HA NOI UNIVERSITY OF SCIENCE AND TECHNOLOGY
SCHOOL OF INFORMATION AND COMMUNICATION TECHNOLOGY

Assembly Language and Computer Architecture Lab

Instructor: **Đỗ Công Thuần**

School of Information and Communication Technology

Hanoi University of Science and Technology

Lab Session 5

Character String with SYSCALL Function

Lab Overview

- Goals of the Lab Session
- MIPS Organization
- SysCall Function
- Assignments

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Goals of the Lab Session

- Students should be able to understand the technique of storing a string in memory.
- Students know how to output a string on the console.
- Students know how to use some algorithms to sort elements in a string.

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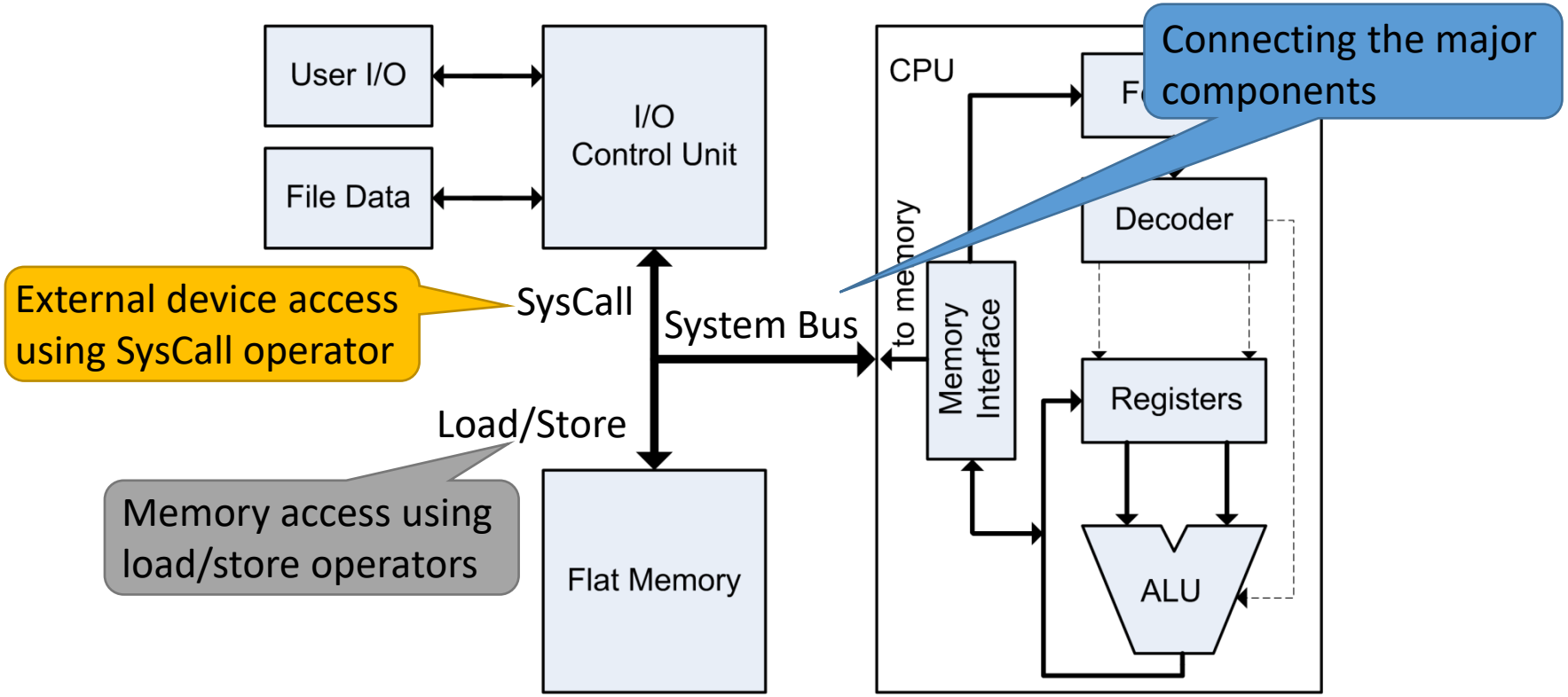
MIPS Organization

- The MIPS computer is organized in a 3-address load/store architecture
- Containing 3 main units
  - **ALU**, which performs all calculations, e.g. addition, subtraction, multiplication, logical operations, ...
  - **Memory**, which stores data and machine code
  - **Control Unit**, which controls the mechanical settings on the computer so that it can execute instructions

MIPS Organization



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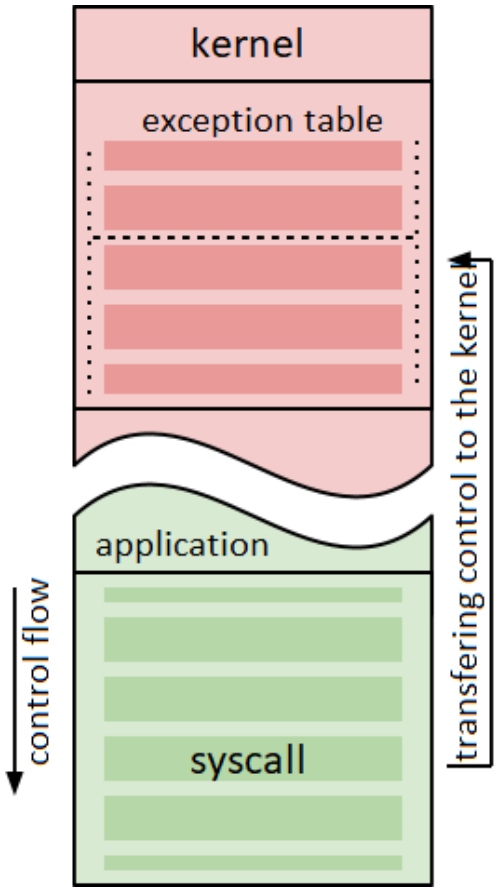
SysCall Function

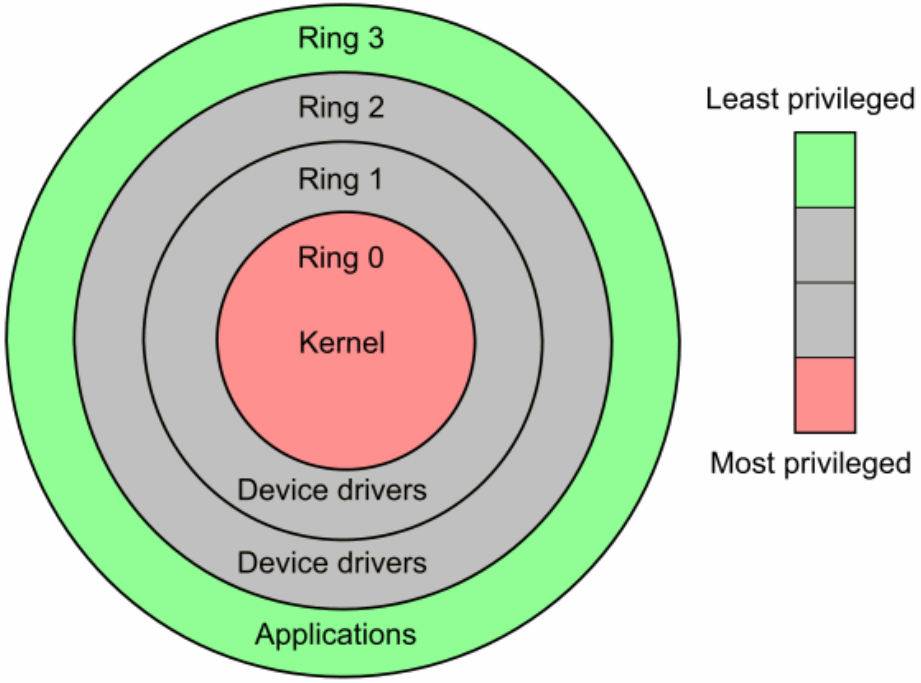
- In modern operating systems, CPUs operate on 2 distinct modes.
- Kernel mode
  - Have complete and unrestricted access to hardware
  - Can execute any CPU instructions and reference to any memory address
- User mode
  - Have no ability to directly access hardware or reference to memory address
    - Must delegate to system APIs to access hardware or memory

SysCall Function



- System call is a function call with a predetermined address.
  - Transferring the processor to the *kernel mode* to execute privileged instructions.
- Compared to a general call, control to the predetermined address is transmitted by hardware.
  - Interrupting the sequential execution of the user application instructions
  - Transferring control to the desired address with the necessary information saved to return to the main program

SysCall Function



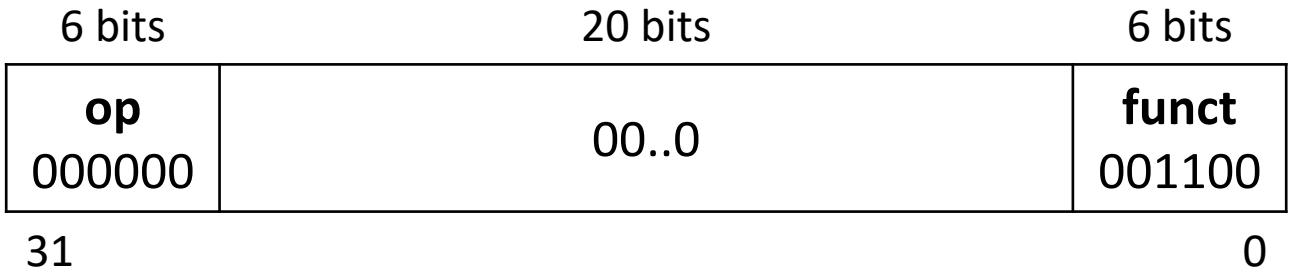
x86 may provide up to 4 protection rings while MIPS is implemented with only 2 rings (0 & 3).

SysCall Function

- The SysCall operator allows the CPU to communicate with an I/O controller to retrieve data from the user, disk drive, etc.
- The SysCall operator is used to call system services.
- The Service ID of the service to be executed is contained in the register `v0`.
- The arguments of the service are loaded into registers `a0-a3`.
- System calls that return values place their results in register `v0` (or `f0` for floating-point results).

SysCall Function

- I-Type instruction



- How to use SysCall?

→Example: print a message in the console

```
addi $v0, $zero, 4  # Load the service id in register v0
la $a0, message     # Load arguments
syscall             # Issue SysCall instruction
```

System Services

Service	ID	ARG.	Results
Print a decimal integer in the console	$v0 = 1	$a0 = the integer to print	$a0 is printed in the console
Read an integer from the user	$v0 = 5	-	$v0 = the integer to read
…	…	…	…

- Refer to the Table of MIPS System Services for more information.
  http://courses.missouristate.edu/kenvollmar/mars/help/syscallhelp.html

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Assignments

- Carefully read the sample codes in the learning material
  - **Sample code 1** shows how to print out a message (i.e. a string) on the console.
  - **Sample code 2** shows an simple implementation of the *strcpy* (string copy) procedure in assembly.
  - **Sample code 3** shows a way to measure the length of a string.

Assignments

- Now, finish the **Assignments #1–6** in the learning material
- Run assembly codes on the MARS simulator
- Collect and analyze all experimental results
- Answer all questions (if any) in the learning material

Assignments

- Write a report including **your assembly code**, all results, explanation, remarks, …
- Send your report to me **right after this class** via Teams Assignment
  - File Name Format: **ReportX_YourFullName_ClassID**, where: X = Lab Session Number (e.g. 1, 2, 3, …)

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Thank you

for your attention

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