NAME
systr_init_library, systr_cleanup_library, systr_run, systr_stop, systr_trace_syscall, systr_untrace_syscall,
systr_get_pid, systr_get_param, systr_set_params, systr_is_entry, systr_pmem_read, systr_pmem_write,
systr_pszmem_read – System Call Tracing Library support functions

SYNOPSIS
#include "sysctr.h"

int systr_init_library(void);
void systr_cleanup_library(void);
int systr_run(char **av);
int systr_stop(void);
int systr_trace_syscall(int syscall, int (*scfunc)(void *, trsyscall_t), void *priv);
int systr_untrace_syscall(int syscall);
int systr_get_pid(trsyscall_t tsc, unsigned long *pid);
int systr_get_param(trsyscall_t tsc, int param, unsigned long *pparam);
int systr_set_params(trsyscall_t tsc, ...);
int systr_is_entry(trsyscall_t tsc);
int systr_pmem_read(trsyscall_t tsc, int where, unsigned long addr, char *buf, int size);
int systr_pmem_write(trsyscall_t tsc, int where, unsigned long addr, char *buf, int size);
int systr_pszmem_read(trsyscall_t tsc, int where, unsigned long addr, char *buf, int bmax);

DESCRIPTION
LibSysCTR is a utility library that can be used to intercept system call functions on a Linux system. Process
monitoring and sandboxing are just two of the potential usages of LibSysCTR. Internally the LibSysCTR
library uses the ptrace(2) functionalities by monitoring and reporting events to the library caller. The Lib-
SysCTR is callback driven, that means that the user initializes the library with systr_init_library(), registers
the system calls he wants to monitor with systr_trace_syscall(), and calls systr_run() to start receiving
events in the form of callback invocation. For each intercepted system call, two calls to the registered call-
back function are performed. One during the system call entry, before the system call itself will be
executed by the kernel, and one after the kernel has processed the system call (right before returning the
userspace). Utility functions are supplied to, retrieve information about the process, get/set the system call
parameters, and read/write the monitored process address space. The LibSysCTR library follows all
threads and processes spawned by the traced task, by giving the caller the complete control over the whole
monitored process hierarchy.

Functions
The following functions are defined:

int systr_init_library(void);

Initialize the library and makes it ready to accept other calls to library functions. It should be
called only once at the beginning of the program. It returns 0 in case of success, and a value <0 in
case of error.

void systr_cleanup_library(void);

Undo the operations done with the systr_init_library() call. It stop the monitoring process and
kills all the processes spawned by the systr_run() call. It should be called after the return of the
systr_run(), when the user has done using the LibSysCTR library.
int systr_run(char **av);

It starts the monitoring activity on the system calls registered with systr_trace_syscall(). The \textit{av} parameter is an array of character pointers that specify the process binary to be monitored. The \textit{av}[0] array element is the path (or name) of the binary file to be executed, while the following elements are the parameters supplied to the binary. The \textit{av} array is terminated by a \textit{NULL} pointer. The function returns when no more monitored processes are available, or when a call to systr_stop() is done by the caller. In case of success the function returns 0, while in case errors happened during the process, a value \texttt{<0} is returned.

int systr_stop(void);

The function stops the internal monitor loop triggered by a call to systr_run() and makes the function systr_run() to return soon. It is usually called from inside a user callback to stop the library event processing. It returns 0 in case of success, and a value \texttt{<0} in case of error.

int systr_trace_syscall(int syscall, int (*scfunc)(void *, trsyscall_t), void *priv);

The function lets the user to register the system call \textit{syscall} to be traced by the \textbf{LibSysCTR} library. The parameter \textit{scfunc} specify a pointer to a callback function that will be invoked at every entry and exit from the \textit{syscall} system call. The callback function template will look like:

\begin{verbatim}
int scfunc(void *priv, trsyscall_t tsc) {
    ...
}
\end{verbatim}

The \textit{priv} parameter will be passed back to the callback function, and it is treated transparently by the \textbf{LibSysCTR} library. The \textit{tsc} parameter that the callback will receive, is a system call context handle that can be used to call other \textbf{LibSysCTR} utility functions. The callback function will return \texttt{SYSTR\_RET\_CONTINUE} if it wants to continue tracing the current process, or \texttt{SYSTR\_RET\_DETACH} if it does not want to receive any more notification from the process associated with the \textit{tsc} context. The systr_trace_syscall() returns 0 in case of success, and a value \texttt{<0} in case of error.

int systr_untrace_syscall(int syscall);

Undo the effects of a systr_trace_syscall() function call, by unregistering the \textit{syscall} from the list of the ones monitored by the \textbf{LibSysCTR} library. it returns 0 in case of success, and a value \texttt{<0} in case of error.

int systr_get_pid(trsyscall_t tsc, unsigned long *pid);

The function will be used to retrieve the process ID (pid) associated with the current system call context \textit{tsc}. The process ID value will be stored in the location pointed by \textit{pid}. The systr_get_pid() function returns 0 in case of success, and a value \texttt{<0} in case of error.

int systr_get_param(trsyscall_t tsc, int param, unsigned long *pparam);

The function lets the caller to retrieve system call parameters (or registers) associated with the context \textit{tsc}. The \textit{param} value specify the system call parameter to be retrieved, and it can be one of the following values:
SYSTR_SYSCALL Returns the system call number.
SYSTR_PARAM_1 Returns the first system call parameter.
SYSTR_PARAM_2 Returns the second system call parameter.
SYSTR_PARAM_3 Returns the third system call parameter.
SYSTR_PARAM_4 Returns the fourth system call parameter.
SYSTR_PARAM_5 Returns the fifth system call parameter.
SYSTR_PARAM_6 Returns the sixth system call parameter.
SYSTR_PARAM_RCODE Returns the return code of the system call (valid only if the system call is exiting).
SYSTR_REG_SP Returns the stack pointer of the process that invoked the current system call.
SYSTR_REG_IP Returns the instruction pointer of the process that invoked the current system call.

The retrieved system call parameter will be stored in the location pointed by pparam. The function returns 0 in case of success, or a value <0 in case of error.

```c
int systr_set_params(trsyscall_t tsc, ...);
```

The function lets the caller to set system call parameters (or registers) associated with the context `tsc`. To optimize the process context writing, the `systr_set_params()` accepts multiple parameter-value couples to be set at the same time. So, following the `tsc` parameter, there will be a list of `parameter,value` couples, terminated with a last `parameter` equal to −1. Example:

```c
unsigned long param1, param2;

systr_set_params(tsc, SYSTR_PARAM_1, &param1, SYSTR_PARAM_2, &param2, -1);
```

The `systr_set_params()` function will return 0 in case of success, or a value <0 in case of error.

```c
int systr_is_entry(trsyscall_t tsc);
```

The `LibSysCTR` system call interception will trigger two callback invocations per each system call. One on system call entry, and one on exit. The `systr_is_entry()` function can be used to distinguish between the entry and the exit from the system call. It returns a value different from 0 in case it is an entry call, or 0 in case it is an exit.

```c
int systr_pmem_read(trsyscall_t tsc, int where, unsigned long addr, char *buf, int size);
```

The function lets the caller to read the memory of the process associated with the context `tsc`. The `where` parameter is either:

- `SYSTR_DATA_SECT` Read memory from the DATA section
- `SYSTR_TEXT_SECT` Read memory from the TEXT section

The `addr` parameter specify the address, in the traced process address space, from where to start the read operation, and the `size` parameter specifies the size in bytes of the block to be read. The read data will be stored in the buffer pointed by `buf`. The function return the number of bytes read (usually `size`), or a number lower than `size` in case errors happened.
int systr_pmem_write(trsyscall_t tsc, int where, unsigned long addr, char *buf, int size);

The function lets the caller to write the memory of the process associated with the context tsc. The where parameter is either:

SYSTR_DATA_SECT Write memory to the DATA section
SYSTR_TEXT_SECT Write memory to the TEXT section

The addr parameter specify the address, in the traced process address space, from where to start the write operation, and the size parameter specifies the size in bytes of the block to be written. The data will be read from the user buffer pointed by buf. The function return the number of bytes written (usually size), or a number lower than size in case errors happened.

int systr_pszmem_read(trsyscall_t tsc, int where, unsigned long addr, char *buf, int bmax);

The function lets the caller to read the memory of the process associated with the context tsc. The data will be read as zero-terminated string, up to bmax bytes. The where parameter is either:

SYSTR_DATA_SECT Read memory from the DATA section
SYSTR_TEXT_SECT Read memory from the TEXT section

The addr parameter specify the address, in the traced process address space, from where to start the read operation. The read data will be stored in the buffer pointed by buf. The function return the number of bytes read, or −1 in case of error.

EXAMPLE

The following example shows a few lines of C code that uses the LibSysCTr library to intercept a few system calls and print parameters during the monitored process life.

#include <stdio.h>
#include <stdlib.h>
#include <signal.h>
#include <unistd.h>
#include <errno.h>
#include <string.h>
#include <linux/unistd.h>
#include <sysctr.h>

static int open_scfunc(void *priv, trsyscall_t tsc) {
    int entry;
    unsigned long pid, param, rcode;
    char buf[512];

    systr_get_pid(tsc, &pid);
    entry = systr_is_entry(tsc);
    systr_get_param(tsc, SYSTR_PARAM_1, &param);
    if (!entry)
        systr_get_param(tsc, SYSTR_PARAM_RCODE, &rcode);
    buf[0] = 0;
    systr_pszmem_read(tsc, SYSTR_DATA_SECT, param, buf, sizeof(buf) - 1);

    fprintf(stderr, "[%lu] %s open(%s)", pid, entry ? "E": "X", buf);

    if (entry)
fprintf(stderr, "=? 0);
else
fprintf(stderr, "=%lu0, rcode);

return SYSTR_RET_CONTINUE;
}

static int close_scfunc(void *priv, trsyscall_t tsc) {
    int entry;
    unsigned long pid, param;

    systr_get_pid(tsc, &pid);
    entry = systr_is_entry(tsc);
    systr_get_param(tsc, SYSTR_PARAM_1, &param);

    fprintf(stderr, " [%lu] %s close(%d)0, pid, entry ? "E": "X", param);

    return SYSTR_RET_CONTINUE;
}

static int exec_scfunc(void *priv, trsyscall_t tsc) {
    int entry;
    unsigned long pid, param;
    char buf[512];

    systr_get_pid(tsc, &pid);
    entry = systr_is_entry(tsc);
    systr_get_param(tsc, SYSTR_PARAM_1, &param);
    buf[0] = 0;
    if (entry)
        systr_pszmem_read(tsc, SYSTR_DATA_SECT, param, buf, sizeof(buf) - 1);

    fprintf(stderr, " [%lu] %s exec(%s)0, pid, entry ? "E": "X", buf);

    return SYSTR_RET_CONTINUE;
}

static int fork_scfunc(void *priv, trsyscall_t tsc) {
    int entry;
    unsigned long pid, cpid;

    systr_get_pid(tsc, &pid);
    entry = systr_is_entry(tsc);
    if (entry)
        fprintf(stderr, " [%lu] E fork()0, pid);  
    else {
        systr_get_param(tsc, SYSTR_PARAM_RCODE, &cpid);
        fprintf(stderr, " [%lu] X fork() -> %lu0, pid, cpid);
    }

    return SYSTR_RET_CONTINUE;
}

static int wait_scfunc(void *priv, trsyscall_t tsc) {

GUN
int entry;
unsigned long pid, res, wpid, options;

int main(int ac, char **av) {
    if (systr_init_library() < 0)
        return 1;
    systr_trace_syscall(__NR_execve, exec_scfunc, NULL);
systr_trace_syscall(__NR_open, open_scfunc, NULL);
systr_trace_syscall(__NR_close, close_scfunc, NULL);
systr_trace_syscall(__NR_fork, fork_scfunc, NULL);
systr_trace_syscall(__NR_vfork, fork_scfunc, NULL);
systr_trace_syscall(__NR_clone, fork_scfunc, NULL);
systr_trace_syscall(__NR_waitpid, wait_scfunc, NULL);
systr_trace_syscall(__NR_wait4, wait_scfunc, NULL);
systr_run(&av[i]);
systr_cleanup_library();
    return 0;
}

LIMITATIONS

The init process cannot be traced using the LibSysCTr library (ptrace limitation). Also, setuid binaries will be traced using the caller permissions, and not the suid ones (ptrace security constraint). The strace(1) command will not work when run from inside a shell monitored by LibSysCTr. Same thing for the gdb(1) debugger (and more in general for all debuggers using the ptrace(2) system call). Currently LibSysCTr supports only i386 CPUs, but it is easily extendible to other CPUs supported by the Linux OS (adding CPU support by extending the sctr_linux.h include file). If you do extend LibSysCTr support to other CPUs, please send sctr_linux.h patches to <davidel@xmailserver.org>.

LICENSE

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http://www.gnu.org/copyleft/lesser.html
AUTHOR
Developed by Davide Libenzi <davidel@xmailserver.org>

AVAILABILITY
The latest version of LibSysCTr can be found at:

http://www.xmailserver.org/sysctr-lib.html

BUGS
There are no known bugs. Bug reports and comments to Davide Libenzi <davidel@xmailserver.org>