بسم الله الرحمن الرحیم

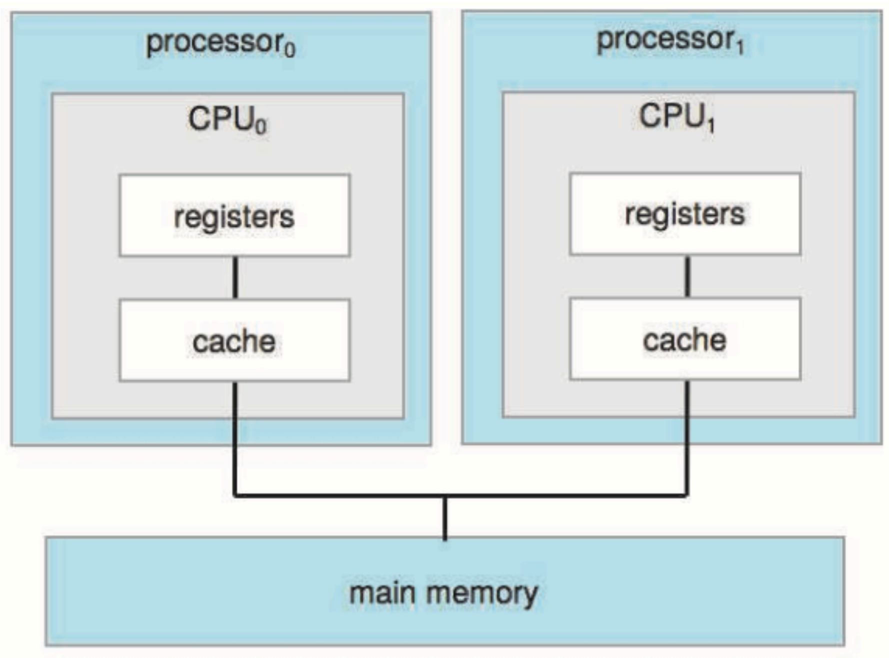
«سیستم عامل»

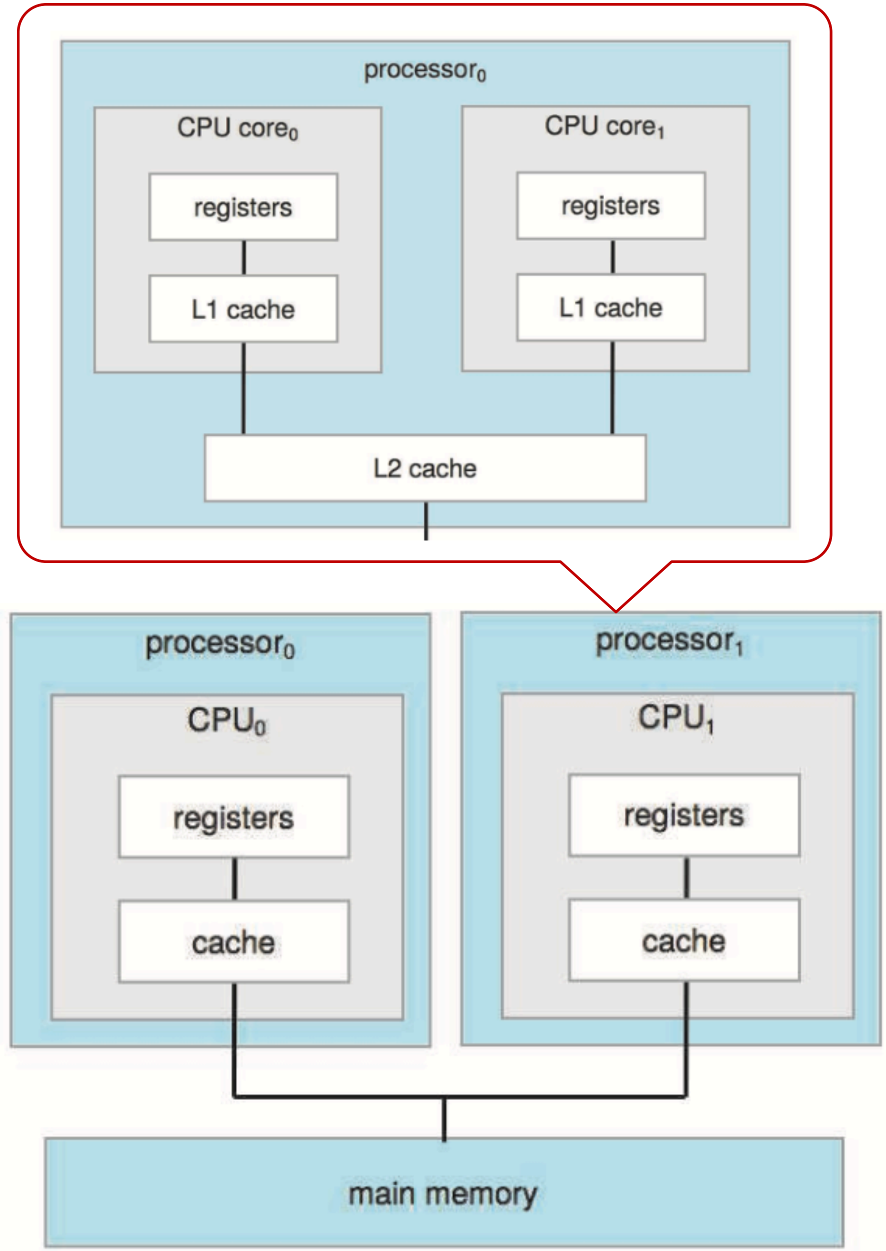
۱

جلسه ۲ : معرفی سیستم عامل: مروری بر سخت‌افزارهای مرتبط با سیستم عامل

مرور مطالب

- سخت‌افزارهای مرتبط
  - ۱) پردازنده
  - ۲) حافظه




processor$_0$
CPU core$_0$
CPU core$_1$
registers
registers
L1 cache
L1 cache
L2 cache
processor$_0$
processor$_1$
CPU$_0$
CPU$_1$
registers
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cache
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main memory

پردازنده

Instruction sets

- **A CPU's instruction set defines what it can do**
  - different for different CPU architectures
  - all have load and store instructions for moving items between memory and registers
    - Load a word located at an address in memory into a register
    - Store the contents of a register to a word located at an address in memory
  - many instructions for comparing and combining values in registers and putting result into a register
- **Look at the Blitz instruction set which is similar to a SUN SPARC instruction set**

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  - performs arithmetic functions and logic operations

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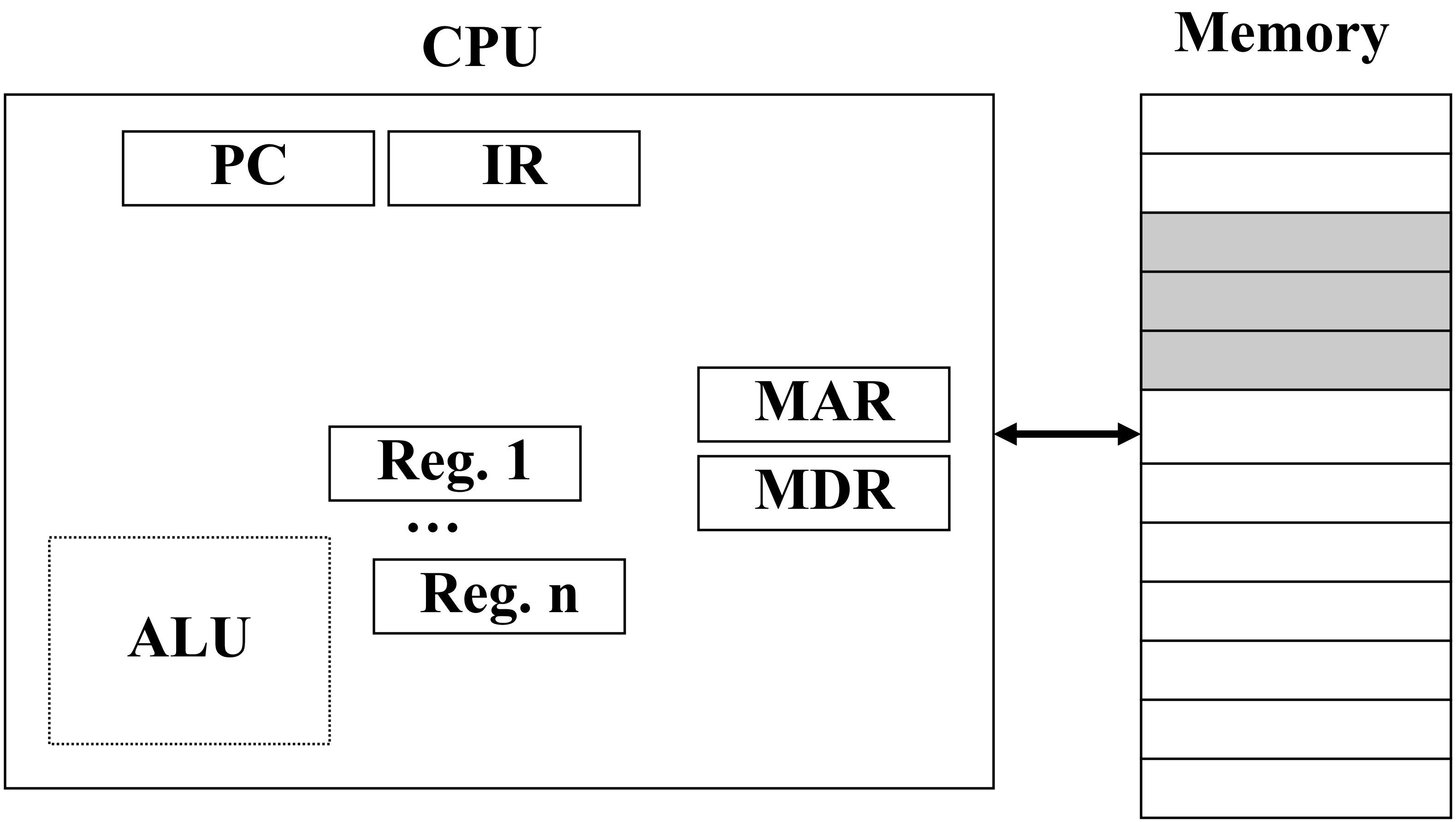
- **Memory Address Register (MAR)**
  - contains address of memory to be loaded from/stored to
- **Memory Data Register (MDR)**
  - contains memory data loaded or to be stored

Program execution

- **The Fetch/Decode/Execute cycle**
  - fetch next instruction pointed to by PC
  - decode it to find its type and operands
  - execute it
  - repeat

- **At a fundamental level, fetch/decode/execute is all a CPU does, regardless of which program it is executing**

Fetch/decode/execute cycle



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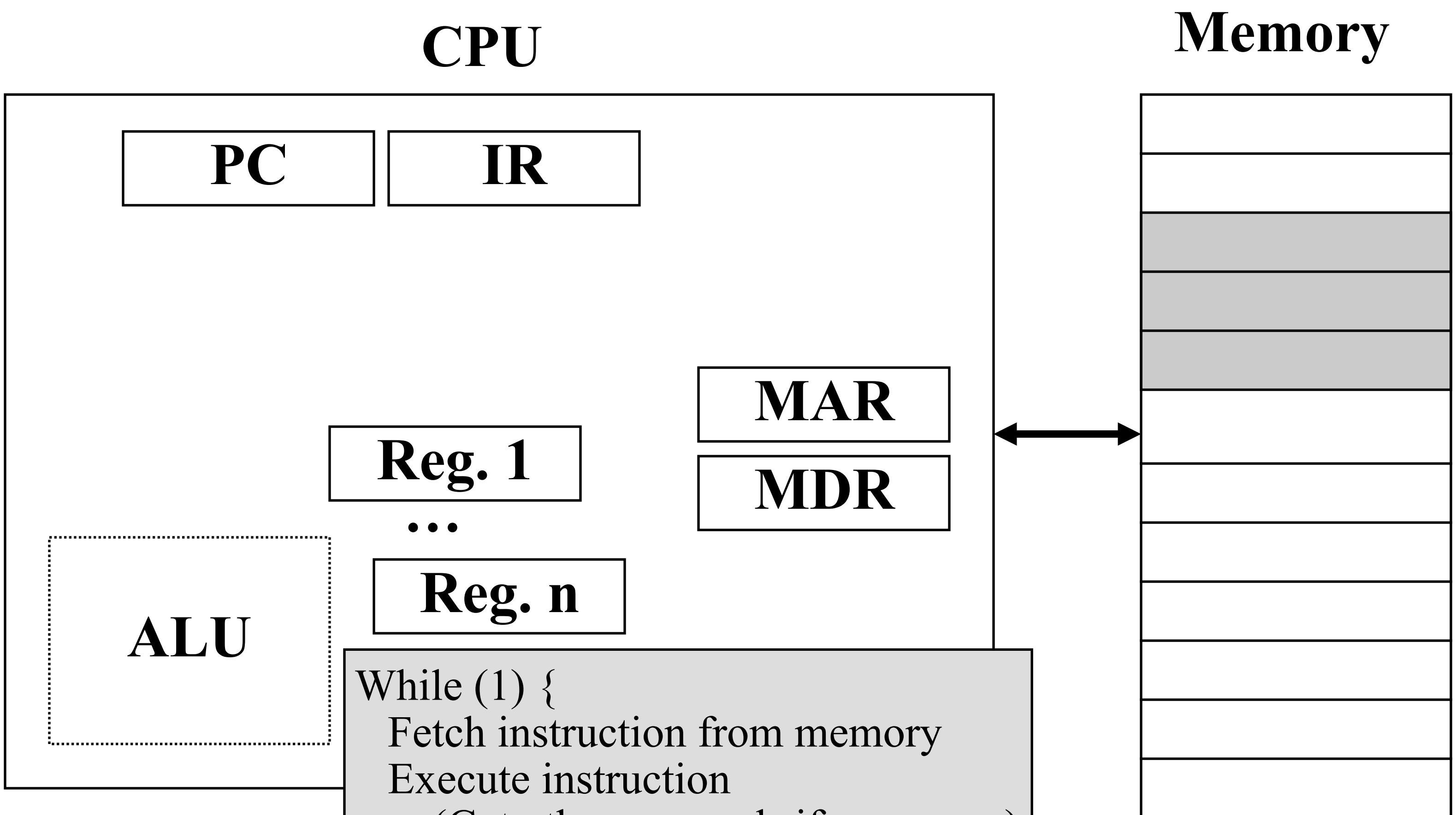


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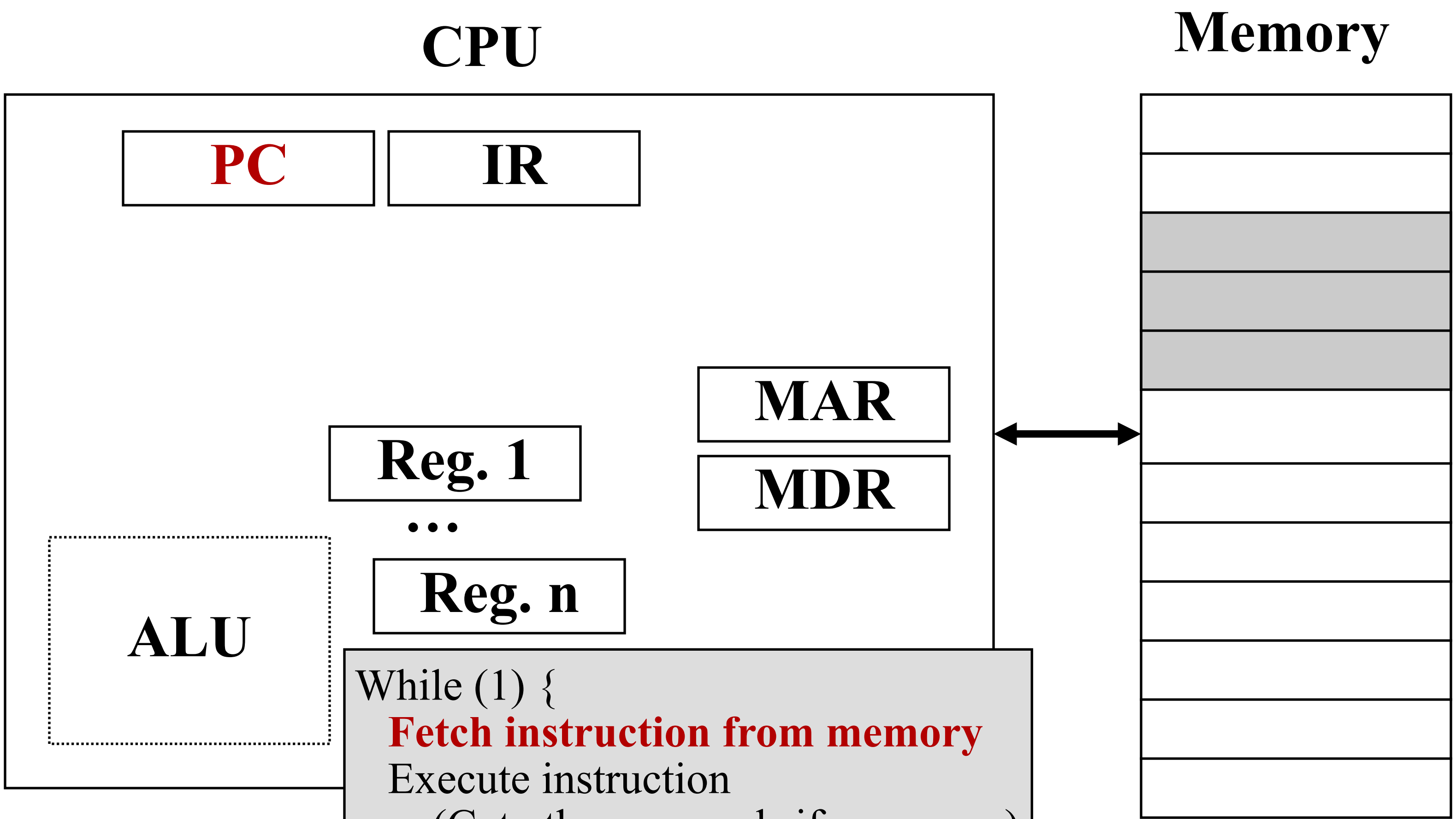


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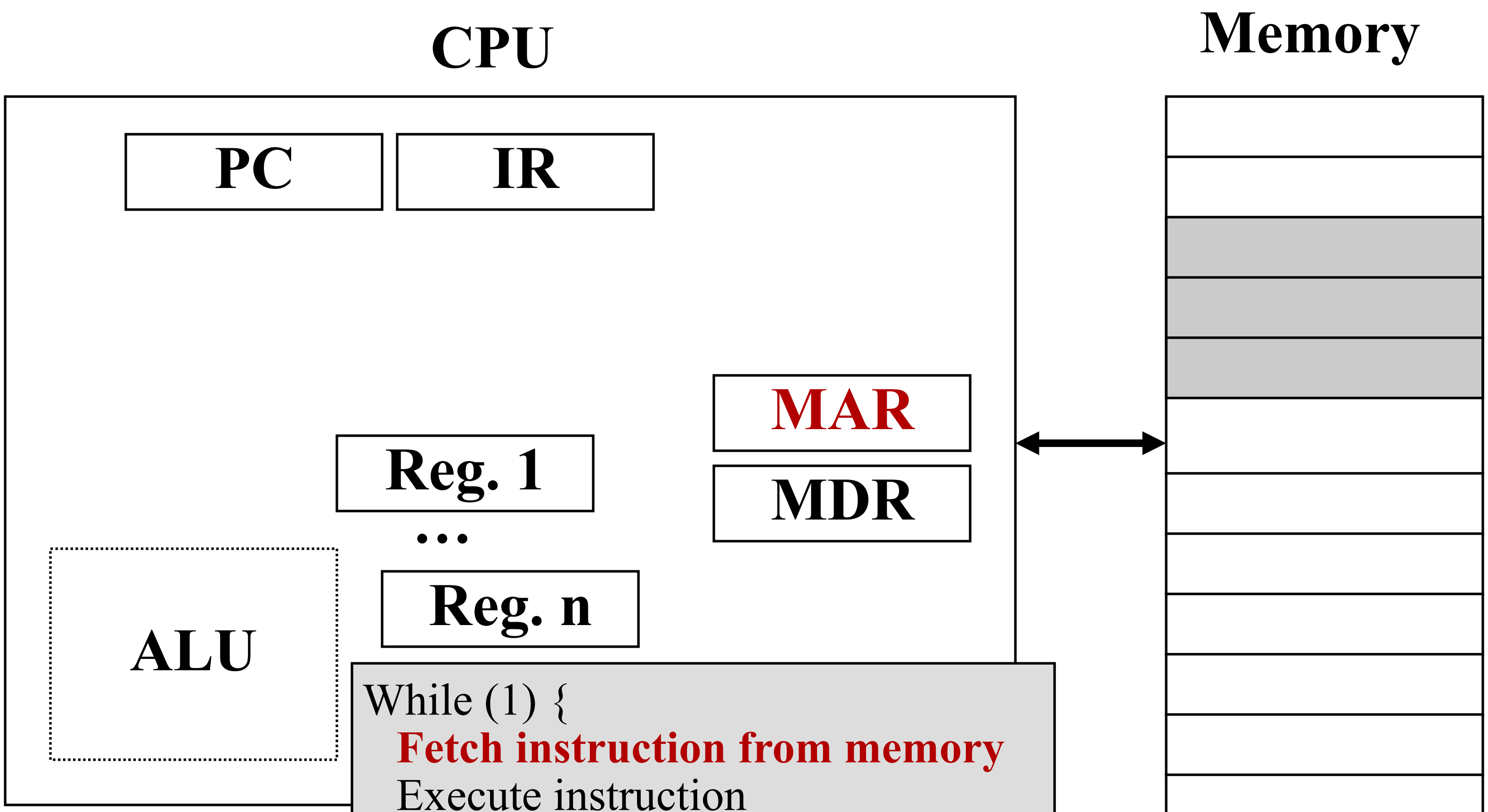

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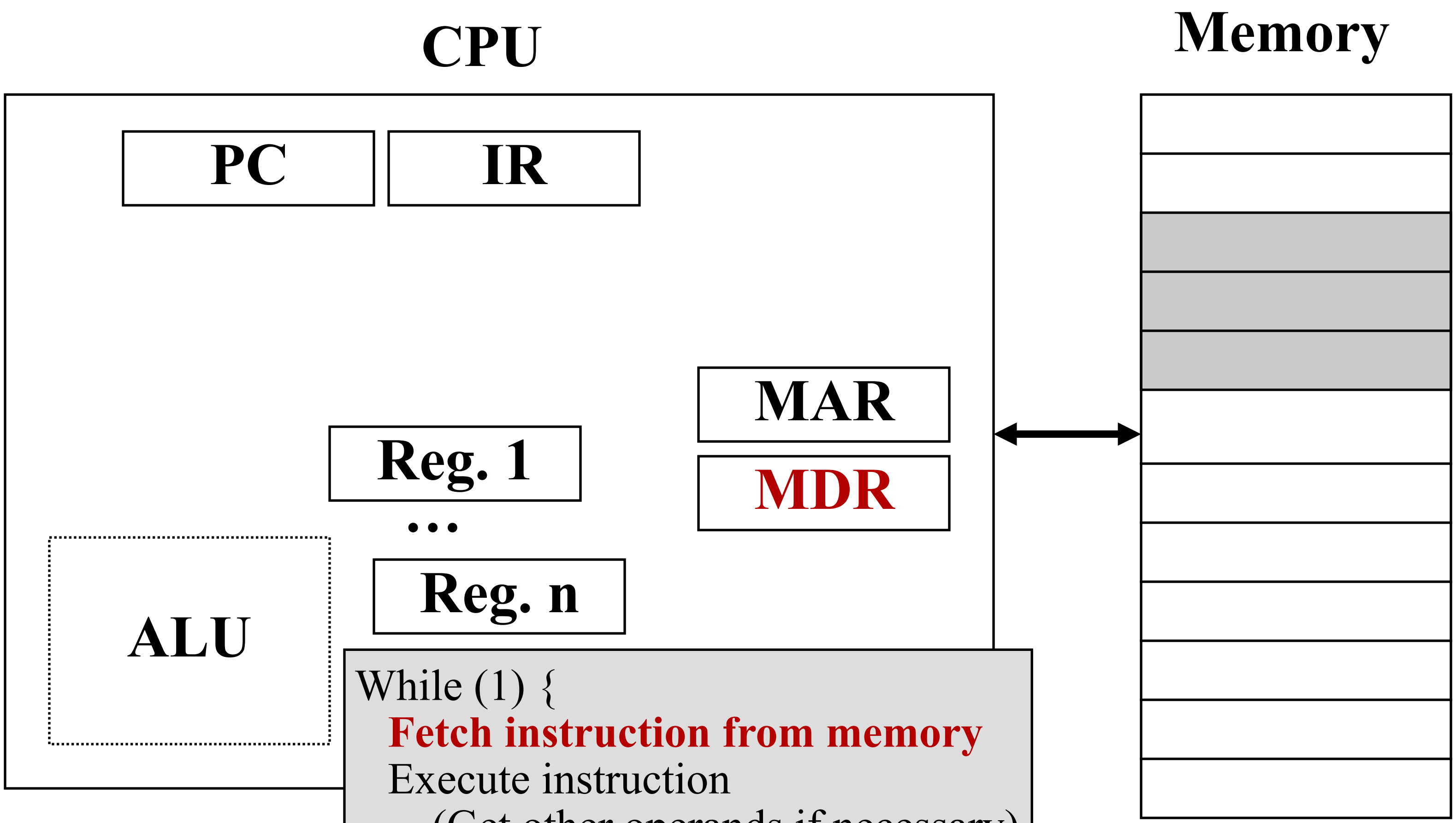

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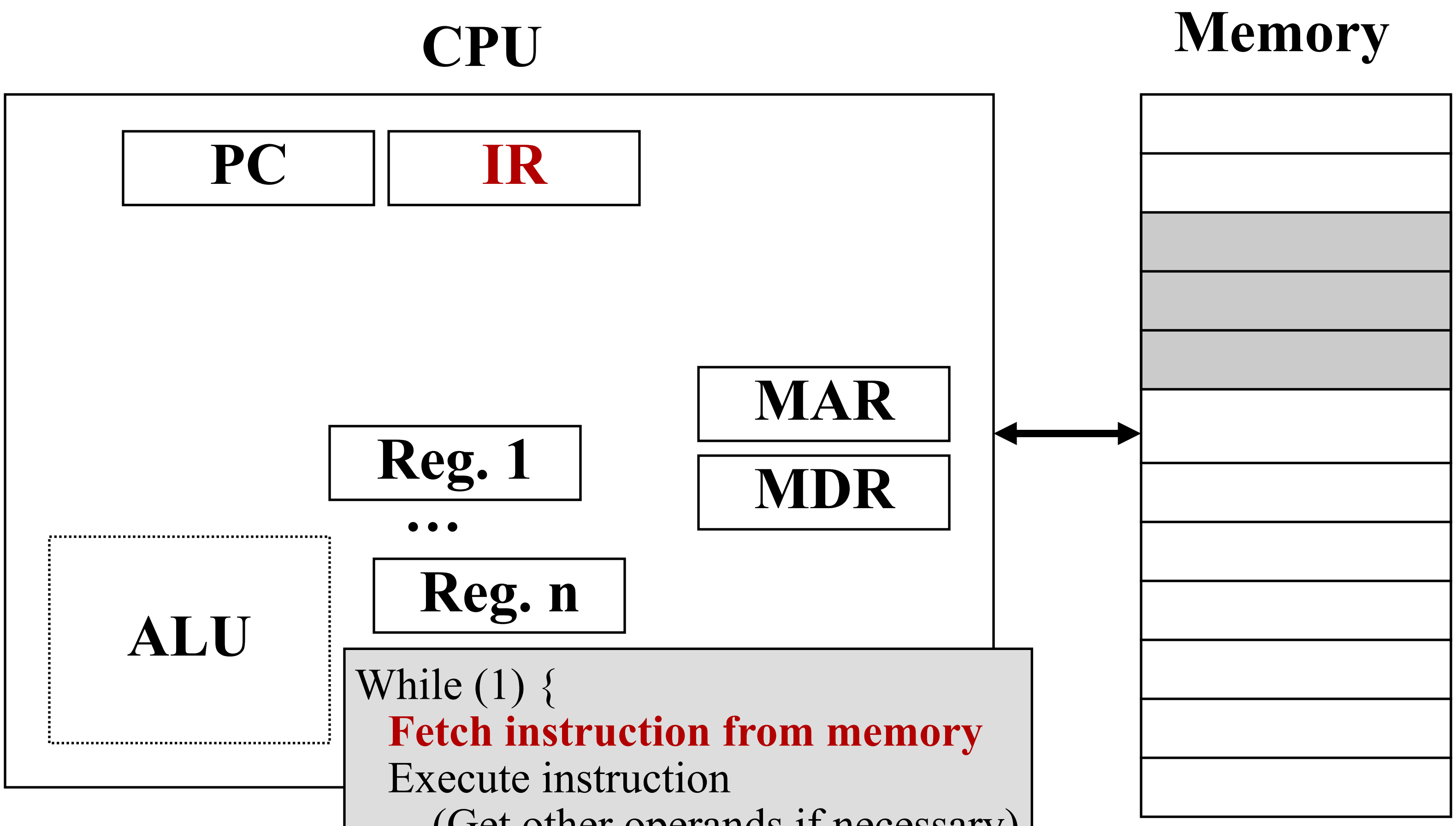


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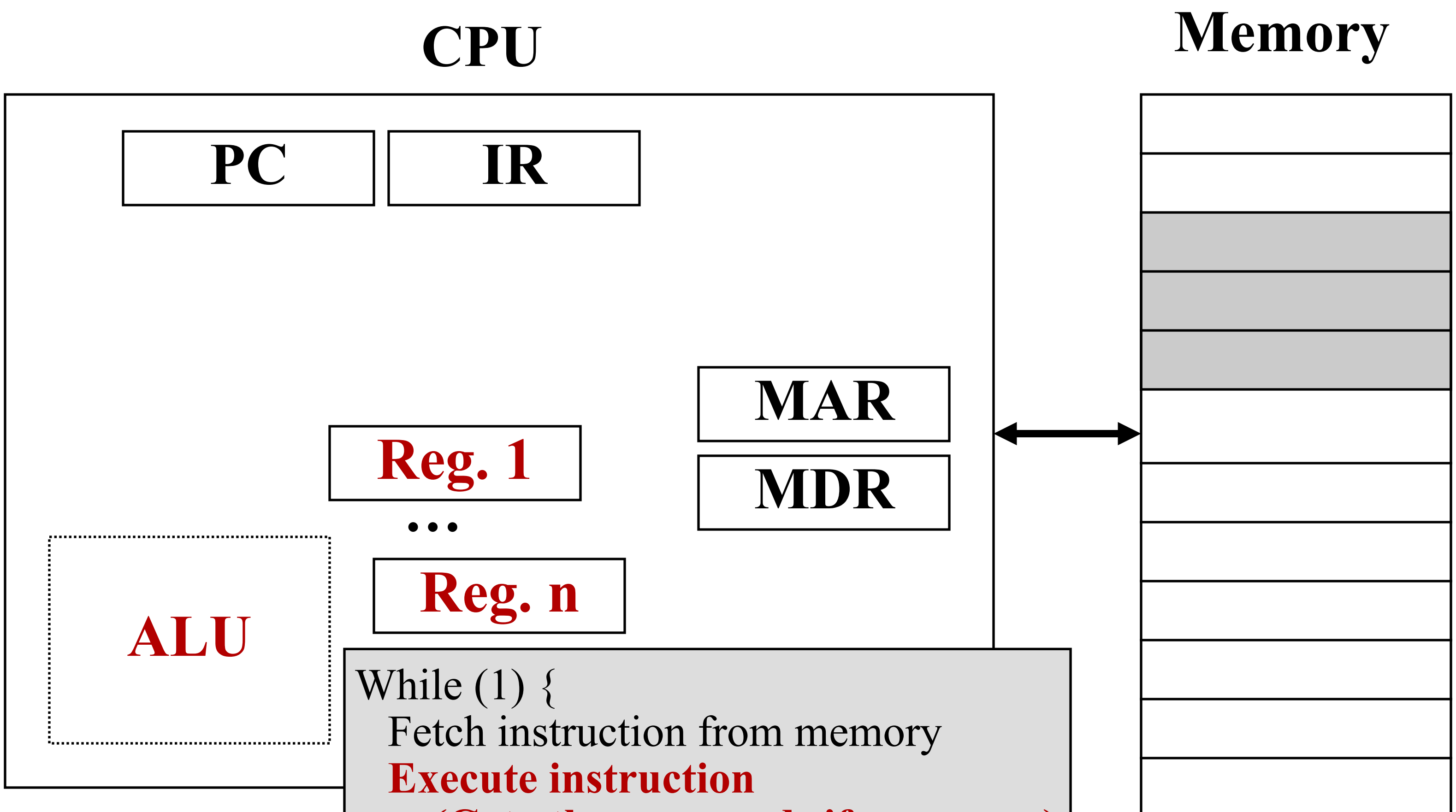

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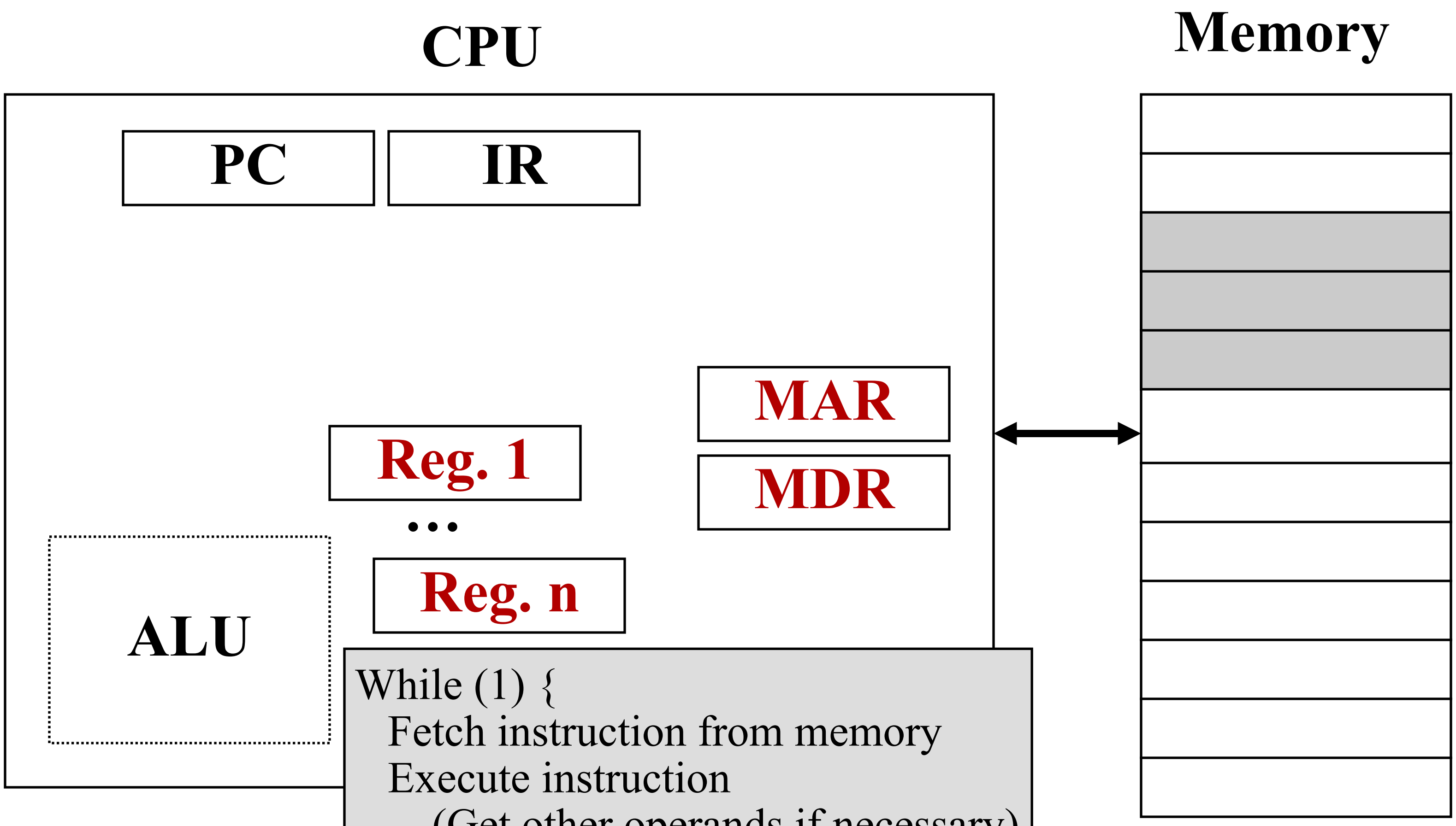


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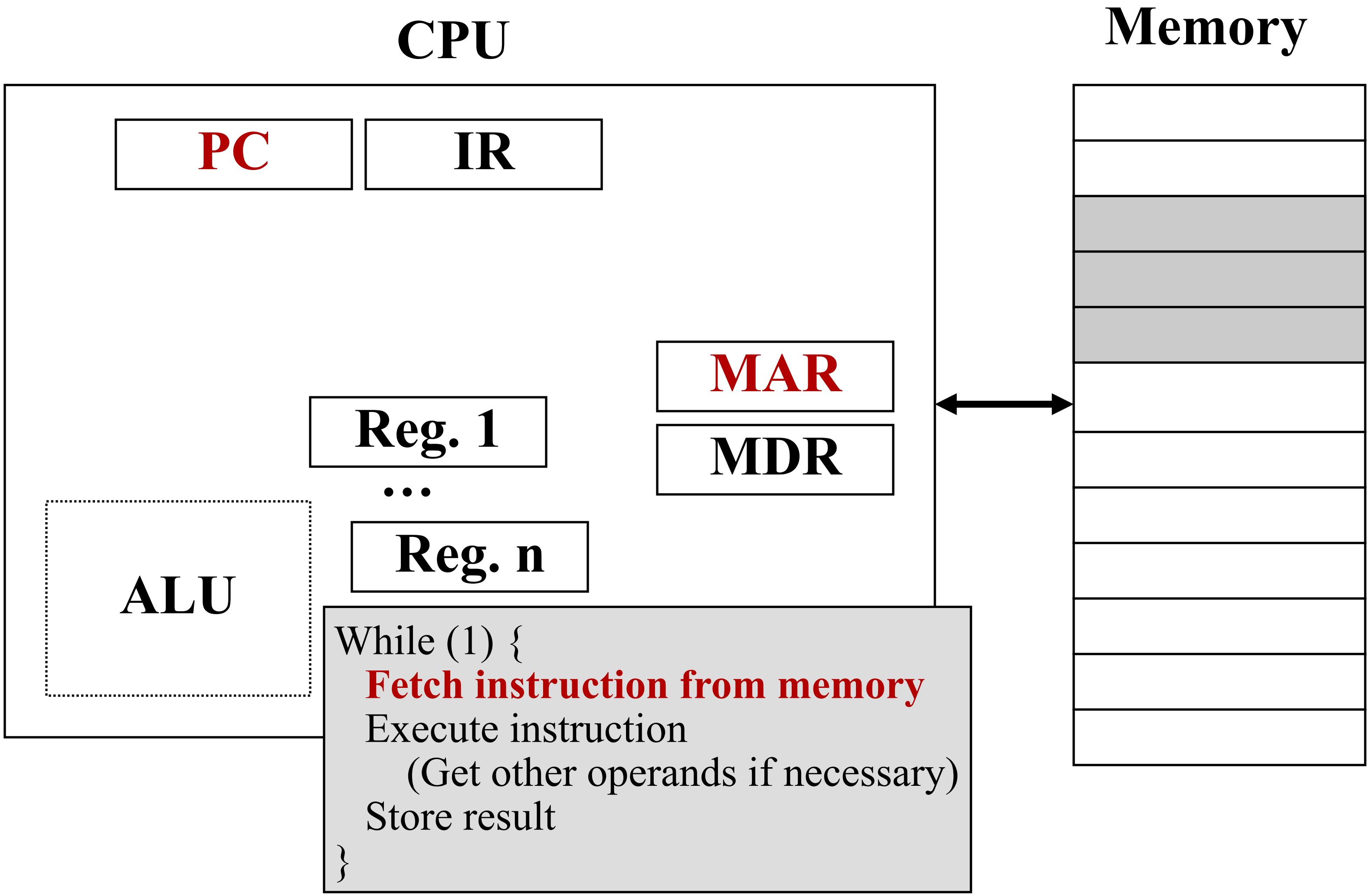

The OS is just a program!

The OS is just a program!

- **The OS is a sequence of instructions that the CPU will fetch/decode/execute**
  - How can the OS cause application programs to run?
  - How can the OS switch the CPU to run a different application and later resume the first one?
  - How can the OS maintain control?
  - In what ways can application code try to seize control indefinitely (ie. cheat)?
  - And how can the OS prevent such cheating?
  - How can applications programs cause the OS to run?

How can the OS invoke an application?

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How can the OS invoke an application?

- **Somehow, the OS must load the address of the application's starting instruction into the PC**
  - The computer boots and begins running the OS
    - **OS code must be loaded into memory somehow**
    - **fetch/decode/execute OS instructions**
    - **OS requests user input to identify application "file"**
    - **OS loads application file (executable) into memory**
    - **OS loads the memory address of the application's starting instruction into the PC**
    - **CPU fetches/decodes/executes the application's instructions**

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  - The address of the interrupt handler's first instruction is placed in the PC by the interrupt h/w

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- Privileged **instructions can only be executed when the mode bit is set**
  - disabling interrupts
  - setting the mode bit!
  - Attempted execution in non-privileged mode generally causes an interrupt (trap) to occur

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- **What stops the running application from modifying the OS?**
  - Specifically, what stops it from modifying the timer interrupt handler to jump control back to the application?

What other ways are there to cheat?

- **What stops the running application from modifying the OS?**
  - Memory protection!
  - Memory protection instructions must be privileged
  - They can only be executed with the mode bit set …
- **Why must the OS clear the mode bit before it hands control to an application?**

How can applications invoke the OS?

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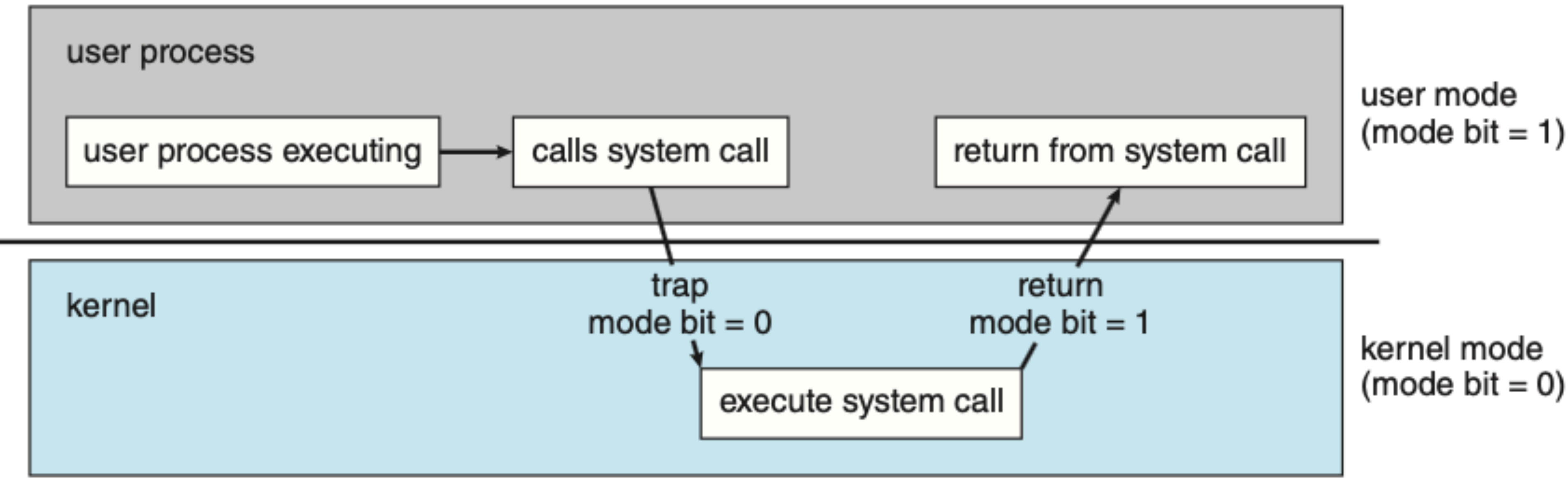
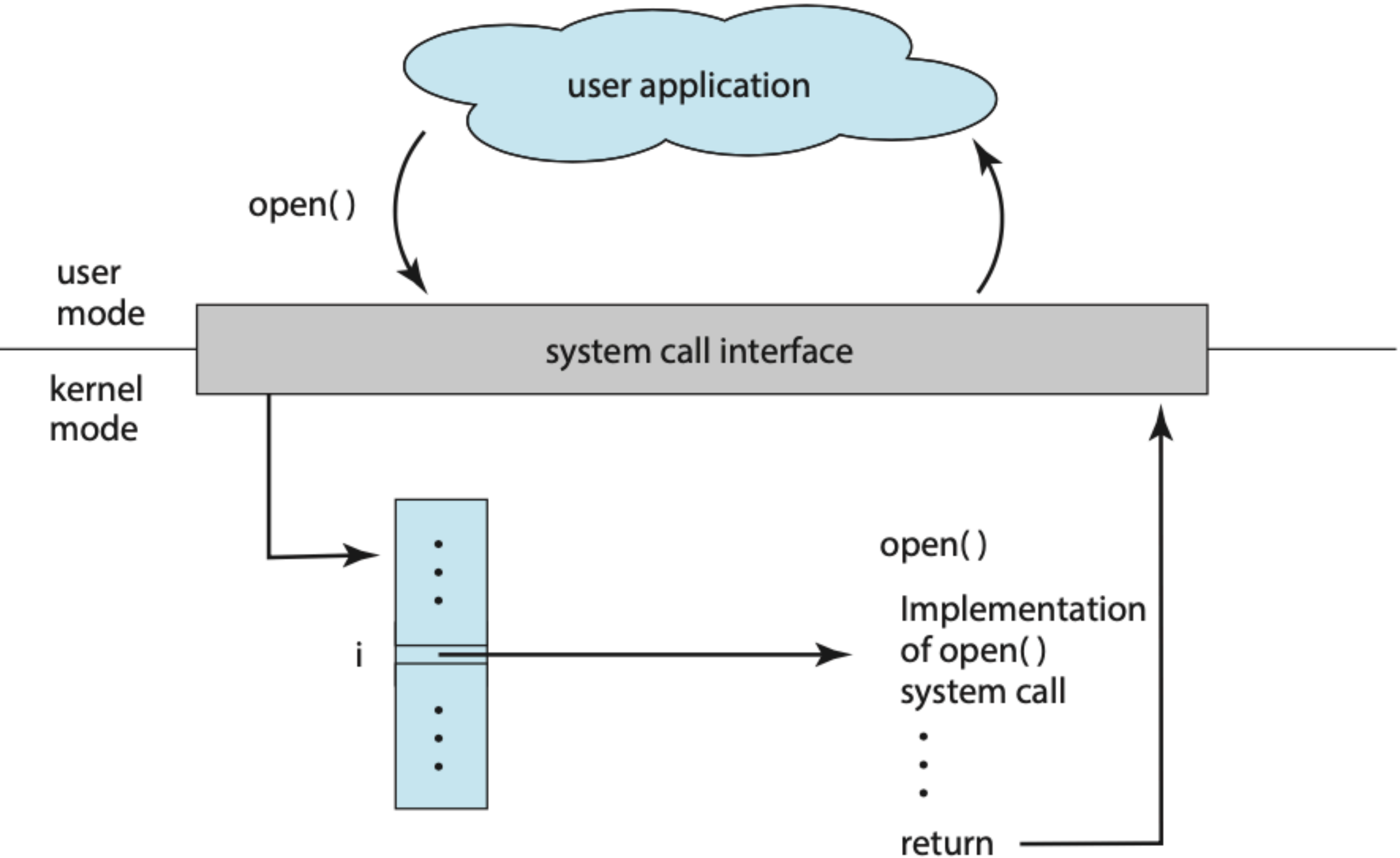
- Why not just set PC to an OS instruction address and transfer control that way?

How can applications invoke the OS?

- **Special instruction causes a trap / interrupt**
- **Trap instruction changes PC to point to a predetermined OS entry point instruction and simultaneously sets the mode bit**
  - application calls a library procedure that includes the appropriate trap instruction
  - fetch/decode/execute cycle begins at a pre-specified OS entry point called a system call
  - CPU is now running in privileged mode
- **Traps, like interrupts, are hardware events, but they are caused by the executing program rather than a device external to the CPU**


user process
user process executing
calls system call
return from system call
user mode
(mode bit = 1)
kernel
trap
mode bit = 0
return
mode bit = 1
execute system call
kernel mode
(mode bit = 0)


user application
open( )
user
mode
system call interface
kernel
mode
i
open( )
Implementation
of open( )
system call
return

How can the OS switch to a new application?

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- **To suspend execution of an application simply capture its memory state and processor state**
  - preserve all the memory values of this application
  - copy values of all CPU registers into a data structure which is saved in memory
  - restarting the application from the same point just requires reloading the register values

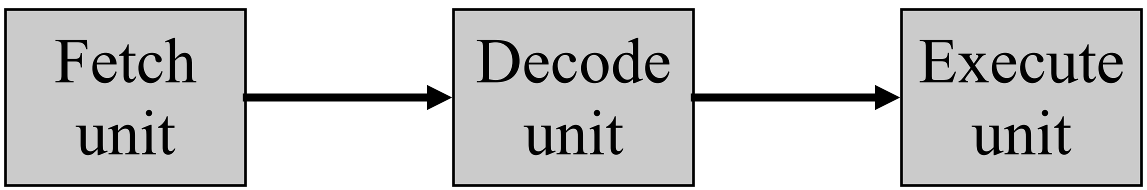
Recap

- Why do we need a timer device?
- Why do we need an interrupt mechanism?
- Why are system calls different to procedure calls?
- How are system calls different to interrupts?
- Why is memory protection necessary?

Why its not quite that simple ...

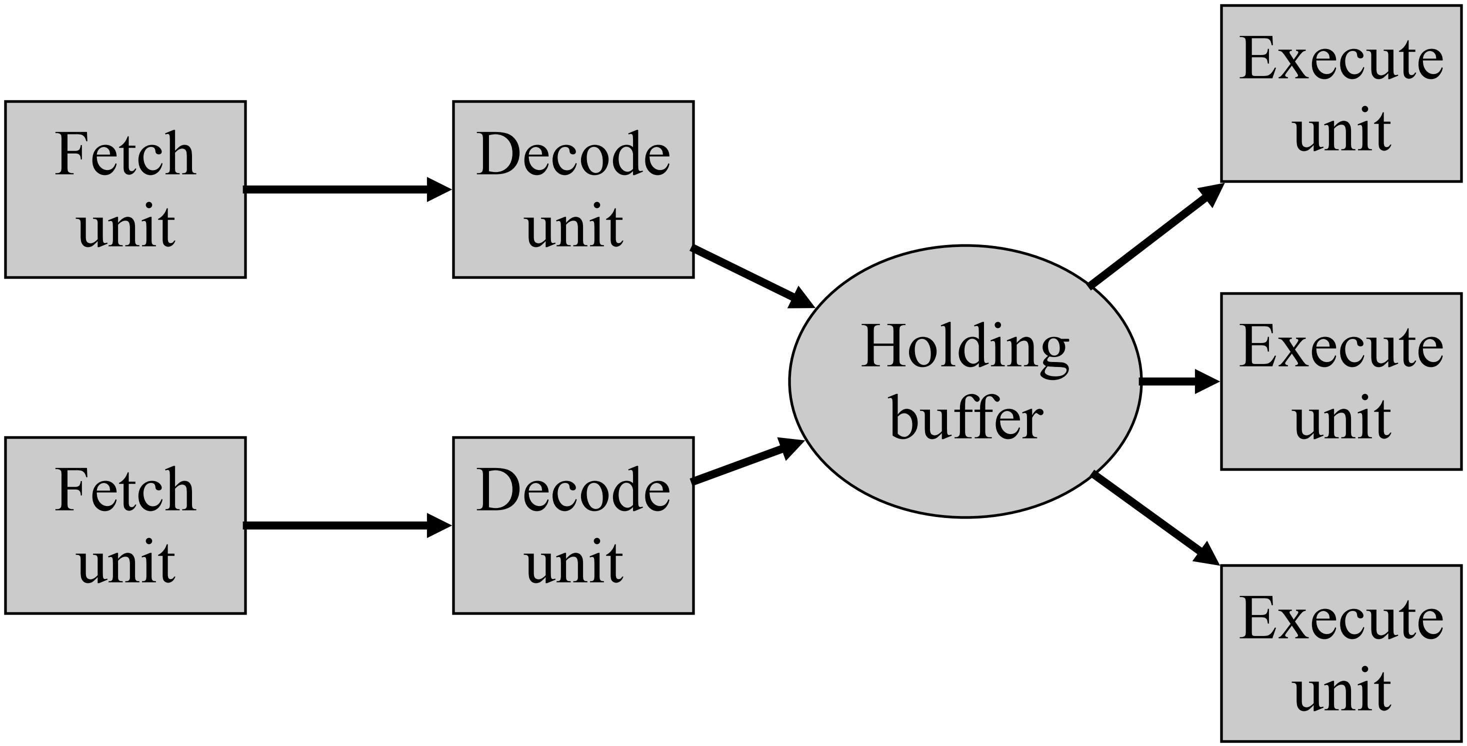
- Pipelined CPUs
- Superscalar CPUs
- Multi-level memory hierarchies
- Virtual memory
- Complexity of devices and buses
- Heterogeneity of hardware

Pipelined CPUs



Execution of current instruction performed in parallel with decode of next instruction and fetch of the one after that

Superscalar CPUs



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- **More details, but fundamentally the same task**
- **The BLITZ CPU is not pipelined or superscalar**

حافظه

The memory hierarchy

- 2GHz processor → 0.5 ns
- Data/inst. cache → 0.5ns – 10 ns, 64 kB- 1MB (this is where the CPU looks first!)
- Main memory → 60 ns, 512 MB – 1GB
- Magnetic disk → 10 ms, 160 Gbytes

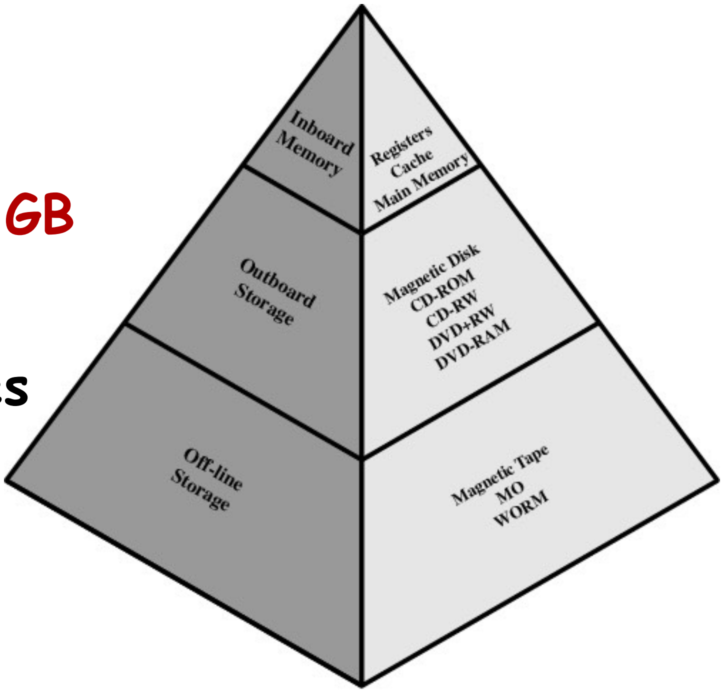

Figure 1.14 The Memory Hierarchy

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- **Movement of data among lower levels of the memory hierarchy is under direct control of the OS**
  - virtual memory page faults
  - file system calls

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- How do you protect one application’s area of memory from other applications?
- How do you relocate an application in memory?

Quiz

How does the OS solve these problems:

- Time sharing the CPU among applications?
- Space sharing the memory among applications?
- Protection of applications from each other?
- Protection of hardware/devices?
- Protection of the OS itself?