

# *Introducción a los Sistemas Operativos*

## *Introducción – IV*

Anexo llamadas al Sistema



# Objetivo

- Programar un llamado a una “System Call” de manera directa. Sin utilizar ninguna librería.
- Considerar distintos aspectos al intentar realizar lo mismo en las siguientes arquitecturas:
  - 32 bits
  - 64 bits

# Hello World!!

- Para programar el clasico “hello world” se necesitan mínimo realizar hacer 2 llamadas al sistema:
  - Una para escribir en pantalla un mensaje  
**SYSCALL WRITE**
  - Otra para terminar la ejecución de un proceso  
**SYSCALL EXIT**



# Hello World!!

- Para obtener información sobre estas SYSCALLs podemos utilizar los manuales del sistema.
- El comando man permite acceder a distintos tipos de documentación, en particular a información referida a systemcalls
  - write (man 2 write)
  - exit (man exit)

# Hello World!!!

- Los manuales de las system calls permiten saber cuales son los parámetros

## NAME

write - write to a file descriptor

## SYNOPSIS

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

```
ssize_t write(int fd, const void *buf, size_t count);
```

## DESCRIPTION

`write()` writes up to count bytes from the buffer pointed buf to the file referred to by the file descriptor fd.

## NAME

exit - cause normal process termination

## SYNOPSIS

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

```
void exit(int status);
```

## DESCRIPTION

The `exit()` function causes normal process termination and the value of status & 0377 is returned to the parent (see `wait(2)`).

# Número de syscalls a utilizar

- Para indicarle al sistema operativo lo que queremos hacer (write o exit), es necesario saber cuál es el número asociado que tiene cada una de las syscalls
- Puede ser distinto en distintas arquitecturas

## Del github de Linus Torvald

- [https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_32.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_32.tbl)
- [https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_64.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_64.tbl)



# Hello World en x86 32bit

[https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_32.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_32.tbl)

```
# 32-bit system call numbers and entry vectors
#
# The format is:
# <number> <abi> <name> <entry point> <compat entry point>
#
# The abi is always "i386" for this file.
#
0      i386    restart_syscall      sys_restart_syscall
1      i386    exit                  sys_exit
2      i386    fork                  sys_fork                sys_fork
3      i386    read                  sys_read
4      i386    write                  sys_write
5      i386    open                  sys_open                compat_sys_open
6      i386    close                  sys_close
```

En x86 32bit las sistem calls tienen los siguientes números:

- write → syscall número 4
- exit → syscall número 1

# Hello World en x86 64bit

[https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_64.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_64.tbl)

```
# 64-bit system call numbers and entry vectors
#
# The format is:
# <number> <abi> <name> <entry point>
#
# The abi is "common", "64" or "x32" for this file.
#
```

0	common	read	sys_read
1	common	write	sys_write
2	common	open	sys_open
3	common	close	sys_close

57	common	fork	sys_fork/ptregs
58	common	vfork	sys_vfork/ptregs
59	64	execve	sys_execve/ptregs
60	common	exit	sys_exit
61	common	wait4	sys_wait4
62	common	kill	sys_kill

En x86 64bit las sistem calls tienen los siguientes números:

- write → syscall número 1
- exit → syscall número 60



# Pasaje de parámetros en x86 32bit

- <https://syscalls.kernelgrok.com/>
  - EAX lleva el numero de syscall que se desea ejecutar
  - EBX lleva el primer parámetro
  - ECX lleva el segundo parámetro
  - EDX ...
  - ESI
  - EDI

Instrucción que inicia la system call: **int 80h**

# Pasaje de parámetros en x86 64bit

- [http://blog.rchapman.org/posts/Linux\\_System\\_Call\\_Table\\_for\\_x86\\_64/](http://blog.rchapman.org/posts/Linux_System_Call_Table_for_x86_64/)
  - EAX lleva el numero de syscall que se desea ejecutar
  - RDI lleva el primer parámetro
  - RSI lleva el segundo parámetro
  - RDX ...
  - R10
  - R8
  - R9

Instrucción que inicia la system call: **syscall**

# Hello world en x86 32 bit

## NAME

write - write to a file descriptor

## SYNOPSIS

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

```
ssize_t write(int fd, const void *buf, size_t count);
```

## DESCRIPTION

`write()` writes up to `count` bytes from the buffer pointed `buf` to the file referred to by the file descriptor `fd`.

```
# 32-bit system call numbers and entry points
#
# The format is:
# <number> <abi> <name> <entry point>
#
# The abi is always "i386" for this file
#
0      i386    restart_syscall
1      i386    exit
2      i386    fork
3      i386    read
4      i386    write
5      i386    open
6      i386    close
```

start:

```
; sys_write(stdout, message, length)
```

```
mov eax, 4      ; sys_write syscall
mov ebx, 1      ; stdout
mov ecx, message ; message address
mov edx, 14     ; message string length
int 80h
```

```
; sys_exit(return_code)
```

```
mov eax, 1      ; sys_exit syscall
mov ebx, 0      ; return 0 (success)
int 80h
```

section .data

```
message: db 'Hello, world!',0x0A ; message and newline
```

## NAME

exit - cause normal process termination

## SYNOPSIS

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

```
void exit(int status);
```

## DESCRIPTION

The `exit()` function causes normal process termination and the value of `status` & 0377 is returned to the parent (see `wait(2)`).



# Hello world en x86 64 bit

## NAME

write - write to a file descriptor

## SYNOPSIS

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

```
ssize_t write(int fd, const void *buf, size_t count);
```

## DESCRIPTION

`write()` writes up to `count` bytes from the buffer pointed `buf` to the file referred to by the file descriptor `fd`.

- write → syscall número 1
- exit → syscall número 60

```
; sys_write(stdout, message, length)
```

```
mov rax, 1 ; sys_write  
mov rdi, 1 ; stdout  
mov rsi, message ; message address  
mov rdx, length ; message string length  
syscall
```

```
; sys_exit(return_code)
```

```
mov rax, 60 ; sys_exit  
mov rdi, 0 ; return 0 (success)  
syscall
```

```
section .data
```

```
message: db 'Hello, world!',0x0A ; message and newline  
length: equ 14 ;
```

## NAME

exit - cause normal process term

## SYNOPSIS

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

```
void exit(int status);
```

## DESCRIPTION

The `exit()` function causes normal process termination and the value of `status` & 0377 is returned to the parent (see `wait(2)`).

# Resumen

- Los manuales del sistema indican los parámetros necesarios para activar una system call

```
NAME
    write - write to a file descriptor

SYNOPSIS
    #include <unistd.h>

    ssize_t write(int fd, const void *buf, size_t count);

DESCRIPTION
    write() writes up to count bytes from the buffer pointed buf to the
    file referred to by the file descriptor fd.
```

- Dependiendo la arquitectura, cambiará:
  - el número de system call utilizado para realizar una función determinada
  - La forma de pasar los parámetros al kernel

# Resumen

- Los procesadores 32 bit y 64 bits usan un esquema de registros diferentes.
- Los procesadores 32 bit y 64 bits usan una instrucción distinta para activar las systemcalls:
  - 32 bits: **int 80h**
  - 64 bits: **syscall**



# Referencias

## Como programar un “hello world” en x86 32bit y 64bit

- <http://shmaxgoods.blogspot.com.ar/2013/09/assembly-hello-world-in-linux.html>
- <https://stackoverflow.com/questions/19743373/linux-x86-64-hello-world-and-register-usage-for-parameters>
- **Mas información sobre formas de pasar parametros a una syscall**
- <https://github.com/torvalds/linux>
- [https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_32.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_32.tbl)
- [https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall\\_64.tbl](https://github.com/torvalds/linux/blob/master/arch/x86/entry/syscalls/syscall_64.tbl)
- <https://syscalls.kernelgrok.com/>
- [http://blog.rchapman.org/posts/Linux\\_System\\_Call\\_Table\\_for\\_x86\\_64/](http://blog.rchapman.org/posts/Linux_System_Call_Table_for_x86_64/)
- <http://www.int80h.org/bsdasm/#system-calls>