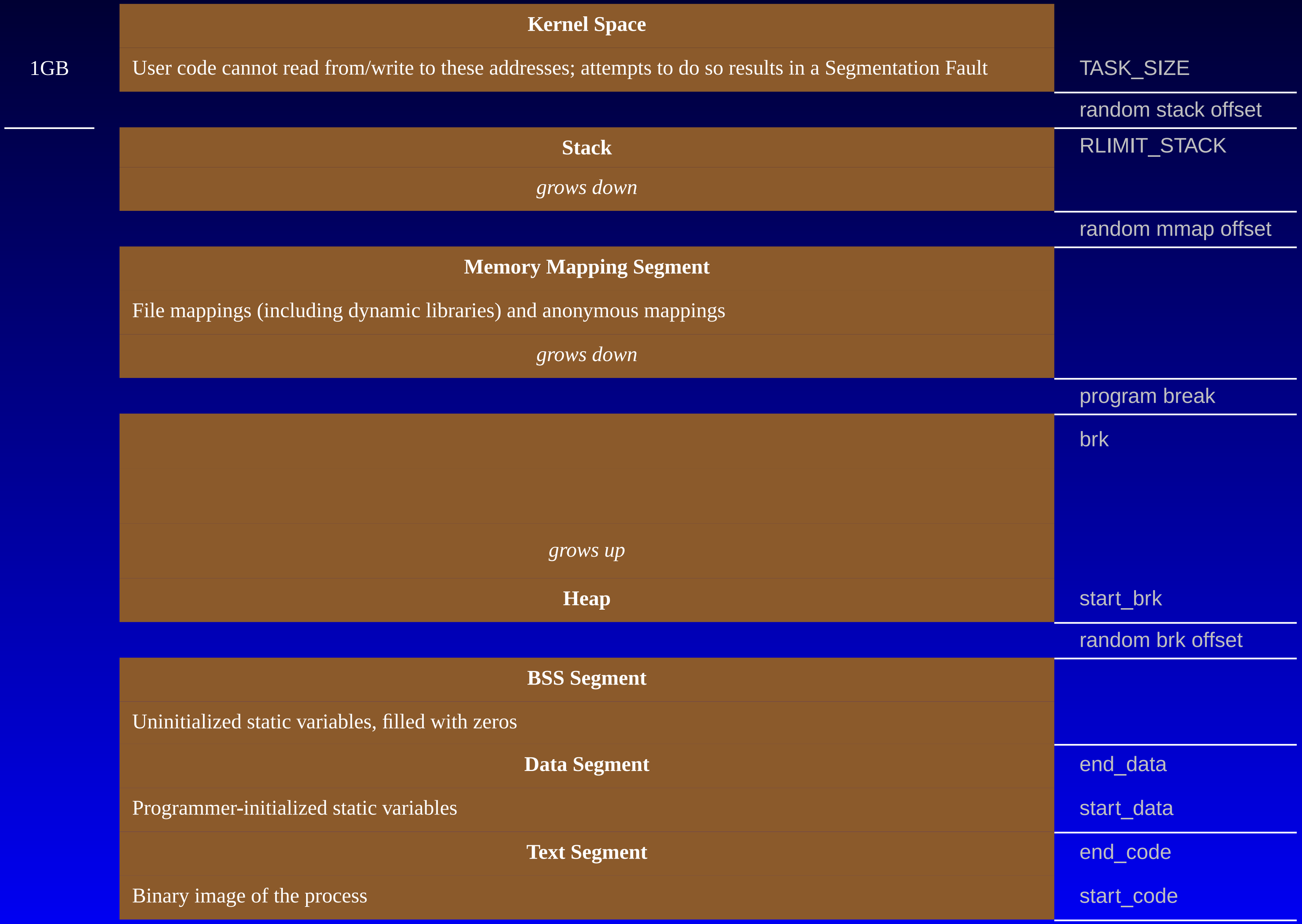
- The o/s also maintains, for each process, a region called the **u-area** *(user area)* . This region holds open file tables, current directory, signal actions, accounting information, system stack segment. When the process makes a system call, the stack frame information is stored in the process' system stack segment, which the process doesn't have access to.

Standard Segment Layout



1GB

Kernel Space

User code cannot read from/write to these addresses; attempts to do so results in a Segmentation Fault

TASK_SIZE

random stack offset

Stack

grows down

RLIMIT_STACK

random mmap offset

Memory Mapping Segment

File mappings (including dynamic libraries) and anonymous mappings

grows down

program break

brk

grows up

Heap

start_brk

random brk offset

BSS Segment

Uninitialized static variables, filled with zeros

Data Segment

end_data

Programmer-initialized static variables

start_data

Text Segment

end_code

Binary image of the process

start_code

Process States

user program is executing in user mode

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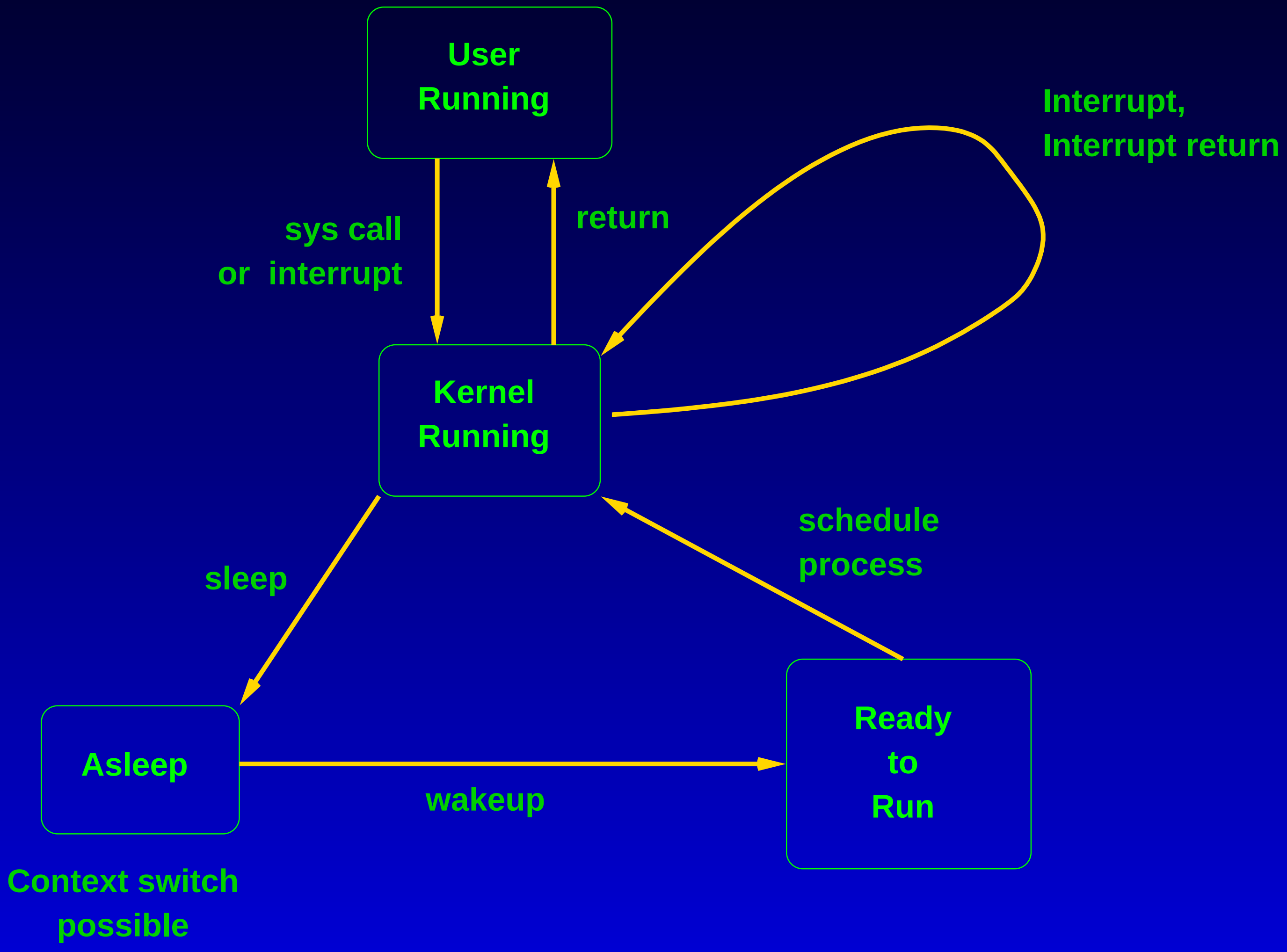
zombie Process no longer exists, but a record of its termination status is available

Process States and Transitions



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Kernel Stack Contains the stack frame of kernel procedures for when the process executes in kernel mode

Unix Definitions

session a session is a group of processes identified by a common id called a session id.

It is capable of establishing a connection with a controlling terminal.

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controlling terminal A controlling terminal is a terminal device that is associated with a session.
A session can only have one or no controlling terminals.
A terminal device cannot control more than one session.

Unix Definitions, con't.

controlling process a session leader that has established a connection to a controlling terminal.

Processes within the session controlled by a terminal are the only ones subject to job control operations from that terminal. *(ctrl-z, fg, bg, jobs)*

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process group a group of processes that are handled together for job control purposes.

Child processes are in their parent's process group by default.

Child processes may be moved into another process group within the same session.

A process group leader is the first process in a newly created process group.

There may be processes in the group which were not descended from the group leader.

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orphaned process group a process group in which the parent of every member in the group is either itself a member of the group or is not a member of the process group’s session. (ie. There is no process that can handle job control signals for the process group)

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superuser a process is recognized as a *superuser* process if its effective user id is zero. Superuser processes have special privileges (such as immunity from file permissions)

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gid_t getgid(void) get real group id

gid_t getegid(void) get effective group id (determines file access privileges, setgid bit)

Changing Process Attributes

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int setuid(uid_t uid) if superuser, real and effective uid set to uid. Otherwise, can only change effective uid to its real uid. (-1 else)

Changing Process Attributes, con't.

int setgid(gid_t gid) If superuser, set real and effective gid to gid. Otherwise, can only set effective gid to real gid. (-1 else)

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real user id,
real group id,
effective user id,
effective group id
environment
close-on-exec flag
signal handling settings
signal handling mask
supplementary group ids
set-user-id bit
set-group-id bit

profiling status
nice value (ie. priority)
scheduler class
attached shared memory segments
process group id
session id
current working directory
root directory
filemode creation mask
resource limits
controlling terminal

text segment
data segment
stack segment
file descriptor table

Child Differences

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- alarm time reset to zero

Typical Usage of fork()

Note that fork() returns + : pid of child when parent process

0 : this is the child process

-1 : on failure (no memory, system process limit, etc)

```
pid_t pid;
if((pid= fork()) > 0) { /* parent process */ }
else if(pid == 0)     { /* child process  */ }
else                  { /* error          */ }
```

(show runrace, see race.c; showsetsid.c)

vfork()

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#include <unistd.h>
pid_t vfork(void);

Often forks are followed by exec(), which replaces the program (text, data, stack, etc).

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Thus, it is now just as efficient to use fork()as vfork(), yet fork()is safe to use.

The parent process is suspended when using vfork() until the child process terminates or calls execve(). The child process may terminate by calling _exit().

clone()

```
#include <sched.h>
pid_t clone(int (*fnc)(void *),void *childstack,int flags,void *arg,... /* pid_t
*pid,struct user_desc *tls,pid_t *ctid */);
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- Like fork(), clone() creates a new process.

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- Used primarily to support threads.
- childstack is used to specify the cloned child’s stackspace. (child cannot re-use stack space as child and parent, which share memory, are simultaneously active)
- The low byte of flags contains the termination signal number when the child dies. Normally SIGCHLD.

_exit()

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void _exit(int status);
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- This function terminates the calling process *immediately*. Never fails!

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  3. If parent is not waiting, then the exiting process becomes a **zombie** process; resources are free'd but the process table slot retains the single byte holding its exit status.

wait(), waitpid()

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	WIFSTOPPED(s)	$\neq$ 0: returns value if child stopped due to job control
	WSTOPSIG(s)	returns signal# that stopped the child process

exec() family

```
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int execl   (const char *path,     const char *arg,...);
int execlp  (const char *file,     const char *arg,...);
int execle  (const char *path,     const char *arg,...,char * const envp[]);
int execv   (const char *path,     char *const argv[]);
int execvp  (const char *file,     char *const argv[]);
int execve  (const char *filename,char *const argv[],char *const envp[]);
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- These functions swap a new program image in, taking the place of the current process.
- The pid is retained.
- Often used with fork(), thus the new program image takes the place of a child process's image.

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(see exec1.c)

Argc, Argv, Envp Review

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0	1	2	3		n
pgmname	arg_1	arg_2	arg_3	. . .	NULL

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pgmname	arg_1	arg_2	arg_3	$\ldots$	NULL

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Argc, Argv, Envp Review

int main(int argc, char *argv[],char *envp[])

argc count of strings contained by args

argv an array of strings (with the last one being NULL)

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List of args : arg0, arg1, ..., argn,NULL

Vector of args : argv, where argv[0]="pgm", argv[1]="arg1", ...

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- Linux uses the "current directory first" default path to find program.

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- _exit() is used to terminate the child process.

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  - polling. A crude way would be to poll to see if the parent process has terminated: while(getppid() != -1) sleep(1); (polling wastes cpu)

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