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## Process API

→ fork, exec, fork exec combo, c/w fork

→ exit

- terminate the current process
- need to clean up address space & OS resources (open files)
  - kernel stack can't be freed by the process using it

→ wait

- wait for a child to terminate *if child hasn't terminated, block until it exits*
- clean up child's resources (kstack)

\* process don't have to call wait

→ hand over unwaited children to init process when parent exits

# Inter Process Communication (IPC)

→ Signals: a set of process events defined by the OS

→ send & delivery done through the OS

→ send: `kill(pid, sig#)` system call

OS tracks a set of pending signals per process

→ delivery: kernel delivers signals before a process returns to user mode.

→ kernel defines default action for each signal

→ also allow user process to define custom

handler: `signal(sig#, handler-func)` system call

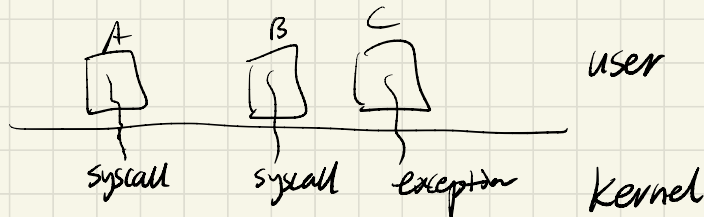
\* custom handler executes in user mode, on a user stack.

OS checks whether sending proc has the perm. to send.

Signal	Standard	Action	Comment
SIGABRT	P1990	Core	Abort signal from <code>abort(3)</code>
SIGALRM	P1990	Term	Timer signal from <code>alarm(2)</code>
SIGBUS	P2001	Core	Bus error (bad memory access)
SIGCHLD	P1990	Ign	Child stopped or terminated
SIGCLD	-	Ign	A synonym for SIGCHLD
SIGCONT	P1990	Cont	Continue if stopped
SIGEMT	-	Term	Emulator trap
SIGFPE	P1990	Core	Floating-point exception
SIGHUP	P1990	Term	Hangup detected on controlling terminal or death of controlling process
SIGILL	P1990	Core	Illegal instruction
SIGINFO	-	-	A synonym for SIGPWR
SIGINT	P1990	Term	Interrupt from keyboard
SIGIO	-	Term	I/O now possible (4.2BSD)
SIGIOT	-	Core	IOT trap. A synonym for SIGABRT
SIGKILL	P1990	Term	Kill signal
SIGLOST	-	Term	File lock lost (unused)
SIGPIPE	P1990	Term	Broken pipe: write to pipe with no readers; see <code>pipe(7)</code>
SIGPOLL	P2001	Term	Pollable event (Sys V); synonym for SIGIO
SIGPROF	P2001	Term	Profiling timer expired
SIGPWR	-	Term	Power failure (System V)
SIGQUIT	P1990	Core	Quit from keyboard
SIGSEGV	P1990	Core	Invalid memory reference
SIGSTKFLT	-	Term	Stack fault on coprocessor (unused)
SIGSTOP	P1990	Stop	Stop process
SIGTSTP	P1990	Stop	Stop typed at terminal
SIGSYS	P2001	Core	Bad system call (SVr4); see also <code>seccomp(2)</code>
SIGTERM	P1990	Term	Termination signal
SIGTRAP	P2001	Core	Trace/breakpoint trap
SIGTTIN	P1990	Stop	Terminal input for background process
SIGTTOU	P1990	Stop	Terminal output for background process
SIGUNUSED	-	Core	Synonymous with SIGSYS
SIGURG	P2001	Ign	Urgent condition on socket (4.2BSD)
SIGUSR1	P1990	Term	User-defined signal 1
SIGUSR2	P1990	Term	User-defined signal 2
SIGVTALRM	P2001	Term	Virtual alarm clock (4.2BSD)
SIGXCPU	P2001	Core	CPU time limit exceeded (4.2BSD); see <code>setrlimit(2)</code>
SIGXFSZ	P2001	Core	File size limit exceeded (4.2BSD); see <code>setrlimit(2)</code>
SIGWINCH	-	Ign	Window resize signal (4.3BSD, Sun)

# Threads

- unit of execution / task
  - execution states: PC, SP, registers
- multithreaded program (concurrent)
  - divide program into tasks (threads)
- Concurrency vs. parallelism
  - ↳ structured into tasks
  - ↳ execute simultaneously
- OS as a multithreaded program



Process = Address Space

+ OS resources

+ threads

each kernel handler  
is its own task / execution