

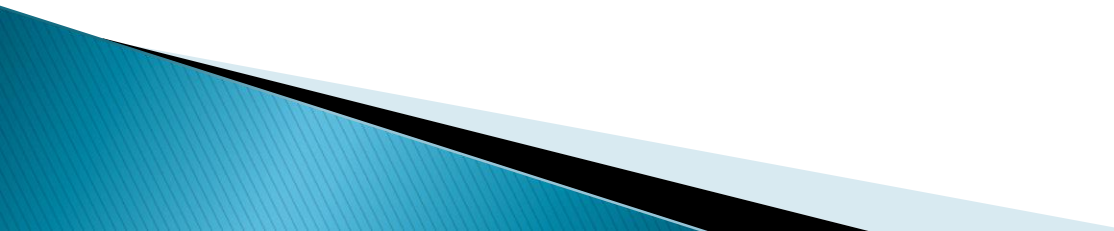
CSC552 – Advanced UNIX Programming

Signals and Times

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Signals

- ▶ Interrupts
 - ▶ Event *generates* signal
 - ▶ Signal *delivered* to process
 - ▶ Signal *pending*
 - ▶ *Lifetime* of signal
 - ▶ Process *catches* signal
 - ▶ Execute *signal handler*
 - ▶ *Signal mask*
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/usr/include/sys/signal.h

POSIX Required Signals (page 257)

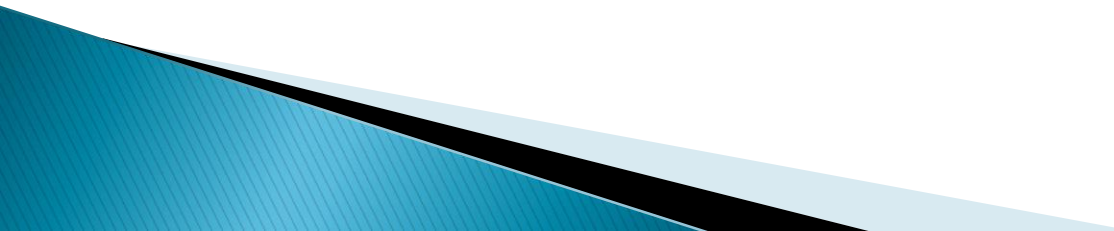
| Signal | Description | default action |
|---------|--|--------------------------|
| SIGABRT | process abort | implementation dependent |
| SIGALRM | alarm clock | abnormal termination |
| SIGBUS | access undefined part of memory object | implementation dependent |
| SIGCHLD | child terminated, stopped or continued | ignore |
| SIGCONT | execution continued if stopped | continue |
| SIGFPE | error in arithmetic operation as in division by zero | implementation dependent |
| SIGHUP | hang-up (death) on controlling terminal (process) | abnormal termination |
| SIGILL | invalid hardware instruction | implementation dependent |
| SIGINT | interactive attention signal (usually ctrl-C) | abnormal termination |

| | | |
|---------|---|--------------------------|
| SIGKILL | terminated (cannot be caught or ignored) | abnormal termination |
| SIGPIPE | write on a pipe with no readers | abnormal termination |
| SIGQUIT | interactive termination: core dump (usually ctrl-) | implementation dependent |
| SIGSEGV | invalid memory reference | implementation dependent |
| SIGSTOP | execution stopped (cannot be caught or ignored) | stop |
| SIGTERM | termination | abnormal termination |
| SIGTSTP | terminal stop | stop |
| SIGTTIN | background process attempting to read | stop |
| SIGTTOU | background process attempting to write | stop |
| SIGURG | high bandwidth data available at a socket | ignore |
| SIGUSR1 | user-defined signal 1 | abnormal termination |
| SIGUSR2 | user-defined signal 2 | abnormal termination |

Child Signals

- ▶ WIFSIGNALED(status)
 - ▶ WTERMSIG(status)
 - ▶ WIFSTOPPED(status)
 - ▶ WSTOPSIG(status)
 - ▶ WCOREDUMP(status)
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- ▶ Example: `processes/waitpid_ex.c`

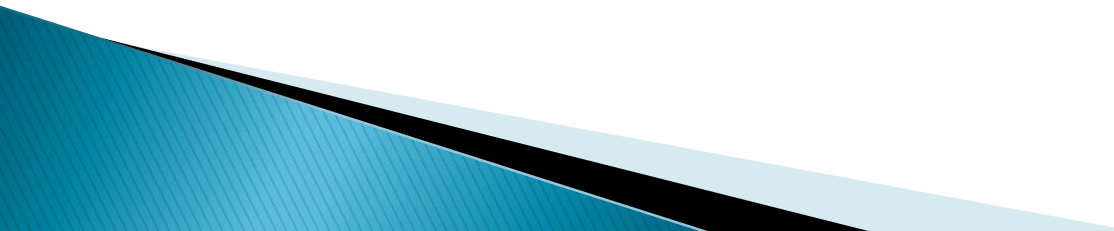
Signal Sets

- ▶ List of signals
 - ▶ sigset_t
 - ▶ sigfillset
 - ▶ sigemptyset
 - ▶ sigaddset
 - ▶ sigdelset
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Signal Handler

- ▶ Three options
 - Write own signal handler (function address)
 - Use default action (SIG_DFL)
 - Ignore signal (SIG_IGN)
- ▶ signal
- ▶ sigaction
 - sigaction structure
- ▶ sigprocmask

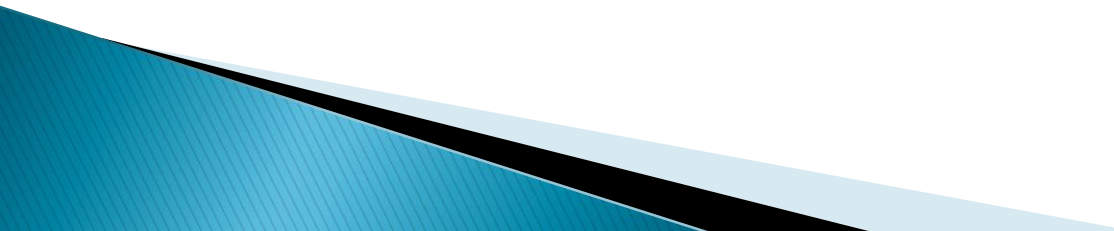
Miscellaneous System Calls

- ▶ kill
 - ▶ raise
 - ▶ alarm
 - ▶ pause
 - ▶ sleep
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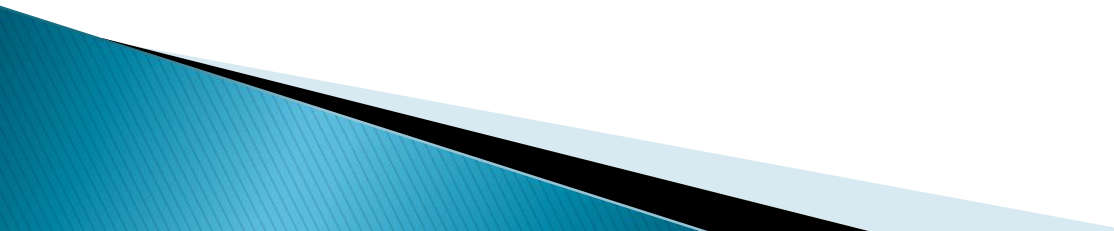
Processes and Signals

- ▶ SIGCHLD signal
- ▶ Process groups
 - Process group leader
 - Process group id (pgid)
 - getpgrp function
- ▶ Control terminal
 - Control process

Signal Examples

- ▶ `signals/timeout.c`
 - ▶ `signals/ignoreCtrlC.c`
 - ▶ `signals/sigTalk.c`
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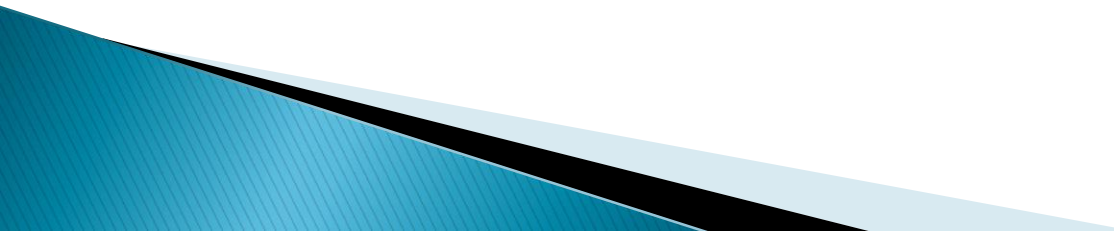
Functions and Signals

- ▶ Restart function
 - ▶ Reentrant functions
 - ▶ Handling errors
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General Rules

- ▶ Restart library calls
- ▶ Use *async-signal safe* functions in signal handlers
- ▶ Analyze interactions in signal handler
 - Block signals
- ▶ Save and restore *errno*

Internals – Process Information

- ▶ Signal handler array
 - Address of signal handler
 - 1 – ignore signal
 - 0 – default action
 - ▶ *Pending signal bitmap*
 - ▶ Process group ID
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Times

- ▶ *Epoch*
- ▶ Time structures
 - tm → /usr/include/iso/time_iso.h
 - timeval
 - timezone

Time Functions

- ▶ time
 - ▶ ctime
 - ▶ localtime
 - ▶ gmtime
 - ▶ asctime
 - ▶ mktime
 - ▶ difftime
 - ▶ gettimeofday
 - ▶ strftime
- 