

CSC 4304 - Systems Programming
Fall 2008

LECTURE - IX
PROCESS CONTROL

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Environment Variables

```
$ env
HOSTNAME=classes
TERM=xterm-color
USER=cs4304_kos
HOSTTYPE=x86_64
PATH=/usr/local/bin:/usr/bin:/opt/gnome/bin:/usr/lib/
mit/sbin:./
CPU=x86_64
PWD=/classes/cs4304/cs4304_kos
LANG=en_US.UTF-8
SHELL=/bin/bash
HOME=/classes/cs4304/cs4304_kos
MACHTYPE=x86_64-suse-linux
LOGNAME=cs4304_kos
...
```

Updating the Environment

```
$ course=csc4304
$ export course
$ env | grep course
course=csc4304
```

or

```
$ export course="systems programming"
$ env | grep course
course=systems programming
```

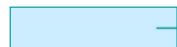
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How is Environment Implemented?

■ Environment Variables

- `int main(int argc, char **argv, char **envp);`

`extern char **environ;`



environment
list



environment
strings

HOME=/home/stevens\0
PATH=./bin:/usr/bin\0
SHELL=/bin/sh\0
USER=stevens\0
LOGNAME=stevens\0

■ `getenv/putenv`

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Example 1

```
#include <stdio.h>
#include <malloc.h>

extern char **environ;

main()
{
    char ** ptr;

    for (ptr=environ; *ptr != 0; ptr++)
        printf("%s\n", *ptr);
}
```

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Example 2

```
#include <stdio.h>
#include <malloc.h>

main(int argc, char *argv[], char *env[])
{
    char ** ptr;

    for (ptr=env; *ptr != 0; ptr++)
        printf("%s\n", *ptr);
}
```

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system function

```
int system(const char *command);
```

- used to execute command strings
- e.g. system("date > file");
- implemented using fork(), exec(), and waitpid()

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Example 3

```
#include <stdio.h>
#include <unistd.h>
extern char **environ;

main()
{
    char    *newenv[5];
    printf("The current environment is..\n");
    system("env");

    printf("***** Now Replacing Environment...\n"); getchar();
    newenv[0] = "HOME=/on/the/range";
    newenv[1] = "LOGNAME=nobody";
    newenv[2] = "PATH=./bin:/usr/bin";
    newenv[3] = "DAY=Wednesday";
    newenv[4] = 0 ;
    environ = newenv;
    execlp("env", "env", NULL);
}
```

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Getting Environment Vars

```
char * getenv(const char *name);
```

```
#include <stdio.h>
#include <stdlib.h>

main()
{
    printf("SHELL = %s\n", getenv("SHELL"));
    printf("HOST = %s\n", getenv("HOST"));
}
```

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Setting Environment Vars

```
int putenv(const char *name); //name=value
int setenv(const char *name, const char *value, int rw);

void unsetenv(const char *name);
```

```
#include <stdio.h>
#include <stdlib.h>

main()
{
    setenv("HOST", "new host name", 1);
    printf("HOST = %s\n", getenv("HOST"));
}
```

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vfork function

```
pid_t vfork(void);
```

- Similar to fork, but:
 - child shares all memory with parent
 - parent is suspended until the child makes an **exit** or **exec** call

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fork example

```
main()
{
    int    ret, glob=10;

    printf("glob before fork: %d\n", glob);
    ret = fork();

    if (ret == 0) {
        glob++;
        printf("child: glob after fork: %d\n", glob) ;
        exit(0);
    }

    if (ret > 0) {

        if (waitpid(ret, NULL, 0) != ret) printf("Wait error!\n");
        printf("parent: glob after fork: %d\n", glob) ;
    }
}
```

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vfork example

```
main()
{
    int    ret, glob=10;

    printf("glob before fork: %d\n", glob);
    ret = vfork();

    if (ret == 0) {
        glob++;
        printf("child: glob after fork: %d\n", glob) ;
        exit(0);
    }

    if (ret > 0) {

        //if (waitpid(ret, NULL, 0) != ret) printf("Wait error!\n");
        printf("parent: glob after fork: %d\n", glob) ;
    }
}
```

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Race Conditions

```
static void charatotime(char *str)
{
    char *ptr;
    int c;

    setbuf(stdout, NULL);
    for (ptr=str;c=*ptr++;) putc(c,stdout);
}

main()
{
    pid_t pid;

    if ((pid = fork())<0) printf("fork error!\n");
    else if (pid ==0) charatotime("12345678901234567890\n");
    else charatotime("abcdefghijklmnopqrstuvwxyz\n");
}
```

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Output

```
$ fork3
12345678901234567890
abcdefghijklmnopqrstuvwxyz
```

```
$ fork3
12a3bc4d5e6f78901g23hi4567jk890
lmnopqrstuvwxyz
```

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Avoid Race Conditions

```
static void charatotime(char *str)
{
    char *ptr;
    int c;

    setbuf(stdout, NULL);
    for (ptr=str;c=*ptr++;) putc(c,stdout);
}

main()
{
    pid_t pid;
    TELL_WAIT();

    if ((pid = fork())<0) printf("fork error!\n");
    else if (pid ==0) {WAIT_PARENT(); charatotime("12345678901234567890\n");}
    else {charatotime("abcdefghijklmnopqrstuvwxyz\n"); TELL_CHILD();}
}
```

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Process Accounting

- Kernel writes an accounting record each time a process terminates
- **acct struct** defined in <sys/acct.h>

```
typedef u_short comp_t;
struct acct {
    char    ac_flag; /* Figure 8.9 - Page 227 */
    char    ac_stat; /* termination status (core flag + signal #) */
    uid_t   ac_uid; gid_t   ac_gid; /* real [ug]id */
    dev_t   ac_tty; /* controlling terminal */
    time_t  ac_btime; /* starting calendar time (seconds) */
    comp_t  ac_utime; /* user CPU time (ticks) */
    comp_t  ac_stime; /* system CPU time (ticks) */
    comp_t  ac_etime; /* elapsed time (ticks) */
    comp_t  ac_mem; /* average memory usage */
    comp_t  ac_io; /* bytes transferred (by r/w) */
    comp_t  ac_rw; /* blocks read or written */
    char    ac_comm[8]; /* command name: [8] for SVR4, [10] for
4.3 BSD */
};
```

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Process Accounting

- Data required for accounting record is kept in the process table
- Initialized when a new process is created
 - (e.g. after fork)
- Written into the accounting file (binary) when the process terminates
 - in the order of termination
- No records for
 - crashed processes
 - abnormal terminated processes

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Pipes

- one-way data channel in the kernel
- has a reading end and a writing end
- e.g. `who | sort` or `ps | grep ssh`

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Process Communication via Pipes

```
int pipe(int filedes[2]);
```

- `pipe` creates a pair of file descriptors, pointing to a pipe inode, and places them in the array pointed to by `filedes`. `filedes[0]` is for reading `filedes[1]` is for writing

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```

main(int ac, char *av[])
{
    int    thepipe[2], newfd, pid; /*
    if ( ac != 3 ){fprintf(stderr, "usage: pipe cmd1 cmd2\n");exit(1);}

    if (pipe(thepipe) == -1){perror( "cannot create pipe"); exit(1); }

    if ((pid = fork()) == -1){fprintf(stderr,"cannot fork\n"); exit(1);}

    /*
    *    parent will read from reading end of pipe
    */

    if ( pid > 0 ){                /* the child will be av[2]      */
        close(thepipe[1]);         /* close writing end      */
        close(0);                 /* will read from pipe   */
        newfd=dup(thepipe[0]);     /* so duplicate the reading end */
        if ( newfd != 0 ){        /* if not the new stdin.. */
            fprintf(stderr,"Dupe failed on reading end\n");
            exit(1);
        }
        close(thepipe[0]);         /* stdin is duped, close pipe */
        execlp( av[2], av[2], NULL);
        exit(1);                 /* oops                    */
    }
}

```

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```

/*
*    child will write into writing end of pipe
*/
close(thepipe[0]);               /* close reading end      */
close(1);                       /* will write into pipe   */
newfd=dup(thepipe[1]);           /* so duplicate writing end */
if ( newfd != 1 ){              /* if not the new stdout.. */
    fprintf(stderr,"Dupe failed on writing end\n");
    exit(1);
}
close(thepipe[1]);               /* stdout is duped, close pipe */
execlp( av[1], av[1], NULL);
exit(1);                        /* oops                    */
}

```

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Summary

- Process Control
 - Environment
 - Process Accounting
 - Pipes
- Next Class: Signals
- Source codes available under:
/classes/cs4304/cs4304_kos/code



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- Advanced Programming in the Unix Environment by R. Stevens
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