Amirkabir University of Technology
(Tehran Polytechnic)

Operating Systems

System Calls

Seyyed Ahmad Javadi

sajavadi@aut.ac.ir

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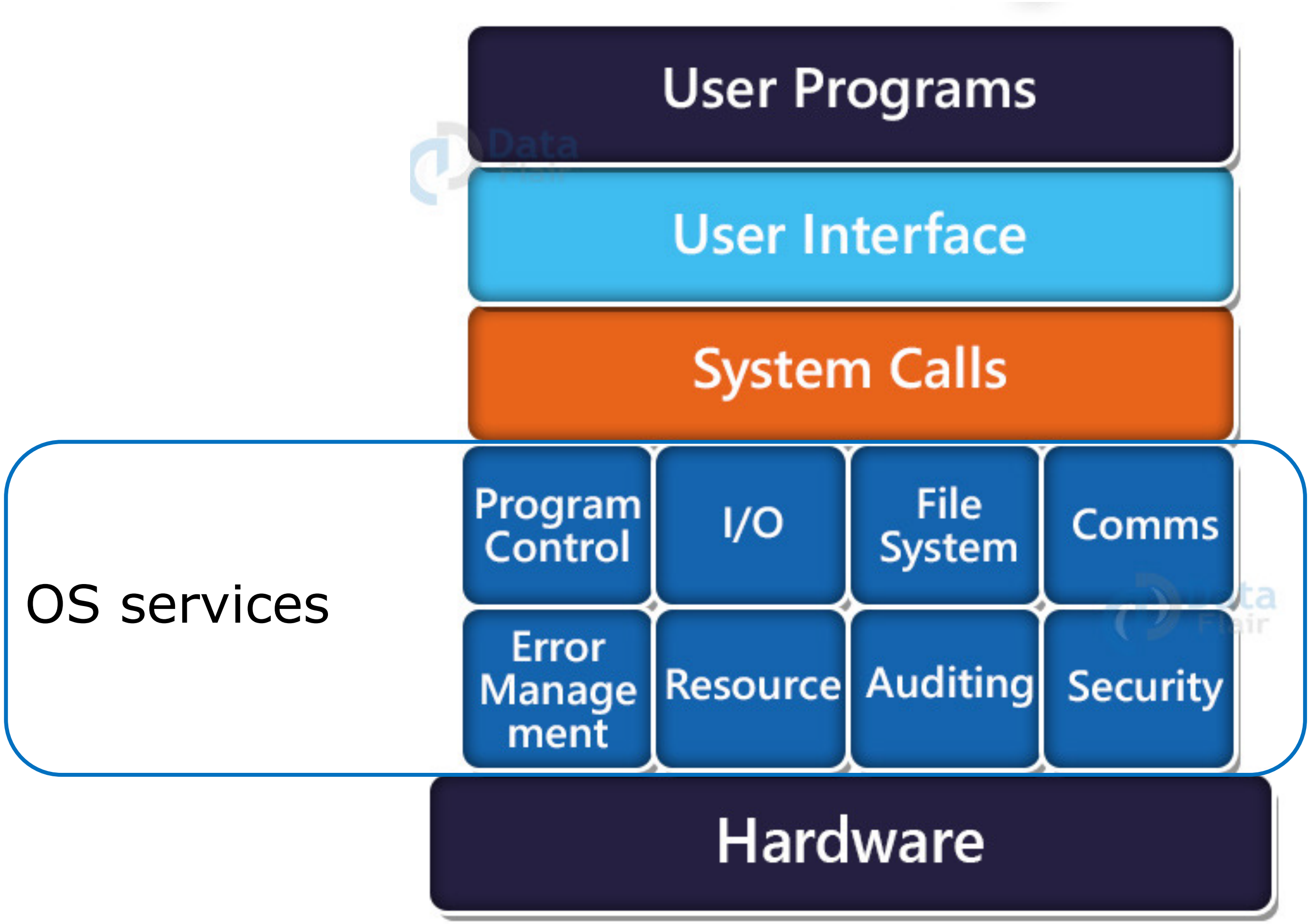
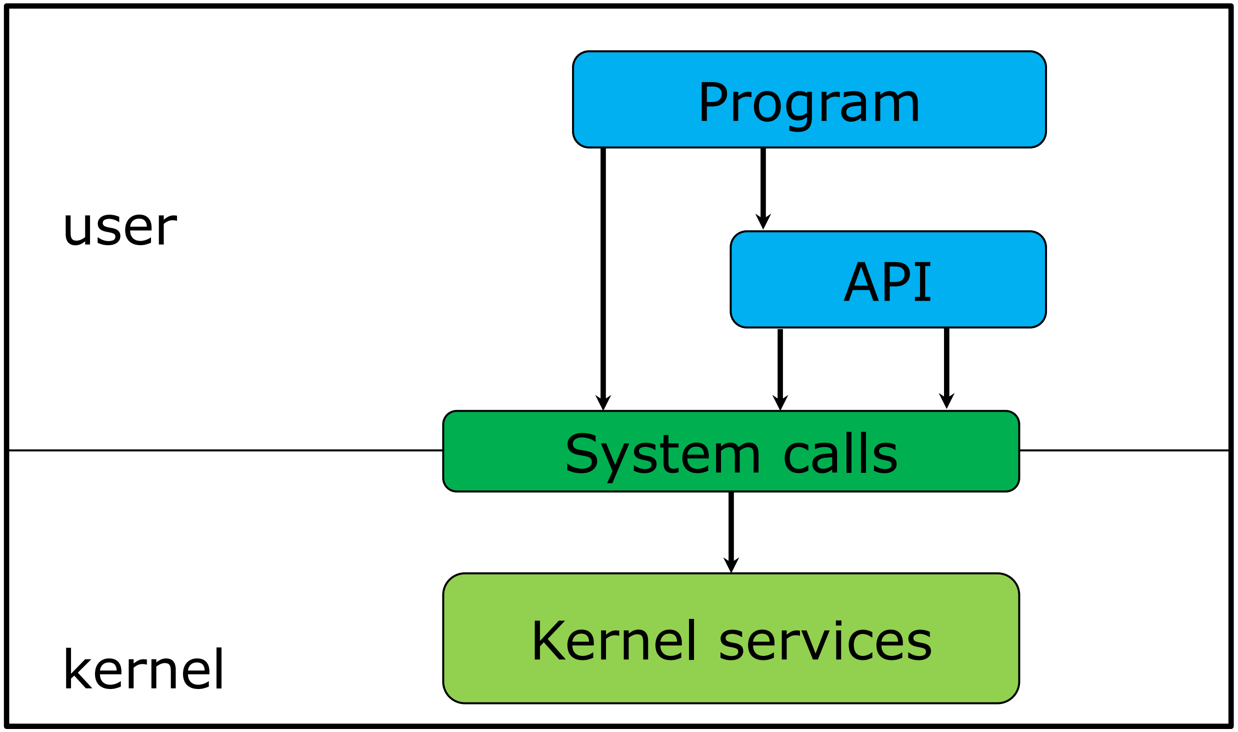
System Calls

- Programming interface to the services provided by the OS.



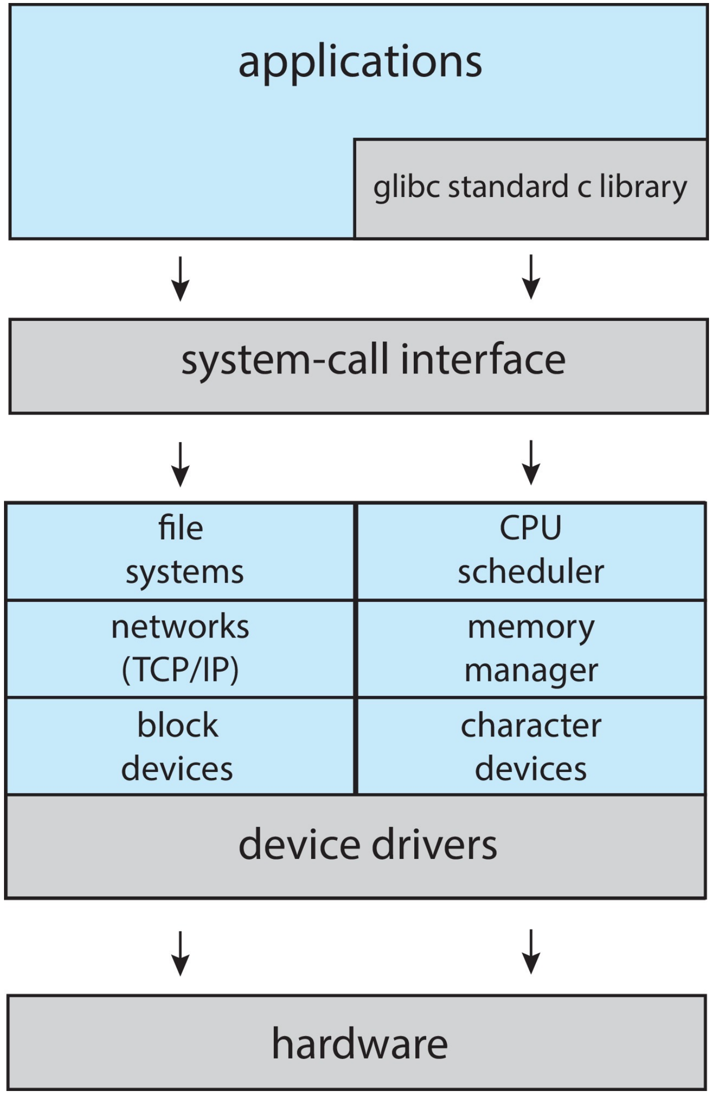
System Calls (cont.)

- Typically written in a high-level language (C or C++ or Assembly).
- Mostly accessed by programs via a high-level Application Programming Interface (API) rather than direct system call use.

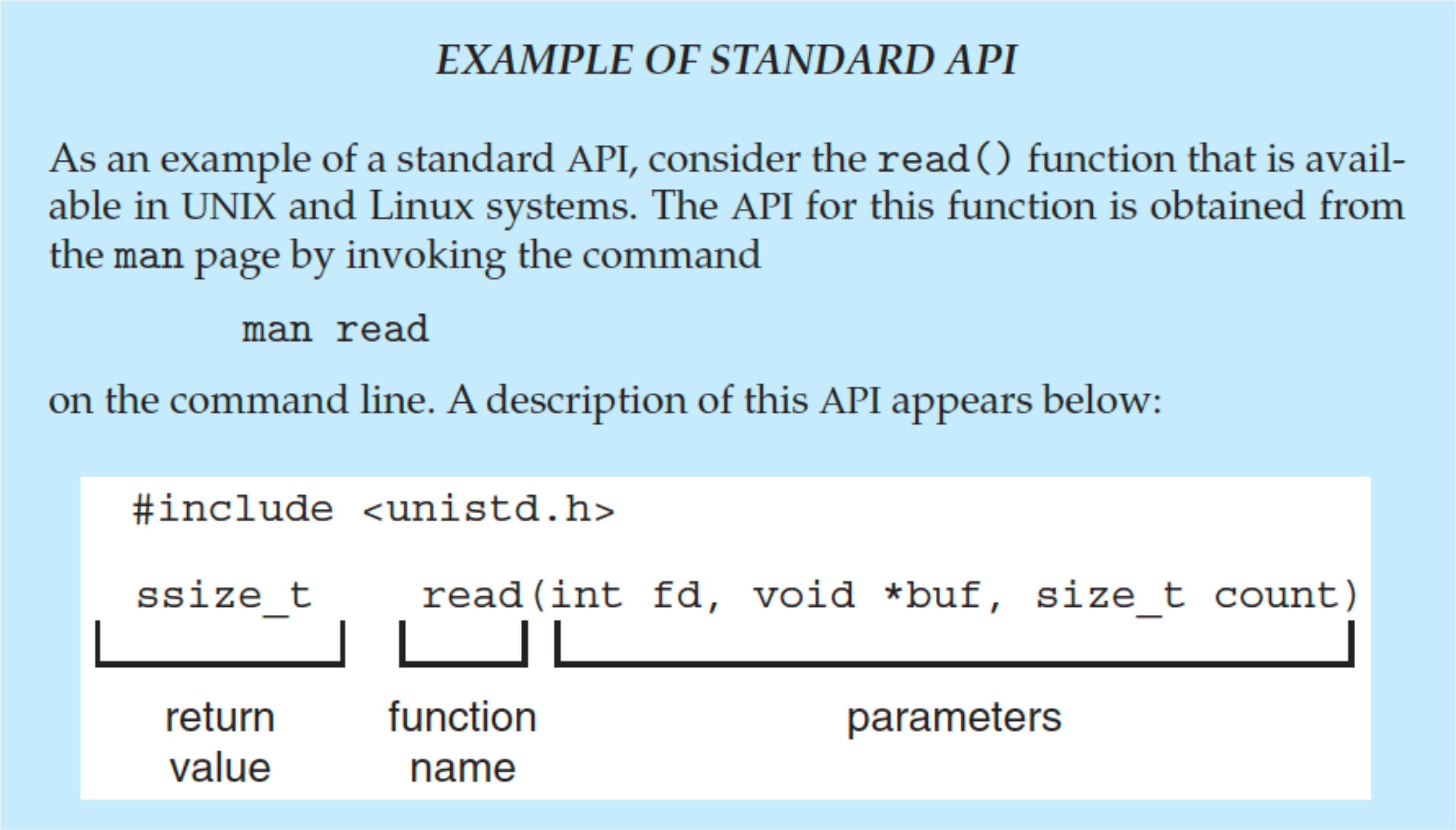


Three most common APIs

- Win32 API for Windows (Win API)
- POSIX API for POSIX-based systems
  - Including virtually all versions of UNIX, Linux (***unistd.h***), and Mac OS X
- Java API for the Java virtual machine.



Example of Standard API



EXAMPLE OF STANDARD API

As an example of a standard API, consider the `read()` function that is available in UNIX and Linux systems. The API for this function is obtained from the `man` page by invoking the command

```
man read
```

on the command line. A description of this API appears below:

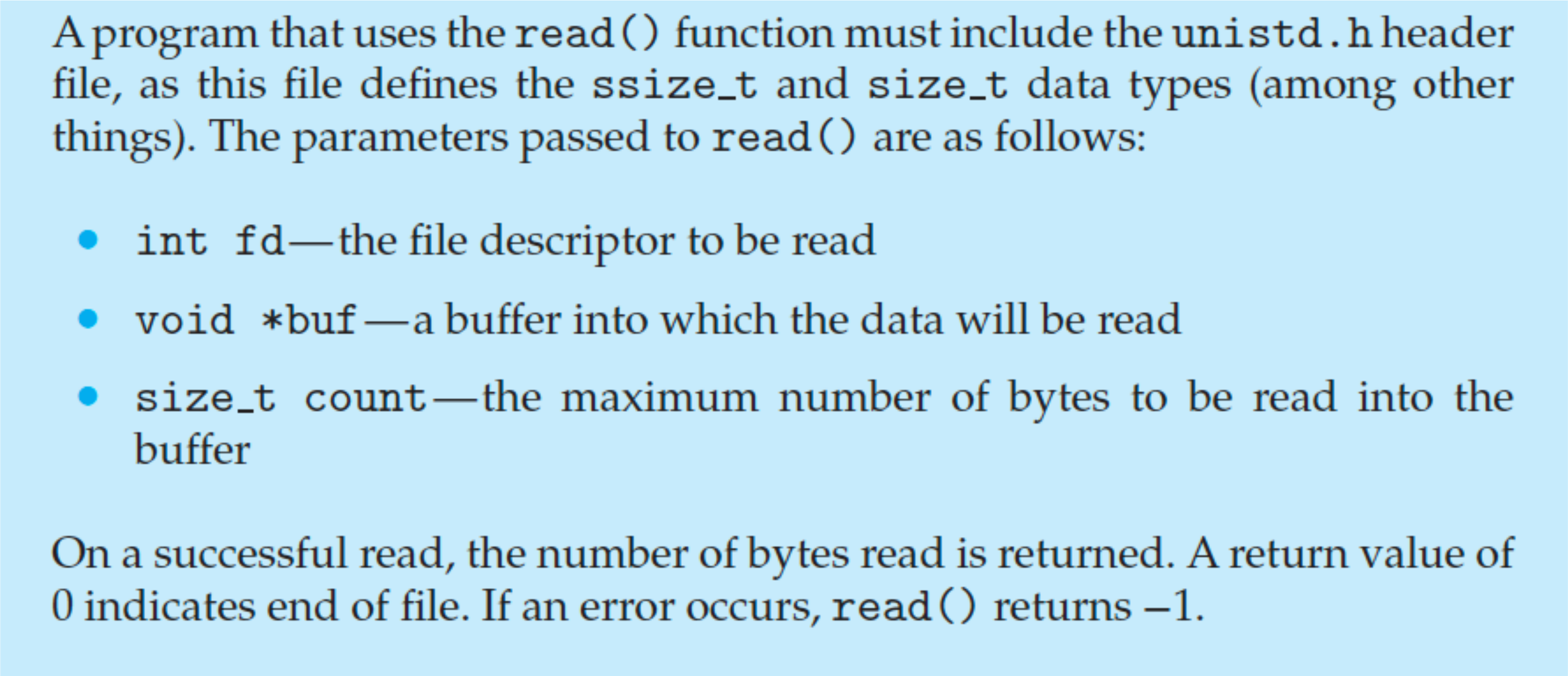
```
#include <unistd.h>

ssize_t    read(int fd, void *buf, size_t count)
```

return value

function name

parameters

Example of Standard API (cont.)



A program that uses the `read()` function must include the `unistd.h` header file, as this file defines the `ssize_t` and `size_t` data types (among other things). The parameters passed to `read()` are as follows:

- `int fd`—the file descriptor to be read
- `void *buf`—a buffer into which the data will be read
- `size_t count`—the maximum number of bytes to be read into the buffer

On a successful read, the number of bytes read is returned. A return value of 0 indicates end of file. If an error occurs, `read()` returns −1.

System Call Implementation

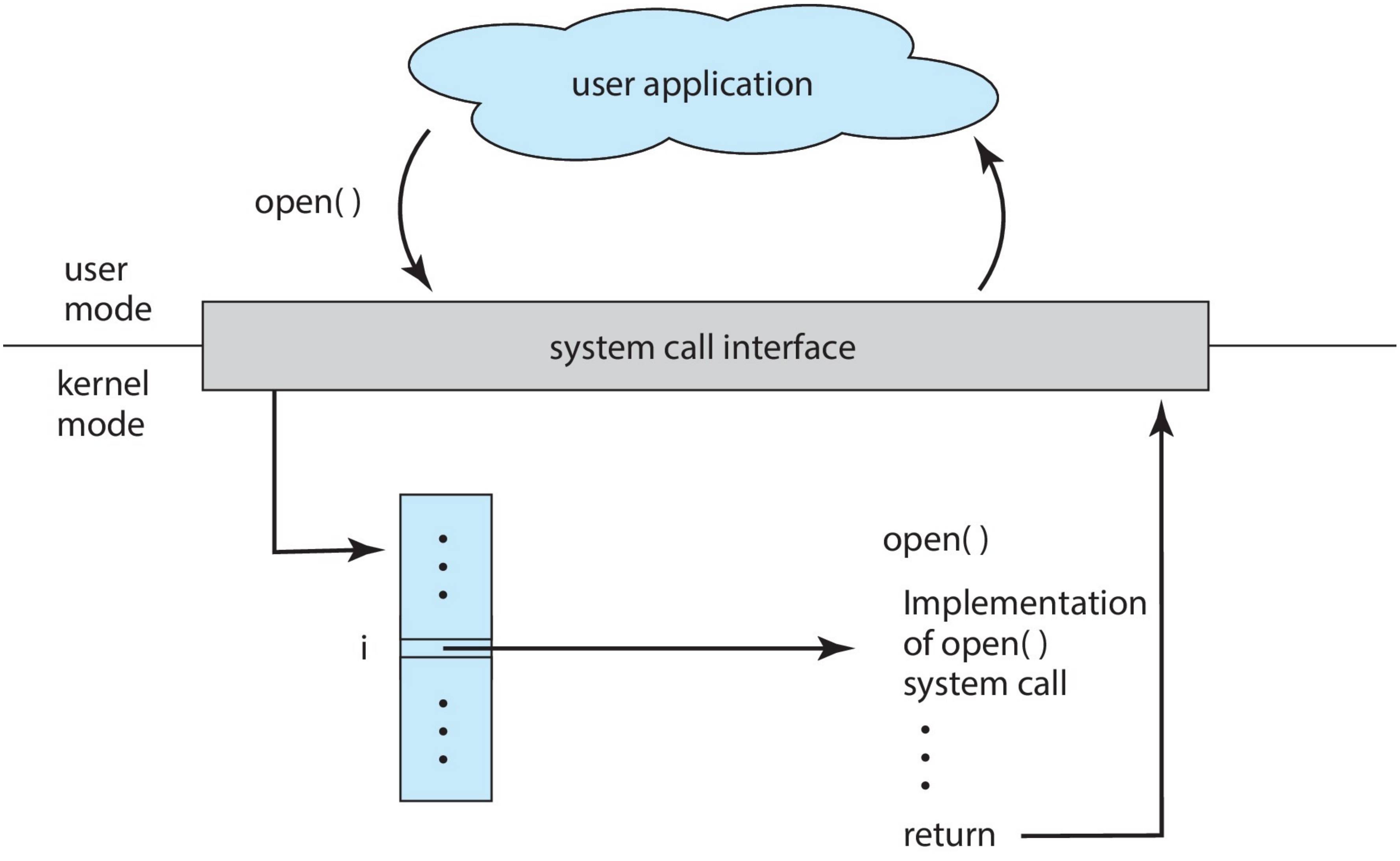
- Typically, a number is associated with each system call
  - System-call interface maintains a table indexed according to these numbers.

- The system call interface invokes the intended system call in OS kernel and returns status of the system call and any return values

System Call Implementation (cont.)

- The caller need know nothing about how the system call is implemented
  - Just needs to obey API and understand what OS will do as a result call.
  - Most details of OS interface hidden from programmer by API
    - Managed by run-time support library

API – System Call – OS Relationship



System calls in assembly programs (demo)

- Put the system call number in the ***EAX register***.
- Store the arguments to the system call in the registers EBX, ECX,...
- Call the relevant interrupt (***80h***).
- The result is ***usually*** returned in the ***EAX*** register.

https://www.tutorialspoint.com/assembly_programming/assembly_system_calls.htm

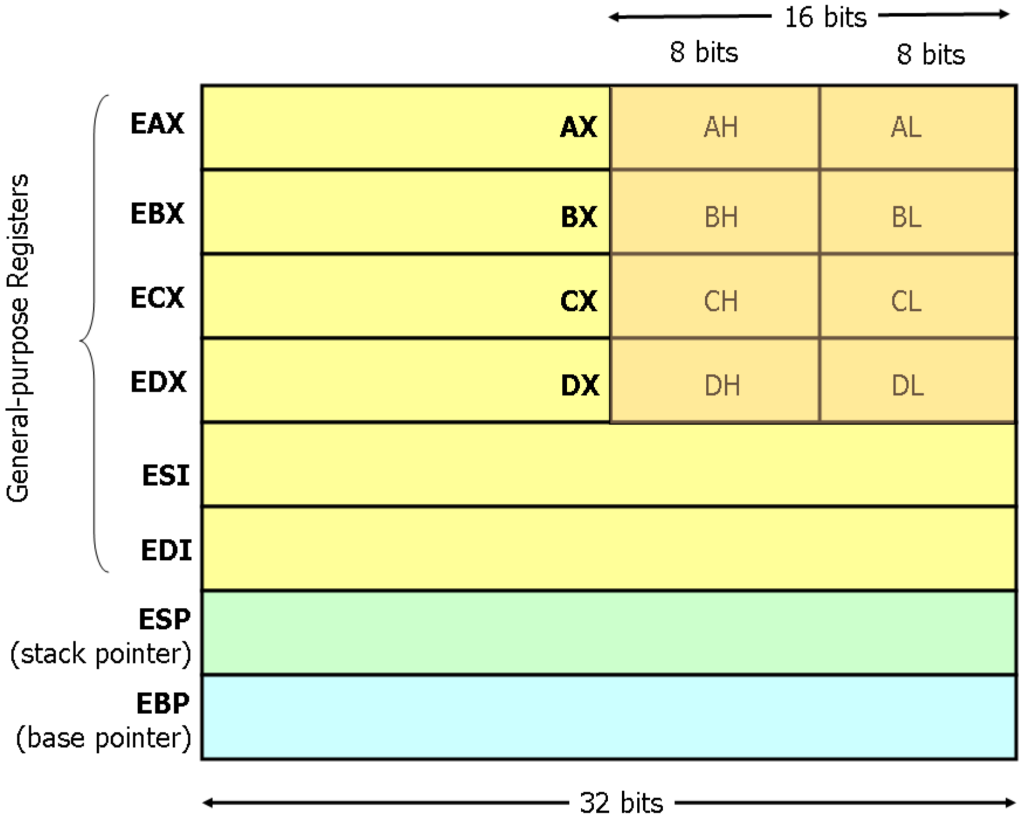
http://faculty.nps.edu/cseagle/assembly/sys_call.html

System Call Parameter Passing

- **Parameter Passing**
  - Register
  - Register pointer to mem. block
  - Stack (Push, Pop)
- Often, more information is required than simply identity of desired system call.
- Exact type and amount of information vary according to OS and call.

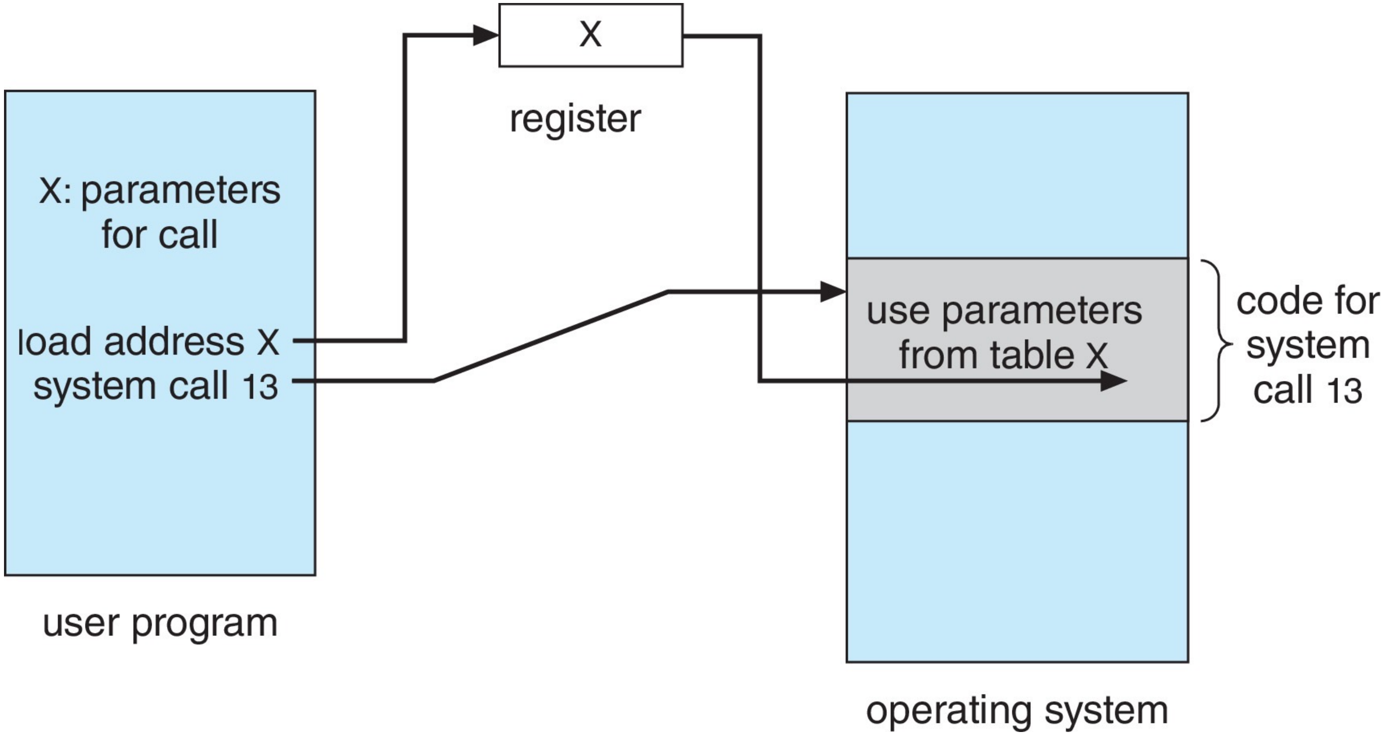
System Call Parameter Passing--Methods

- **Simplest**: pass the parameters in registers.
  - In some cases, may be more parameters than registers.



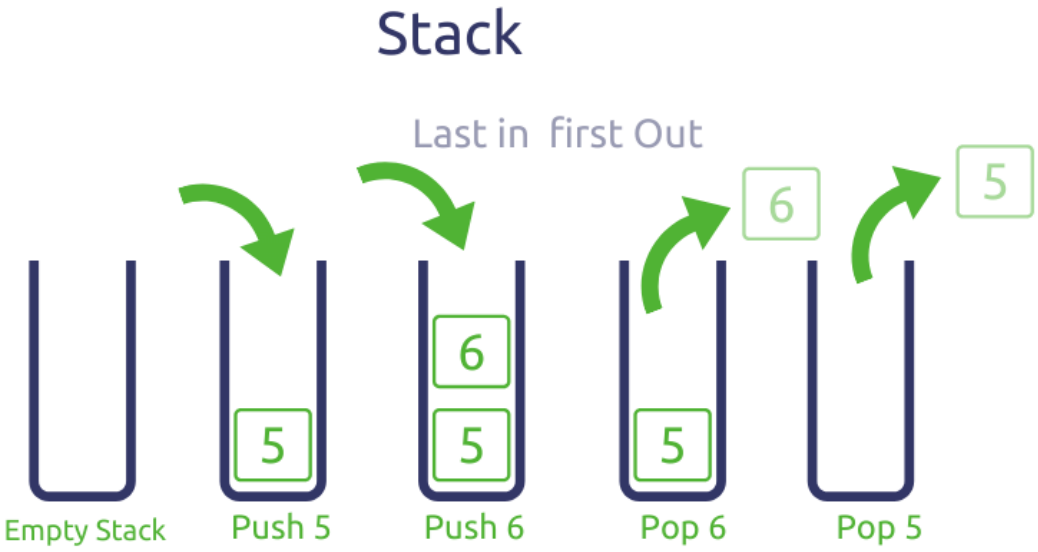
System Call Parameter Passing—Methods (cont.)

- Parameters stored **in a block, or table, in memory**, and address of block passed as a parameter in a register.
  - **This approach taken by Linux and Solaris.**



System Call Parameter Passing—Methods (cont.)

- Parameters placed, or pushed, onto the stack by the program and popped off the stack by the operating system.



System Call Parameter Passing—Methods (cont.)

Methods\features	Is there a limitation on the number of parameters?	Is there a limitation on the length of the parameters?
Register		
Register pointer to mem. block		
Stack (Push, Pop)		

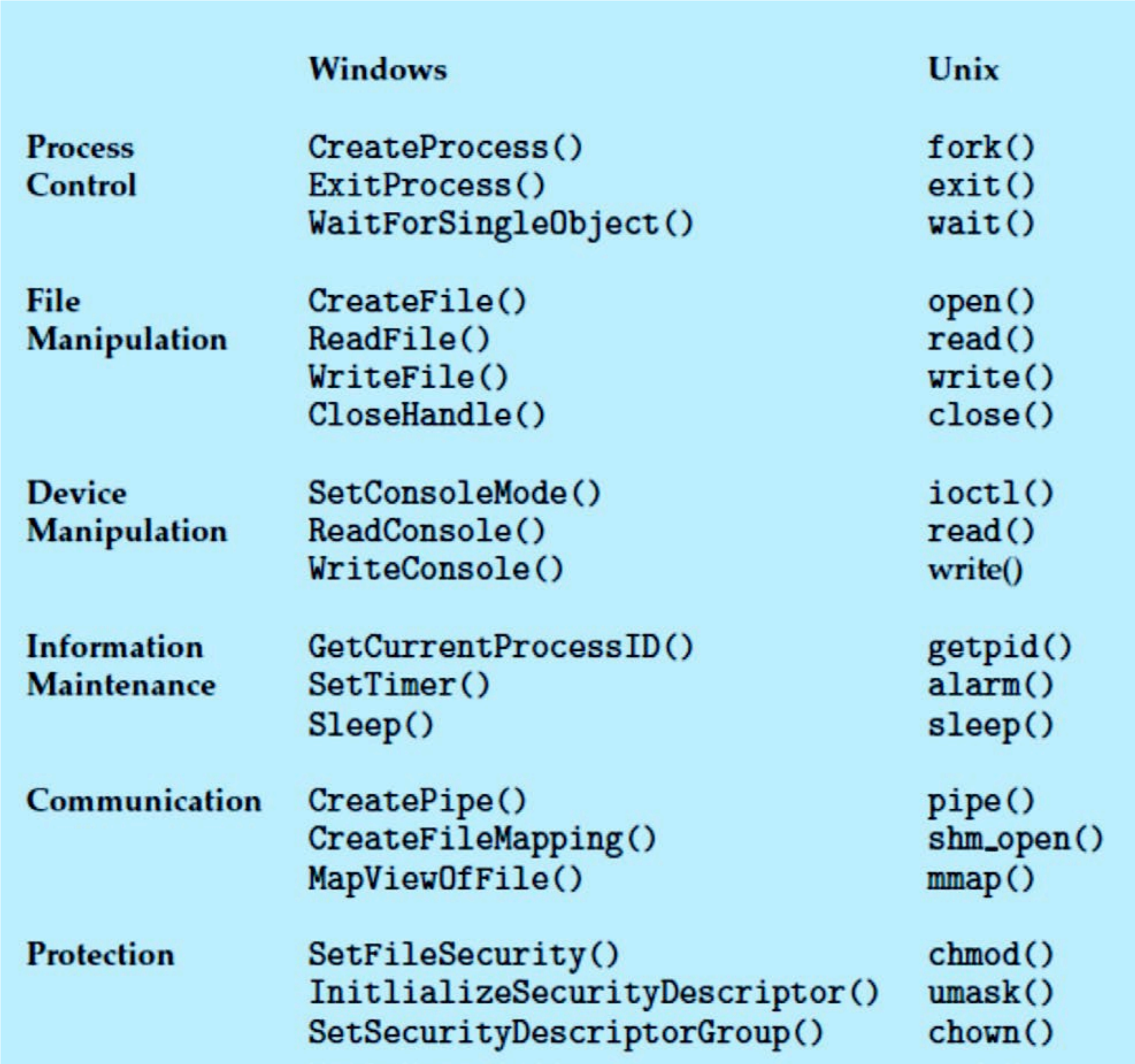
System Call Parameter Passing—Methods (cont.)

Methods\features	Is there a limitation on the number of parameters?	Is there a limitation on the length of the parameters?
Register	YES	YES
Register pointer to mem. block	NO	NO
Stack (Push, Pop)	NO	NO

Types of System Calls

- **Process control**
  - Create process, terminate process
  - …
- **File management**
  - create file, delete file
  - …
- **Device management**
  - request device, release device
  - …
- **Please study the reference book for more details**

Types of System Calls (Cont.)



	Windows	Unix

Process Control	`CreateProcess()`
	`ExitProcess()`
	`WaitForSingleObject()`
		`fork()`
		`exit()`
		`wait()`

File Manipulation	`CreateFile()`
	`ReadFile()`
	`WriteFile()`
	`CloseHandle()`
		`open()`
		`read()`
		`write()`
		`close()`

Device Manipulation	`SetConsoleMode()`
	`ReadConsole()`
	`WriteConsole()`
		`ioctl()`
		`read()`
		`write()`

Information Maintenance	`GetCurrentProcessID()`
	`SetTimer()`
	`Sleep()`
		`getpid()`
		`alarm()`
		`sleep()`

Communication	`CreatePipe()`
	`CreateFileMapping()`
	`MapViewOfFile()`
		`pipe()`
		`shm_open()`
		`mmap()`

Protection	`SetFileSecurity()`
	`InitlializeSecurityDescriptor()`
	`SetSecurityDescriptorGroup()`
		`chmod()`
		`umask()`
		`chown()`

Why Applications are Operating System Specific

- Apps compiled on one system usually not executable on other OSs.

- Each OS provides its own unique system calls
  - Own file formats, etc.

- Apps can be multi-operating system
  - Written in interpreted language like Python, Ruby, and interpreter available on multiple OSs.
  - App written in language that includes a VM containing the running app (like Java).
  - Use standard language (like C), compile separately on each operating system to run on each.