

# ***UNIX PROGRAMMING***

## ***MODULE-5***

### **SIGNALS AND DAEMON PROCESSES**

- ✓ Signals are software interrupts.
- ✓ Signals provide a way of handling asynchronous events: a user at a terminal typing the interrupt key to stop a program or the next program in a pipeline terminating prematurely.
- ✓ When a signal is sent to a process, it is pending on the process to handle it.
- ✓ The process can react to pending signals in one of three ways:
  - i. Accept the **default action** of the signal, which for most signals will terminate the process.
  - ii. **Ignore** the signal. The signal will be discarded and it has no effect whatsoever on the recipient process.
  - iii. Invoke a **user-defined** function. The function is known as a signal handler routine and the signal is said to be *caught* when this function is called.

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Name	Description	Default action
<b>SIGABRT</b>	abnormal termination ( <code>abort</code> )	terminate+core
**** <b>SIGALRM</b>	timer expired ( <code>alarm</code> )	terminate
<b>SIGBUS</b>	hardware fault	terminate+core
<b>SIGCANCEL</b>	threads library internal use	ignore
***** <b>SIGCHLD</b>	change in status of child	ignore
<b>SIGCONT</b>	continue stopped process	continue/ignore
<b>SIGEMT</b>	hardware fault	terminate+core
<b>SIGFPE</b>	arithmetic exception	terminate+core
<b>SIGFREEZE</b>	checkpoint freeze	ignore
<b>SIGHUP</b>	hangup	terminate
<b>SIGILL</b>	illegal instruction	terminate+core
<b>SIGINFO</b>	status request from keyboard	ignore
*** <b>SIGINT</b>	terminal interrupt character	terminate
<b>SIGIO</b>	asynchronous I/O	terminate/ignore
<b>SIGIOT</b>	hardware fault	terminate+core
<b>SIGKILL</b>	termination	terminate
<b>SIGLWP</b>	threads library internal use	ignore
<b>SIGPIPE</b>	write to pipe with no readers	terminate
<b>SIGPOLL</b>	pollable event ( <code>poll</code> )	terminate
<b>SIGPROF</b>	profiling time alarm ( <code>setitimer</code> )	terminate
<b>SIGPWR</b>	power fail/restart	terminate/ignore
<b>SIGQUIT</b>	terminal quit character	terminate+core
*** <b>SIGSEGV</b>	invalid memory reference	terminate+core
<b>SIGSTKFLT</b>	coprocessor stack fault	terminate
<b>SIGSTOP</b>	stop	stop process
<b>SIGSYS</b>	invalid system call	terminate+core
*** <b>SIGTERM</b>	termination	terminate
<b>SIGTHAW</b>	checkpoint thaw	ignore
<b>SIGTRAP</b>	hardware fault	terminate+core
<b>SIGTSTP</b>	terminal stop character	stop process
<b>SIGTTIN</b>	background read from control tty	stop process

<b>SIGTTOU</b>	background write to control tty	stop process
<b>SIGURG</b>	urgent condition (sockets)	ignore
<b>SIGUSR1</b>	user-defined signal	terminate
<b>SIGUSR2</b>	user-defined signal	terminate
<b>SIGVTALRM</b>	virtual time alarm ( <code>setitimer</code> )	terminate
<b>SIGWAITING</b>	threads library internal use	ignore
<b>SIGWINCH</b>	terminal window size change	ignore
<b>SIGXCPU</b>	CPU limit exceeded ( <code>setrlimit</code> )	terminate+core/ignore
<b>SIGXFSZ</b>	file size limit exceeded ( <code>setrlimit</code> )	terminate+core/ignore
<b>SIGXRES</b>	resource control exceeded	ignore

## THE UNIX KERNEL SUPPORT OF SIGNALS

- ✓ When a signal is generated for a process, the kernel will set the corresponding signal flag in the process table slot of the recipient process.
- ✓ If the recipient process is asleep, the kernel will awaken the process by scheduling it.
- ✓ When the recipient process runs, the kernel will check the process U-area that contains an **array of signal handling specifications**.
- ✓ If array entry contains a zero value, the process will accept the default action of the signal.
- ✓ If array entry contains a 1 value, the process will ignore the signal and kernel will discard it.
- ✓ If array entry contains any other value, it is used as the function pointer for a user-defined signal handler routine.

## SIGNAL

What are signals? Mention different sources for signals? Write a program to set up signal Handlers-SIGINIIT and SIGALR,

- ✓ The function prototype of the signal API is:

**`#include <signal.h>`**

**`void (*signal(int sig_no, void (*handler)(int)))(int);`**

sources of signal are :  
keyboard, hardware and c program.

- ✓ The formal argument of the API are: **sig\_no** is a signal identifier like **SIGINT** or **SIGTERM**. The handler argument is the function pointer of a user-defined signal handler function.
- ✓ The following example attempts to catch the **SIGTERM** signal, ignores the **SIGINT** signal, and accepts the default action of the **SIGSEGV** signal.

- ✓ The pause API suspends the calling process until it is interrupted by a signal and the corresponding signal handler does a return:

## Example1:-

```
#include<iostream.h>
#include<signal.h>
void catch_sig(int sig_num)          /*signal handler function*/
{
    signal (sig_num,catch_sig);

    cout<<"catch_sig:"<<sig_num<<endl;
}
int main()                          /*main function*/
{
    signal(SIGTERM,catch_sig);
    signal(SIGINT,SIG_IGN);
    signal(SIGSEGV,SIG_DFL);
    pause( ); /*wait for a signal interruption*/
}
```

- ✓ The SIG\_IGN specifies a signal is to be ignored, which means that if the signal is generated to the process, it will be discarded without any interruption of the process.
- ✓ The SIG\_DFL specifies to accept the default action of a signal.

## Example2:-

```
#include<stdio.h>
#include<signal.h>
#include<unistd.h>
void handle_sigint(int sig)
{
    printf("Caught signal %d\n", sig);
}
int main()
{
    signal(SIGINT, handle_sigint);
    while (1)
    {
        printf("hello world\n");
        sleep(1);
    }
    // signal demonstration example
    return 0;
}
```

## SIGNAL MASK<sup>imp</sup>

- ✓ A process initially inherits the parent's signal mask when it is created, but any pending signals for the parent process are not passed on.

- ✓ A process may query or set its signal mask via the sigprocmask API:

```
#include <signal.h>
```

```
int sigprocmask(int cmd, const sigset_t *new_mask, sigset_t *old_mask);
```

- ✓ Returns: 0 if OK, 1 on error
- ✓ The new\_mask argument defines a set of signals to be set or reset in a calling process signal mask, and the cmd argument specifies how the new\_mask value is to be used by the API.
- ✓ The possible values of cmd and the corresponding use of the new\_mask value are:

Cmd value	Meaning
<b>SIG_SETMASK</b>	Overrides the calling process signal mask with the value specified in the new_mask argument
<b>SIG_BLOCK</b>	Adds the signals specified in the new_mask argument to the calling process signal mask.
<b>SIG_UNBLOCK</b>	Removes the signals specified in the new_mask argument from the calling process signal mask.

- ✓ If the actual argument to new\_mask argument is a NULL pointer, the cmd argument will be ignored, and the current process signal mask will not be altered.
- ✓ If the actual argument to old\_mask is a NULL pointer, no previous signal mask will be returned.
- ✓ The sigset\_t contains a collection of bit flags.

The BSD UNIX and POSIX.1 define a set of API known as sigsetops functions:

```
#include<signal.h>
```

```
int sigemptyset (sigset_t* sigmask);
```

```
int sigaddset (sigset_t* sigmask, const int sig_num);
```

```
int sigdelset (sigset_t* sigmask, const int sig_num);
```

```
int sigfillset (sigset_t* sigmask);
```

```
int sigismember (const sigset_t* sigmask, const int sig_num);
```

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- ✓ The sigemptyset API clears all signal flags in the sigmask argument.
- ✓ The sigaddset API sets the flag corresponding to the signal\_num signal in the sigmask argument.
- ✓ The sigdelset API clears the flag corresponding to the signal\_num signal in the sigmask argument.
- ✓ The sigfillset API sets all the signal flags in the sigmask argument. [ all the above functions return 0 if OK, -1 on error ].
- ✓ The sigismember API returns 1 if flag is set, 0 if not set and -1 if the call fails.
- ✓ The following example checks whether the SIGINT signal is present in a process signal mask and adds it to the mask if it is not there.

```
#include<stdio.h>
#include<signal.h>
int main()
{
    sigset_t sigmask;
    sigemptyset(&sigmask); /*initialise set*/
    if(sigprocmask(0,0,&sigmask)==-1) /*get current signal mask*/
    {
        perror("sigprocmask");
        exit(1);
    }
    else
        sigaddset(&sigmask,SIGINT);          /*set SIGINT flag*/
        sigdelset(&sigmask, SIGSEGV);        /*clear SIGSEGV
        flag*/ if(sigprocmask(SIG_SETMASK,&sigmask,0)==-1)
        perror("sigprocmask");
}
```

- ✓ A process can query which signals are pending for it via the sigpending API:  
#include<signal.h>  
int sigpending(sigset\_t\* sigmask);
- ✓ Returns 0 if OK, -1 if fails.
- ✓ The sigpending API can be useful to find out whether one or more signals are pending for a process and to set up special signal handling methods for these signals before the process calls the sigprocmask API to unblock them.

The following example reports to the console whether the SIGTERM signal is pending for the process:

```
#include<iostream.h>
#include<stdio.h>
#include<signal.h>
int main()
{
    sigset_t sigmask; sigemptyset(&sigmask);
    if(sigpending(&sigmask)==-1)
        perror("sigpending");
    else cout << "SIGTERM signal is:" << (sigismember(&sigmask,SIGTERM) ?
        "Set" : "No Set") << endl;
}
```

In addition to the above, UNIX also supports following APIs for signal mask manipulation:

```
#include<signal.h>
int sighold(int signal_num);
int sigrelse(int signal_num);
int sigignore(int signal_num);
int sigpause(int signal_num);
```

## SIGACTION imp

- ✓ The sigaction API **blocks the signal it is catching** allowing a process to specify additional signals to be blocked when the API is handling a signal.
- ✓ The sigaction API prototype is:

```
#include<signal.h>
int sigaction(int signal_num, struct sigaction* action, struct sigaction* old_action);
```

- ✓ Returns: **0 if OK, 1 on error**

The struct sigaction data type is defined in the <signal.h> header as:

```
struct sigaction
{
    void (*sa_handler)(int);
    sigset_t sa_mask;
    int sa_flag;
}
```

The following program illustrates the uses of sigaction:

```
#include<iostream.h>
```

---

```
#include<stdio.h>
#include<unistd.h>
#include<signal.h>
void callme(int sig_num)
{
    cout<<"catch signal:"<<sig_num<<endl;
}
int main(int argc, char* argv[])
{
    sigset_t sigmask;
    struct sigaction action,old_action;
    sigemptyset(&sigmask);
    if(sigaddset(&sigmask,SIGTERM)==-1 ||
sigprocmask(SIG_SETMASK,&sigmask,0)==-1)
perror("set signal mask");
sigemptyset(&action.sa_mask);
sigaddset(&action.sa_mask,SIGSEGV);
action.sa_handler=callme;
action.sa_flags=0;
if(sigaction(SIGINT,&action,&old_action)==-1)
perror("sigaction");
pause();
cout<<argv[0]<<"exists\n";
return 0;
}
```

imp

## THE SIGCHLD SIGNAL AND THE waitpid API

- ✓ When a child process terminates or stops, the kernel will generate a SIGCHLD signal to its parent process. Depending on how the parent sets up the handling of the SIGCHLD signal, different events may occur:

Parent accepts the **default action** of the SIGCHLD signal:

- ❖ SIGCHLD does not terminate the parent process.
- ❖ Parent process will be awakened.
- ❖ API will return the child's exit status and process ID to the parent.
- ❖ Kernel will clear up the Process Table slot allocated for the child process.
- ❖ Parent process can call the waitpid API repeatedly to wait for each child it created.

Parent **ignores** the SIGCHLD signal: o SIGCHLD signal will be discarded.

- ❖ Parent will not be disturbed even if it is executing the waitpid system call.



- ❖ If the parent calls the waitpid API, the API will suspend the parent until all its child processes have terminated.
- ❖ Child process table slots will be cleared up by the kernel.
- ❖ API will return a -1 value to the parent process.

Process **catches** the SIGCHLD signal:

- ❖ The signal handler function will be called in the parent process whenever a child process terminates.
- ❖ If the SIGCHLD arrives while the parent process is executing the waitpid system call, the waitpid API may be restarted to collect the child exit status and clear its process table slots.
- ❖ Depending on parent setup, the API may be aborted and child process table slot not freed.

[Explain Sigsetjmp and Siglongjmp functions with an example](#)

## THE sigsetjmp AND siglongjmp APIs [imp](#)

- ✓ The function prototypes of the APIs are:  

```
#include <setjmp.h>
int sigsetjmp(sigjmp_buf env, int savemask);
int siglongjmp(sigjmp_buf env, int val);
```
- ✓ The sigsetjmp and siglongjmp are created to support signal mask processing. Specifically, it is implementation- dependent on whether a process signal mask is saved and restored when it invokes the setjmp and longjmp APIs respectively.
- ✓ The only difference between these functions and the setjmp and longjmp functions is that sigsetjmp has an additional argument.
- ✓ If savemask is nonzero, then sigsetjmp also saves the current signal mask of the process in env.
- ✓ When siglongjmp is called, if the env argument was saved by a call to sigsetjmp with a nonzero savemask, then siglongjmp restores the saved signal mask.
- ✓ The siglongjmp API is usually called from user-defined signal handling functions. This is because a process signal mask is modified when a signal handler is called, and siglongjmp should be called to ensure the process signal mask is restored properly when “jumping out” from a signal handling function.

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The following program illustrates the uses of `sigsetjmp` and `siglongjmp` APIs.

```
#include<iostream.h>
#include<stdio.h>
#include<unistd.h>
#include<signal.h>
#include<setjmp.h>
sigjmp_buf env;
void callme(int sig_num)
{
    cout<< "catch signal:" <<sig_num <<endl; siglongjmp(env,2);
}
int main()
{
    sigset_t sigmask;
    struct sigaction action,old_action;
    sigemptyset(&sigmask);
    if(sigaddset(&sigmask,SIGTERM)==-1) //
    sigprocmask(SIG_SETMASK,&sigmask,0)==-1)
        perror("set signal mask");
    sigemptyset(&action.sa_mask);
    sigaddset(&action.sa_mask,SIGSEGV);
    action.sa_handler=(void(*)())callme; action.sa_flags=0;
    if(sigaction(SIGINT,&action,&old_action)==-1)
        perror("sigaction");
    if(sigsetjmp(env,1)!=0)
    {
        cerr<< "return from signal interruption";
        return 0;
    }
    else
        cerr<<"return from signal interruption"; return 0;
        cerr<<"return from first time sigsetjmp is called";
        pause();
    }
}
```

### **KILL**

- ✓ A process can send a signal to a related process via the kill API. This is a simple means of inter-process communication or control. The function prototype of the API is:  

```
#include<signal.h>
int kill(pid_t pid, int signal_num);
```
- ✓ Returns: 0 on success, -1 on failure.
- ✓ The `signal_num` argument is the integer value of a signal to be sent to one or more processes designated by `pid`. The possible values of `pid` and its use by the kill API are:

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pid > 0	The signal is sent to the process whose process ID is pid.
pid == 0	The signal is sent to all processes whose process group ID equals the process group ID of the sender and for which the sender has permission to send the signal.
pid < 0	The signal is sent to all processes whose process group ID equals the absolute value of pid and for which the sender has permission to send the signal.
pid == 1	The signal is sent to all processes on the system for which the sender has permission to send the signal

The following program illustrates the implementation of the UNIX kill command using the kill API:

```
#include<iostream.h>
#include<stdio.h>
#include<unistd.h>
#include<string.h>
#include<signal.h>
int main(int argc,char** argv)
{
    int pid, sig = SIGTERM;
    if(argc==3)
    {
        if(sscanf(argv[1], "%d",&sig)!=1)
        {
            cerr<<"invalid number:" << argv[1] << endl;
            return -1;
        }
        argv++,argc--;
    }
    while(--argc>0)
    if(sscanf(*++argv, "%d", &pid)==1)
    {
        if(kill(pid,sig)==-1)
            perror("kill");
    }
    cerr<<"invalid pid:" << argv[0] <<endl;
    return 0;
}
```

The UNIX kill command invocation syntax is:

**Kill [ -<signal\_num> ] <pid>.....**

Where signal\_num can be an integer number or the symbolic name of a signal. <pid> is process ID.

## kill and alarm api

### **ALARM**

- ✓ The alarm API can be called by a process to request the kernel to send the SIGALRM signal after a certain number of real clock seconds. The function prototype of the API is:

```
#include<signal.h>
```

```
Unsigned int alarm(unsigned int time_interval);
```

- ✓ Returns: 0 or number of seconds until previously set alarm.
- ✓ The alarm API can be used to implement the sleep API:

```
#include<signal.h>
```

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

```
#include<unistd.h>
```

```
void wakeup( )
```

```
unsigned int sleep (unsigned int timer )
```

```
{
```

```
    struct sigaction action;
```

```
    action.sa_handler=wakeup;
```

```
    action.sa_flags=0; sigemptyset(&action.sa_mask);
```

```
    if(sigaction(SIGALRM,&action,0)==-1)
```

```
    {
```

```
        perror("sigaction"); return -1;
```

```
    }
```

```
    (void) alarm (timer);
```

```
    (void) pause( );
```

```
    return 0;
```

```
}
```

- ✓ Sleep is suspended calling process for the specific number of CPU seconds.
- ✓ The process will be awakened by either the elapsed time exceeding the timer value or process is interrupted by the signal.

. Write a short note on (i)Interval timers  
(ii)POSIX.1b Timers (iii)SIGCHLD signal

### **INTERVAL TIMERS**

- ✓ The interval timer can be used to schedule a process to do some tasks at a fixed time interval, to time the execution of some operations, or to limit the time allowed for the execution of some tasks.

The following program illustrates how to set up a real-time clock interval timer using the alarm API:

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

```
#include<unistd.h>
```

```
#include<signal.h>
```

```
#define INTERVAL 5
```

```
void callme(int sig_no)
```

```
{
```

```
    alarm(INTERVAL);           /*do scheduled tasks*/
```

```
}
int main()
{
    struct sigaction action;
    sigemptyset(&action.sa_mask);
    action.sa_handler=(void(*)()) callme;
    action.sa_flags=SA_RESTART;
    if(sigaction(SIGALRM,&action,0)==-1)
    {
        perror("sigaction");
        return 1;
    }
    if(alarm(INTERVAL)==-1)
        perror("alarm");
    else while(1)
    {
        /*do normal operation*/
    }
    return 0;
}
```

- ✓ In addition to alarm API, UNIX also invented the setitimer API, which can be used to define up to three different types of timers in a process:
  - ❖ Real time clock timer
  - ❖ Timer based on the user time spent by a process
  - ❖ Timer based on the total user and system times spent by a process
- ✓ The getitimer API is also defined for users to query the timer values that are set by the setitimer API.

The setitimer and getitimer function prototypes are:

```
#include<sys/time.h>
int setitimer(int which, const struct itimerval * val, struct itimerval * old);
int getitimer(int which, struct itimerval * old);
```

The *which* arguments to the above APIs specify which timer to process. Its possible values and the corresponding timer types are:

ITIMER_ REAL	Documents in a real time and generate a SIGALRM signal when it expires.
ITIMER_VIRTUAL	Documents in virtual time (time used by the process) and generate a SIGVTALRM signal when it expires.
ITIMER_PROF	Documents in virtual time and system time for the process and generate a SIGPROF signal when it expires.

The struct itimerval datatype is defined as:

```
struct itimerval
{
    struct timeval it_value; /*current value*/
    struct timeval it_interval; /* time interval*/
};
```

Example program:

```
#include<unistd.h>
#include<signal.h>
#define INTERVAL 5
void callme(int sig_no)
{
    /*do scheduled tasks*/
}
int main()
{
    struct itimerval val;
    struct sigaction action;
    sigemptyset(&action.sa_mask);
    action.sa_handler=(void(*)()) callme;
    action.sa_flags=SA_RESTART;
    if(sigaction(SIGALARM,&action,0)==-1)
    {
        perror("sigaction");
        return 1;
    }
    val.it_interval.tv_sec =INTERVAL;
    val.it_interval.tv_usec =0;
    val.it_value.tv_sec =INTERVAL;
    val.it_value.tv_usec =0;
    if(setitimer(ITIMER_REAL, &val , 0)==-1)
        perror("alarm");
    else while(1)
    {
        /*do normal operation*/
    }
    return 0;
}
```

The setitimer and getitimer APIs return a zero value if they succeed or a -1 value if they fail:

## POSIX.1b TIMERS

- ✓ POSIX.1b defines a set of APIs for interval timer manipulations. The POSIX.1b timers are more flexible and powerful than are the UNIX timers in the following ways:
- ❖ Users may define multiple independent timers per system clock.
- ❖ The timer resolution is in nanoseconds.
- ❖ Users may specify the signal to be raised when a timer expires.
- ❖ The time interval may be specified as either an absolute or a relative time

```
#include<signal.h>
#include<time.h>
int timer_create(clockid_t clock, struct sigevent* spec, timer_t* timer_hdrp);
int timer_settime(timer_t timer_hdr, int flag, struct itimerspec* val, struct
itimerspec* old);
int timer_gettime(timer_t timer_hdr, struct itimerspec* old);
int timer_getoverrun(timer_t timer_hdr);
int timer_delete(timer_t timer_hdr);
```

13) What is Daemon process? List out its coding rules

## DAEMON PROCESSES

### INTRODUCTION

- ✓ Daemons are processes that live for a long time. They are often started when the system is bootstrapped and terminate only when the system is shut down.

### DAEMON CHARACTERISTICS

- ✓ The characteristics of daemons are:
  - ❖ Daemons run in background.
  - ❖ Daemons have super-user privilege.
  - ❖ Daemons don't have controlling terminal.
  - ❖ Daemons are session and group leaders.

What are the daemon process?  
Enlist their characteristics and coding rules? also, write a program to transform a normal user process into a daemon process

### CODING RULES

- ✓ **Call umask to set the file mode creation mask to 0.** The file mode creation mask that's inherited could be set to deny certain permissions. If the daemon process is going to create files, it may want to set specific permissions.
- ✓ **Call fork and have the parent exit.** This does several things. First, if the daemon was started as a simple shell command, having the parent terminate makes the shell think that the command is done. Second, the child inherits the process group ID of the parent but gets a new process ID, so we're guaranteed that the child is not a process group leader.

Explain the Client-server model in Daemon processes? Explain error logging in detail

- ✓ **Call `setsid` to create a new session.** The process (a) becomes a session leader of a new session, (b) becomes the process group leader of a new process group, and (c) has no controlling terminal.
- ✓ **Change the current working directory to the root directory.** The current working directory inherited from the parent could be on a mounted file system. Since daemons normally exist until the system is rebooted, if the daemon stays on a mounted file system, that file system cannot be unmounted.
- ✓ **Unneeded file descriptors should be closed.** This prevents the daemon from holding open any descriptors that it may have inherited from its parent.
- ✓ **Some daemons open file descriptors 0, 1, and 2 to `/dev/null` so that any library routines that try to read from standard input or write to standard output or standard error will have no effect.** Since the daemon is not associated with a terminal device, there is nowhere for output to be displayed, nor is there anywhere to receive input from an interactive user. Even if the daemon was started from an interactive session, the daemon runs in the background, and the login session can terminate without affecting the daemon.

Example Program:

```
#include <unistd.h>
#include <sys/types.h>
int daemon_initialise( )
{
    pid_t pid;
    if (( pid = fork() ) < 0) return -1;
    else if ( pid != 0)
        exit(0); /* parent exits */
    setsid( ); /* child continues */
    chdir("/");
    umask(0);
    return 0;
}
```



### **ERROR LOGGING**

14) Give Daemon process characteristics and explain how error logging is carried out by a daemon process with suitable diagram.

- ✓ One problem a daemon has is how to handle error messages. It can't simply write to standard error, since it shouldn't have a controlling terminal.
- ✓ We don't want all the daemons writing to the console device, since on many workstations, the console device runs a windowing system. A central daemon error-logging facility is required.

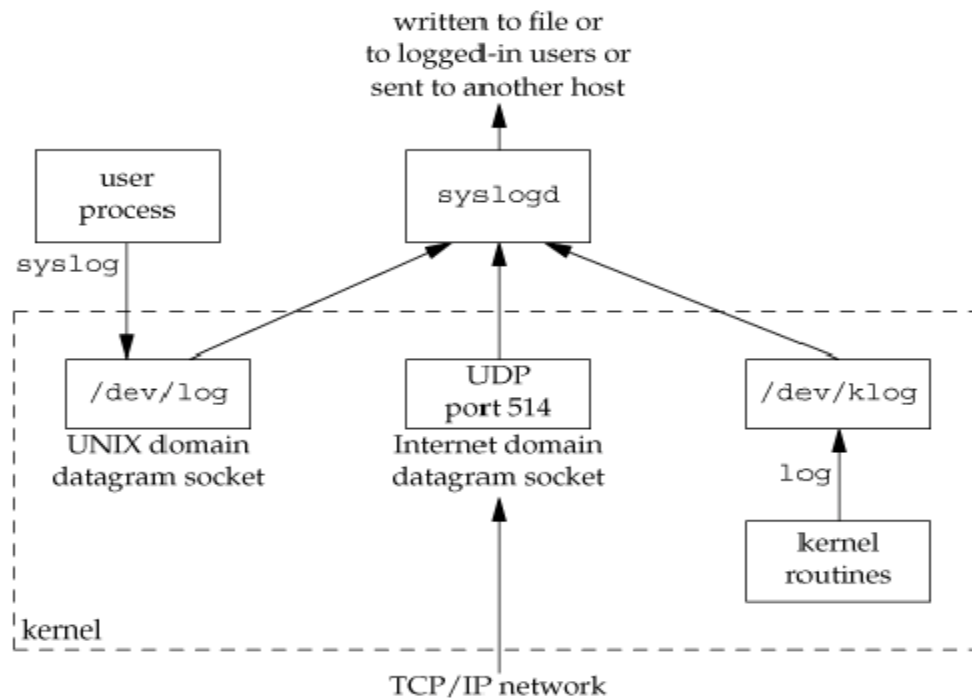


Fig : BSD syslog facility

- ✓ There are three ways to generate log messages:
  - ❖ Kernel routines can call the log function. These messages can be read by any user process that opens and reads the /dev/klog device.
  - ❖ Most user processes (daemons) call the syslog(3) function to generate log messages. This causes the message to be sent to the UNIX domain datagram socket /dev/log.
  - ❖ A user process on this host, or on some other host that is connected to this host by a TCP/IP network, can send log messages to UDP port 514. Note that the syslog function never generates these UDP datagrams: they require explicit network programming by the process generating the log message.
- ✓ Normally, the syslogd daemon reads all three forms of log messages. On start-up, this daemon reads a configuration file, usually /etc/syslog.conf, which determines where different classes of messages are to be sent. For example, urgent messages can be sent to the system administrator (if logged in) and printed on the console, whereas warnings may be logged to a file. Our interface to this facility is through the syslog function.

```
#include <syslog.h>
void openlog(const char *ident, int option, int facility);
void syslog(int priority, const char *format, ...);
void closelog(void);
int setlogmask(int maskpri);
```

## **SINGLE-INSTANCE DAEMONS**

- ✓ Some daemons are implemented so that only a single copy of the daemon should be running at a time for proper operation. The file and record-locking mechanism provides the basis for one way to ensure that only one copy of a daemon is running. If each daemon creates a file and places a write lock on the entire file, only one such write lock will be allowed to be created. Successive attempts to create write locks will fail, serving as an indication to successive copies of the daemon that another instance is already running.
- ✓ File and record locking provide a convenient mutual-exclusion mechanism. If the daemon obtains a write-lock on an entire file, the lock will be removed automatically if the daemon exits. This simplifies recovery, removing the need for us to clean up from the previous instance of the daemon.

PROGRAM: Ensure that only one copy of a daemon is running

```
#include <unistd.h>
#include <stdlib.h>
#include <fcntl.h>
#include <syslog.h>
#include <string.h>
#include <errno.h>
#include <stdio.h>
#include <sys/stat.h>
#define LOCKFILE "/var/run/daemon.pid"
#define LOCKMODE (S_IRUSR/S_IWUSR/S_IRGRP/S_IROTH)
extern int lockfile(int); int already_running(void)
{
    int fd;
    char buf[16];
    fd = open(LOCKFILE, O_RDWR/O_CREAT, LOCKMODE);
    if (fd < 0)
    {
        syslog(LOG_ERR, "can't open %s: %s", LOCKFILE, strerror(errno));
        exit(1);
    }
    if (lockfile(fd) < 0)
    {
```

```
    if (errno == EACCES || errno == EAGAIN)
    {
        close(fd);
        return(1);
    }
    syslog(LOG_ERR, "can't lock %s: %s", LOCKFILE, strerror(errno)); exit(1);
}

ftruncate(fd, 0);
sprintf(buf, "%ld", (long)getpid());
write(fd, buf, strlen(buf)+1);
return(0);
}
```

## **DAEMON CONVENTIONS**

- ✓ If the daemon uses a lock file, the file is usually stored in /var/run. Note, however, that the daemon might need superuser permissions to create a file here.
- ✓ The name of the file is usually name.pid, where name is the name of the daemon or the service. For example, the name of the cron daemon's lock file is /var/run/crond.pid.
- ✓ If the daemon supports configuration options, they are usually stored in /etc. The configuration file is named name.conf, where name is the name of the daemon or the name of the service. For example, the configuration for the syslogd daemon is /etc/syslog.conf.
- ✓ Daemons can be started from the command line, but they are usually started from one of the system initialization scripts (/etc/rc\* or /etc/init.d/\*).
- ✓ If the daemon should be restarted automatically when it exits, we can arrange for init to restart it if we include a respawn entry for it in /etc/inittab.
- ✓ If a daemon has a configuration file, the daemon reads it when it starts, but usually won't look at it again. If an administrator changes the configuration, the daemon would need to be stopped and restarted to account for the configuration changes.
- ✓ To avoid this, some daemons will catch SIGHUP and reread their configuration files when they receive the signal. Since they aren't associated with terminals and are either session leaders without controlling terminals or members of orphaned process groups, daemons have no reason to expect to receive SIGHUP. Thus, they can safely reuse it