Operating Systems
Lecture 8: Limited Direct Execution + Memory Virtualisation

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Aug 17, 2018

Administrative

1. Homework due in 3 hours noon
2. Quiz (worth 10%) on Tuesday. Syllabus - from start till MLFQ (including MLFQ)
3. Lab on weekend?

VM crashes (fork bomb)

PsUtil demo

Direct Execution

OS

Program

Direct Execution

OS	Program
1. Create entry for process	

Direct Execution

OS	Program
1. Create entry for process	
2. Allocate memory for process	

Direct Execution

OS	Program
1. Create entry for process 2. Allocate memory for process	
3. Load program into memory	

Direct Execution

OS	Program
1. Create entry for process 2. Allocate memory for process 3. Load program into memory 4. Set up stack	

Direct Execution

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Direct Execution

OS	Program
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	1. Run main() 2. Execute return from main
1. Free memory	

Direct Execution

OS	Program
1. Create entry for process 2. Allocate memory for process 3. Load program into memory 4. Set up stack 5. Execute call main()	
	1. Run main() 2. Execute return from main
1. Free memory 2. Remove process from process list	

Direct Execution Challenges

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2. How does OS ensure that the program doesn't make illegal access (issuing I/O)

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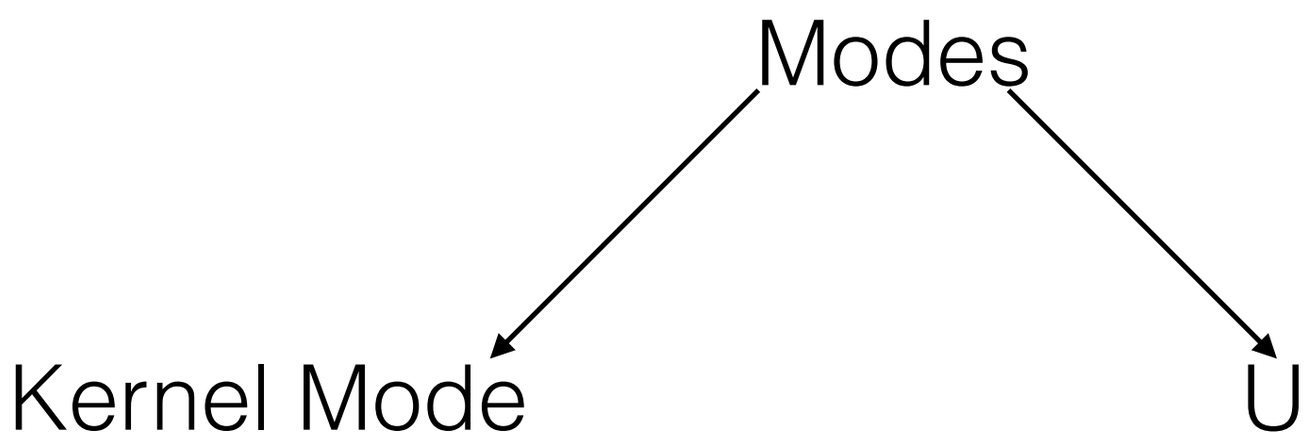
- Goal: A process must be able to perform I/O and some other restricted operations, but without giving the process complete control over the system.

Restricted Operations



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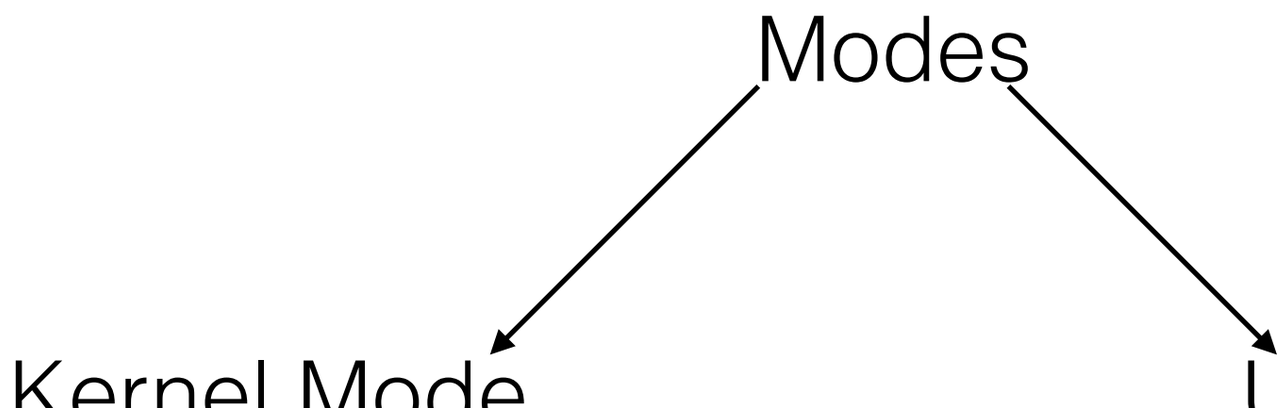
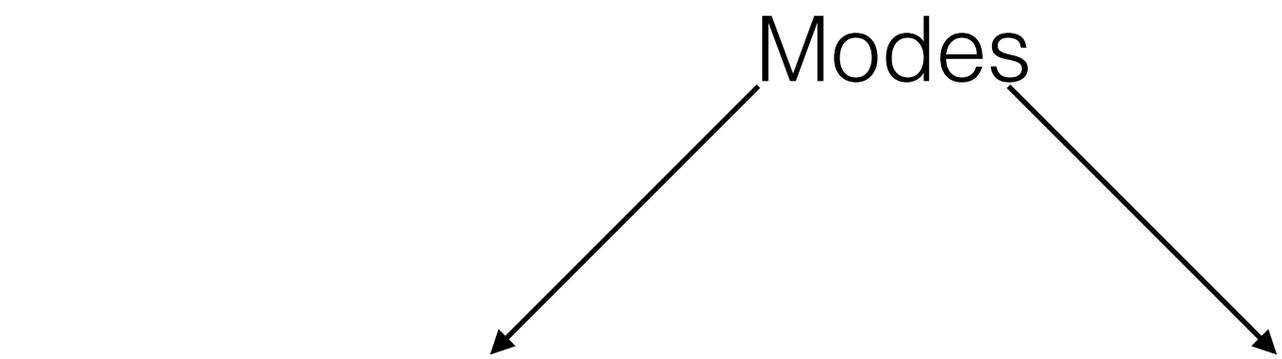


Kernel Mode

User Mode

1. Restricted mode - can not issue IO

Restricted Operations



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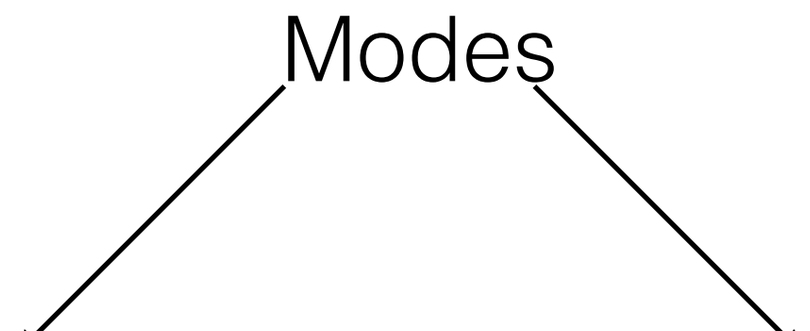

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Code can issue IO.
Mode that OS runs in.

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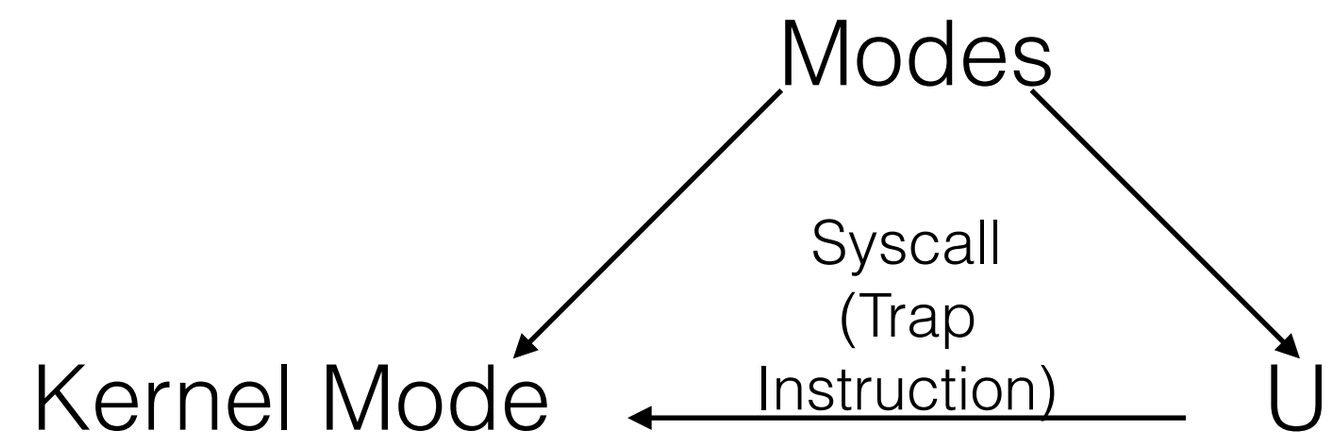

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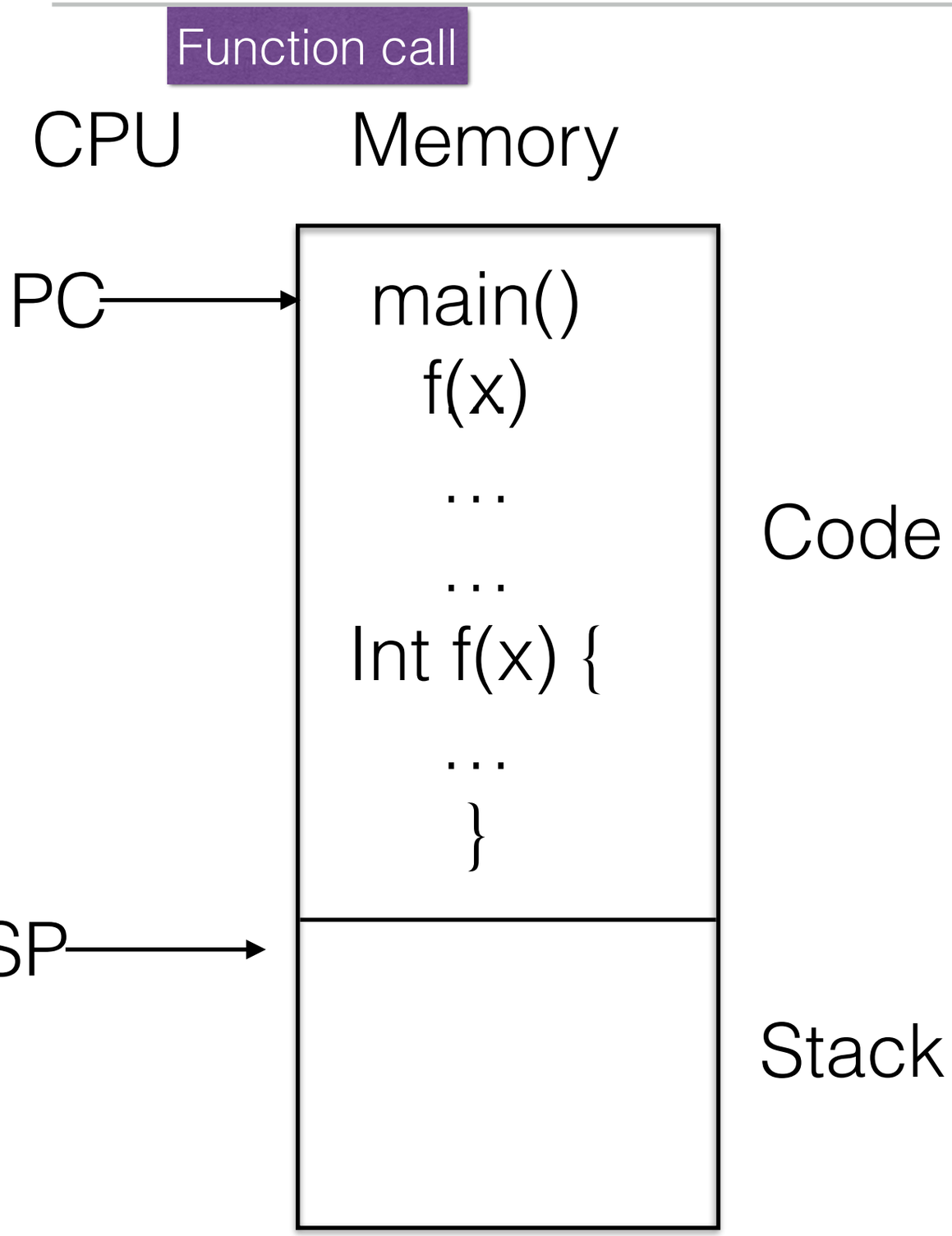
Traps v/s Function Calls



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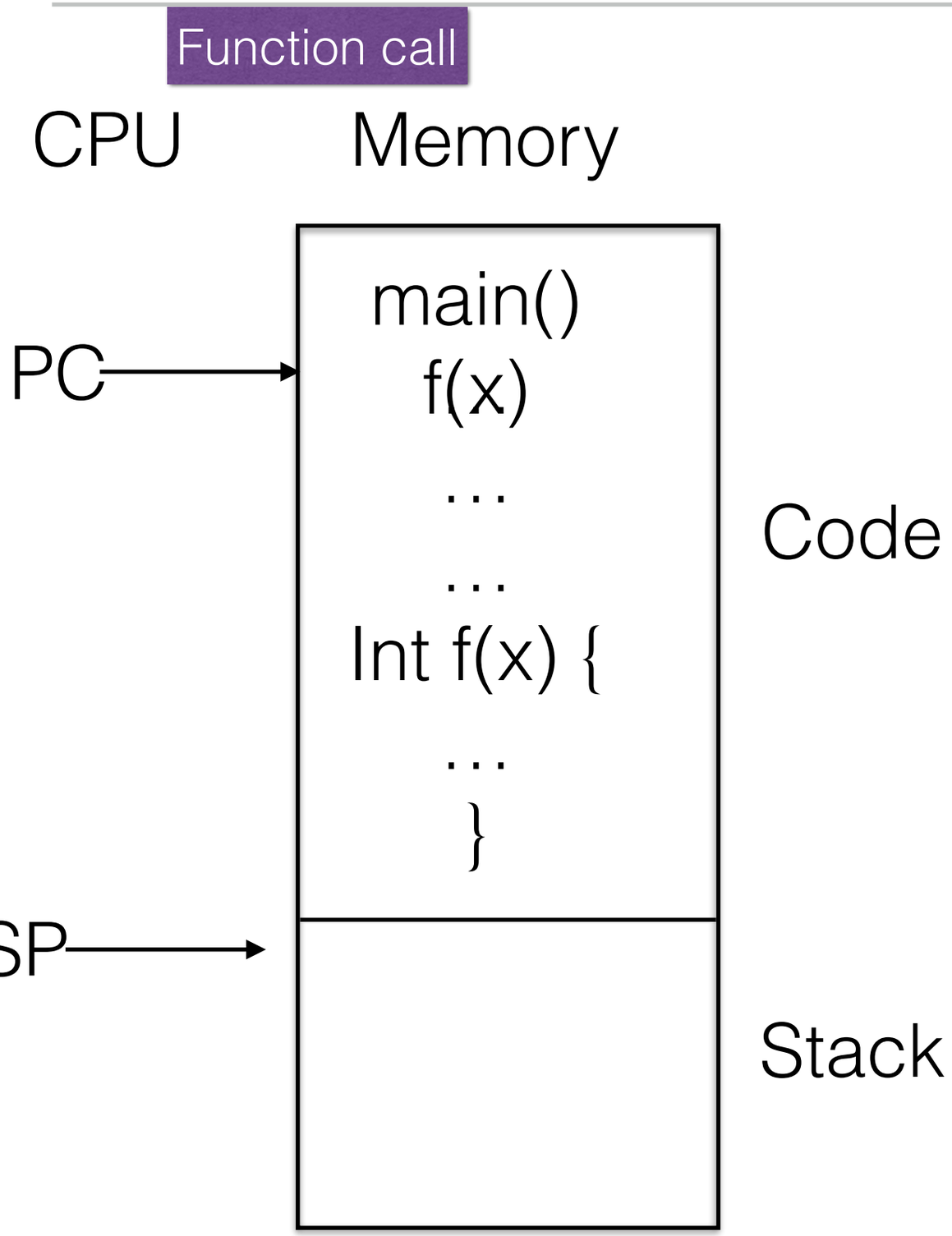

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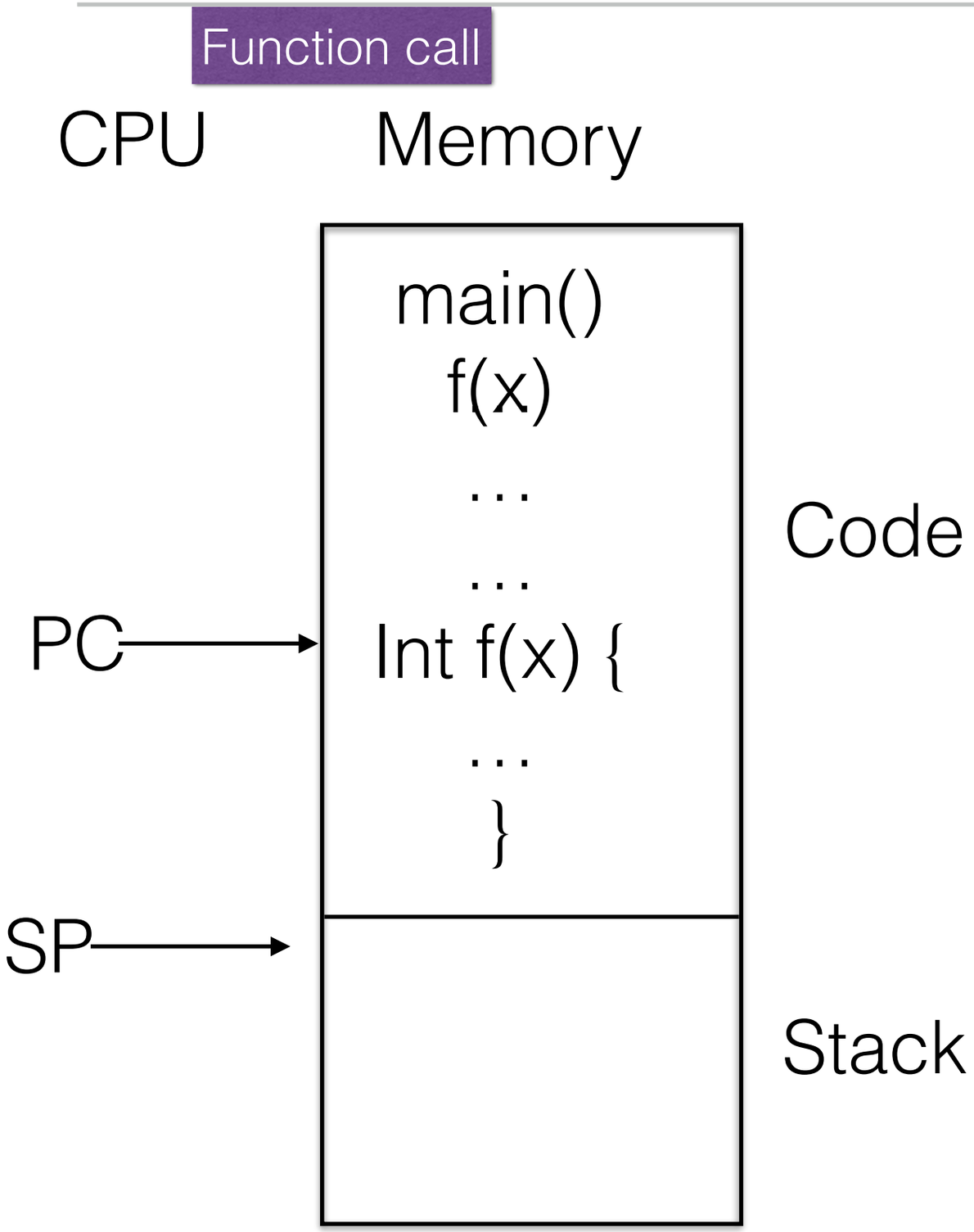

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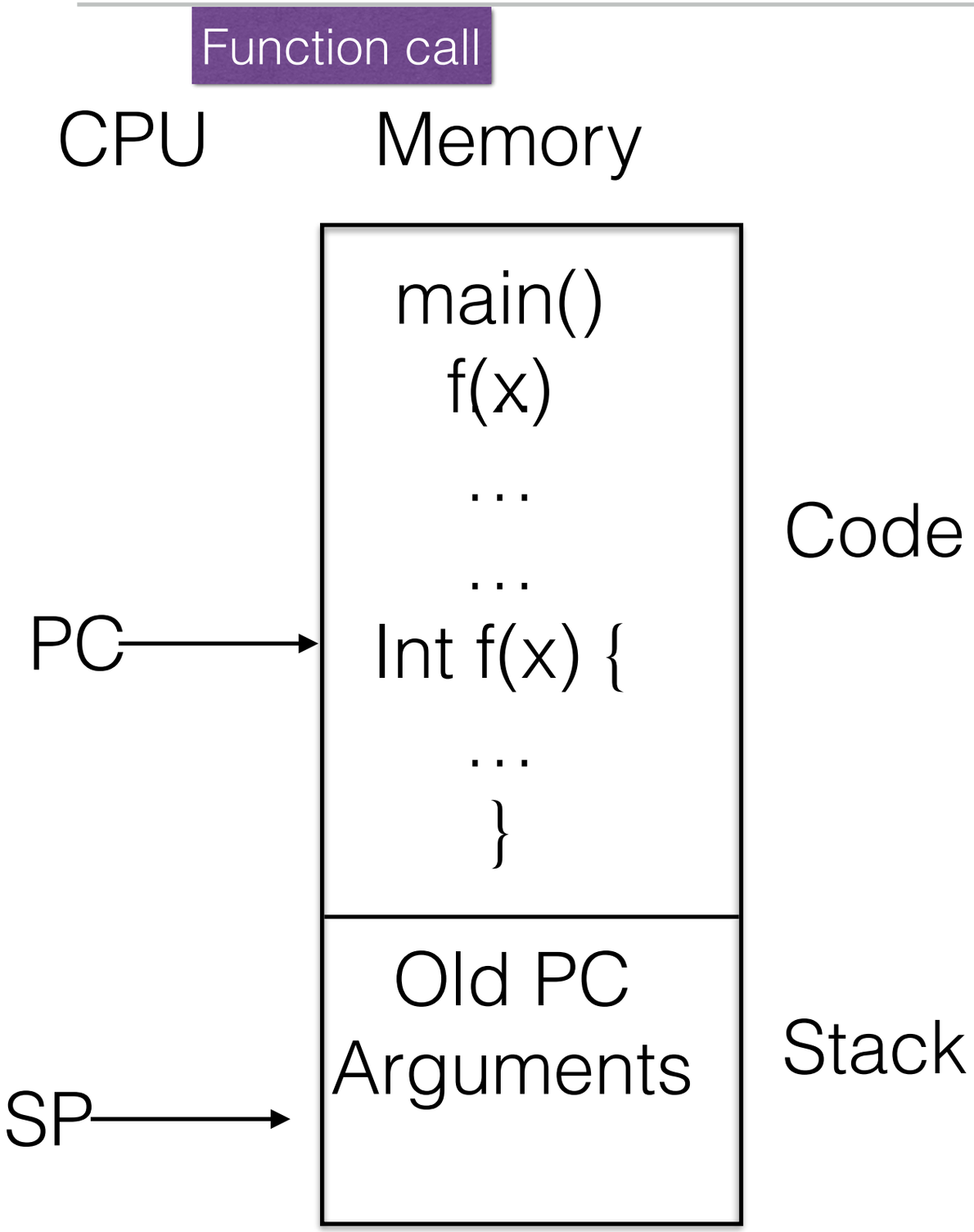

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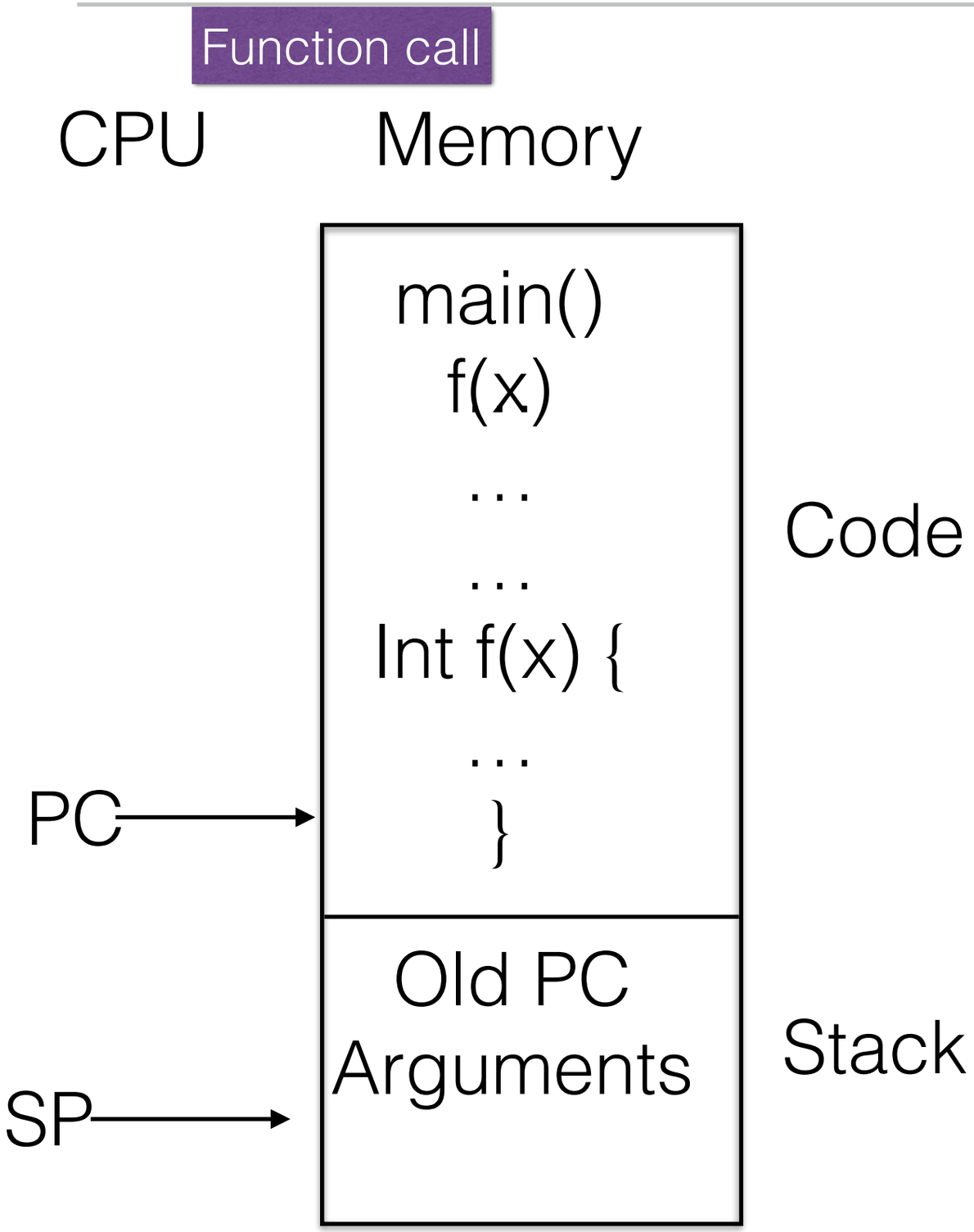

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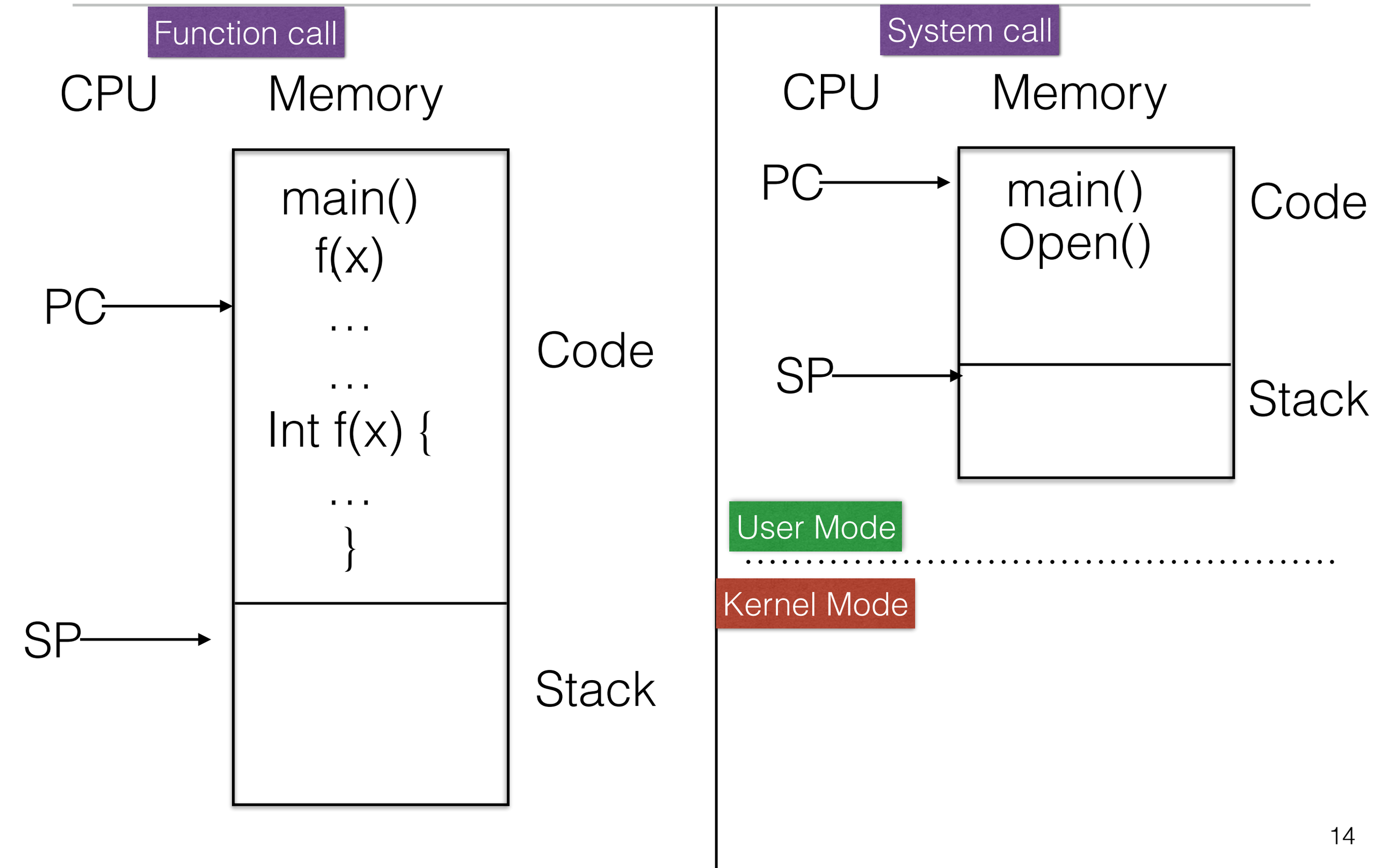

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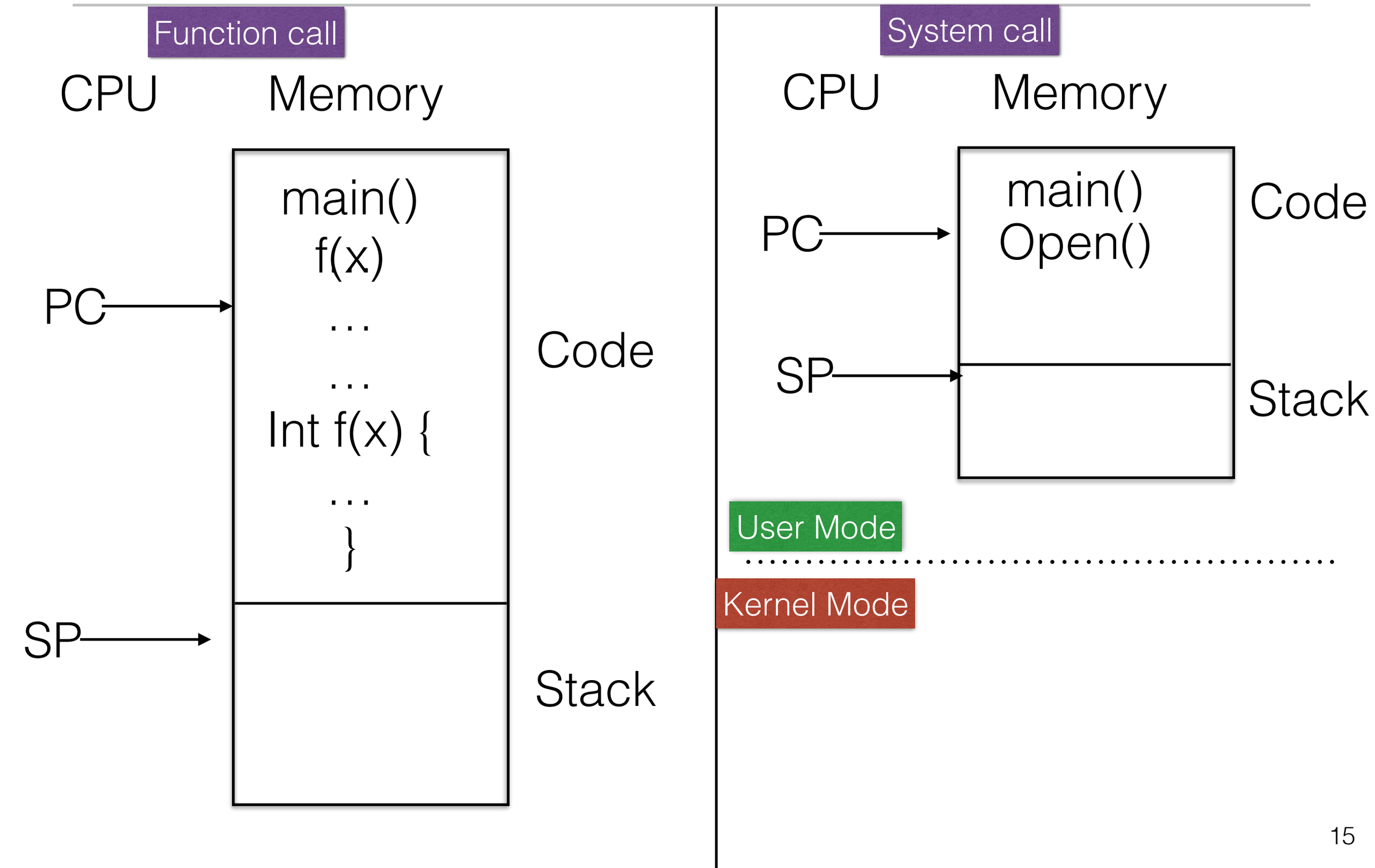

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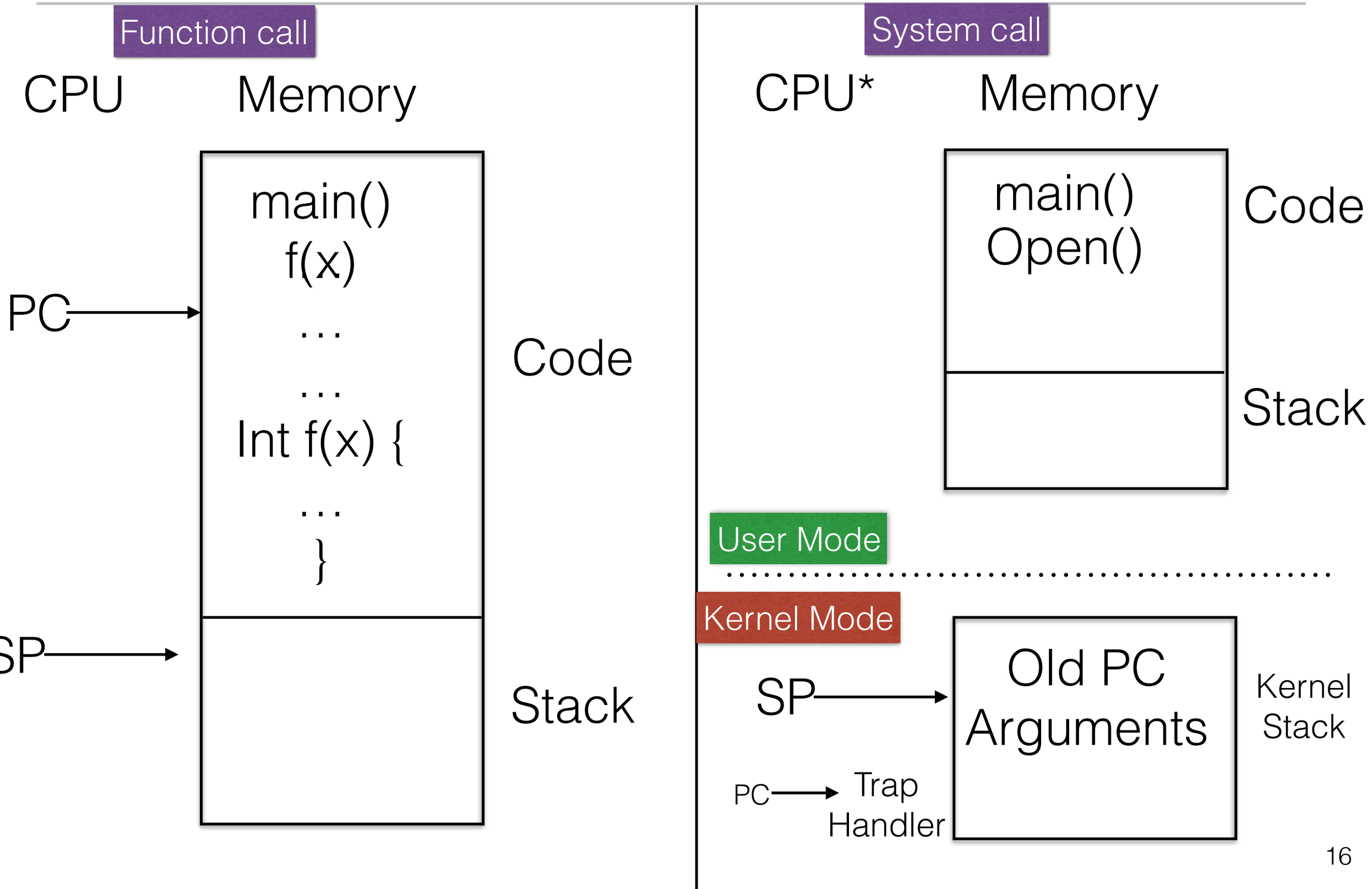

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Fill kernel stack with reg/PC		
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	restore regs from kernel stack	
	move to user mode	
	jump to main	

Load program into memory
Setup user stack with argv
Fill kernel stack with reg/PC
return-from-trap

restore regs from kernel stack
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Run main()
...
Call system call
trap into OS

save regs to kernel stack
move to kernel mode
jump to trap handler

Handle trap
  Do work of syscall
return-from-trap

restore regs from kernel stack
move to user mode
jump to PC after trap

...
return from main
trap (via `exit()`)

Free memory of process
Remove from process list

Switching Between Processes

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- How does OS get back in control?

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    - Restart!

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		Process A
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	timer interrupt	
	save regs(A) to k-stack(A)	
	move to kernel mode	
	jump to trap handler	
Handle the trap		
Call `switch()` routine		
save regs(A) to proc-struct(A)		
restore regs(B) from proc-struct(B)		
switch to k-stack(B)		
return-from-trap (into B)		

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	move to user mode	
	jump to B's PC	
		Process B
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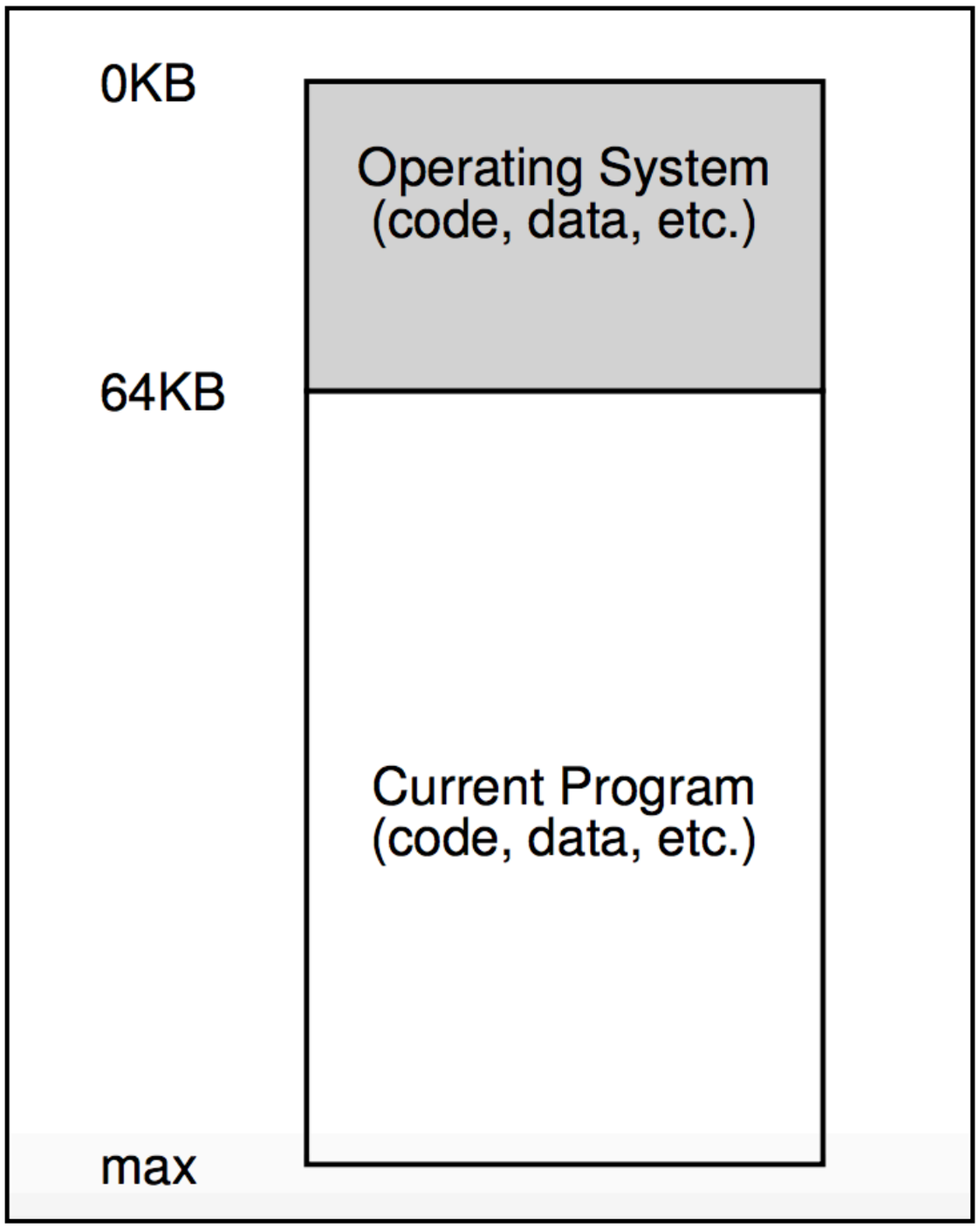
- More on it when we study concurrency!

Memory Virtualisation

Early days
Single program



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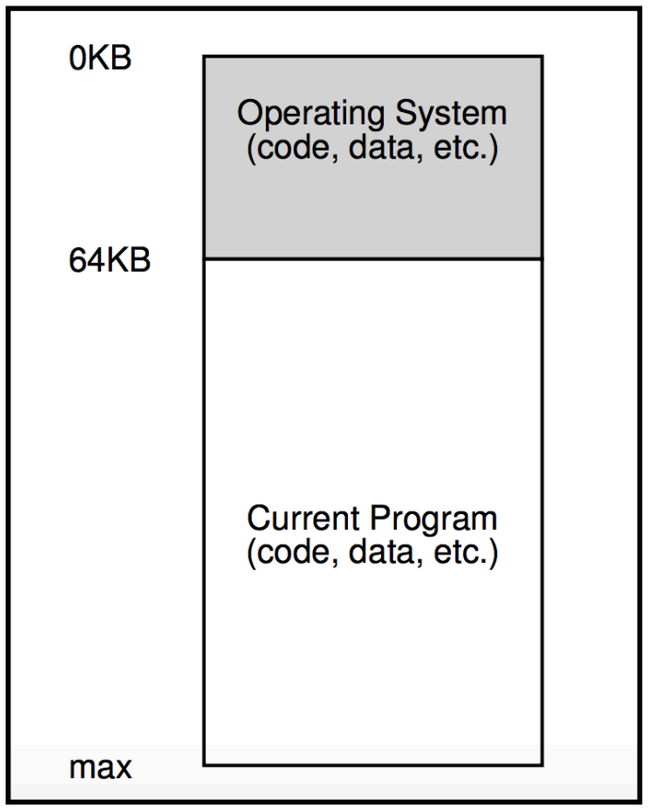

Early days
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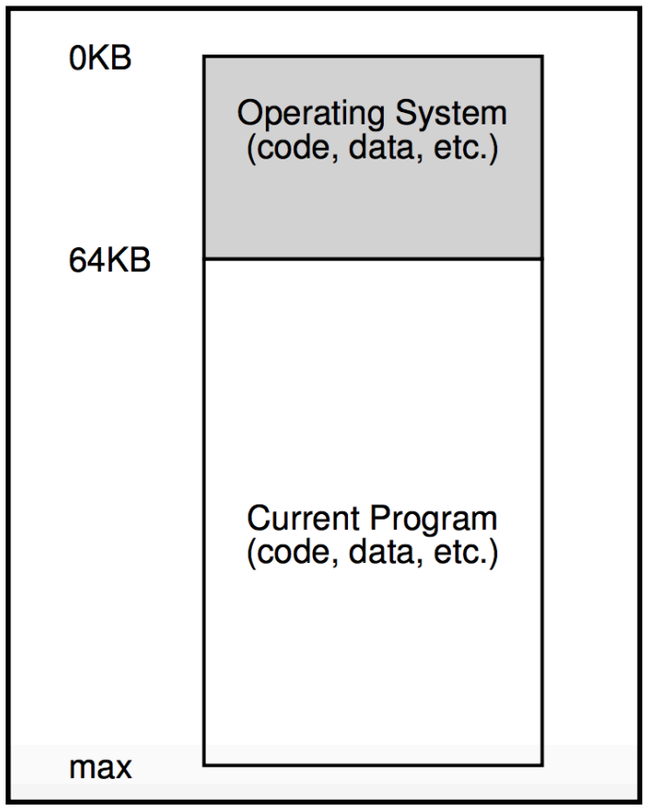
Memory Virtualisation



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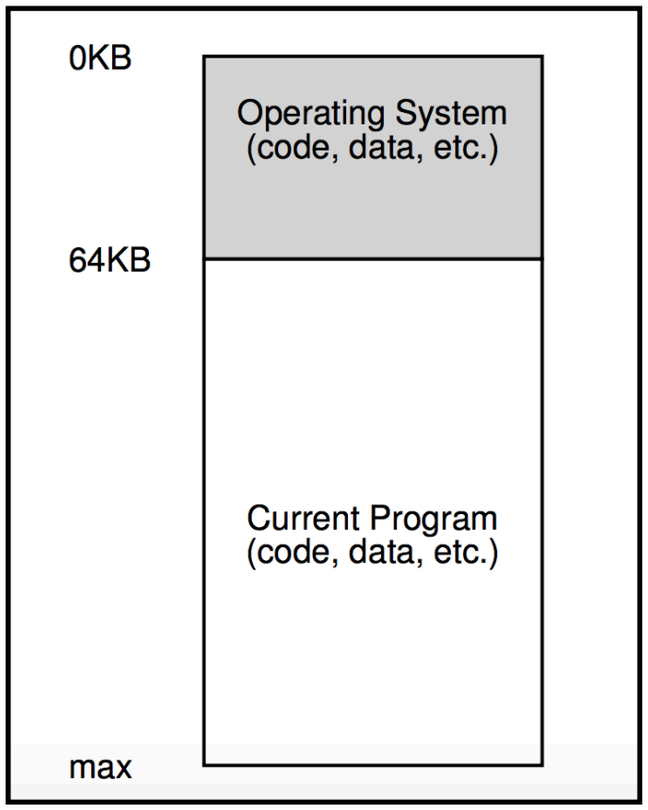
Memory Virtualisation



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- Single program takes total memory
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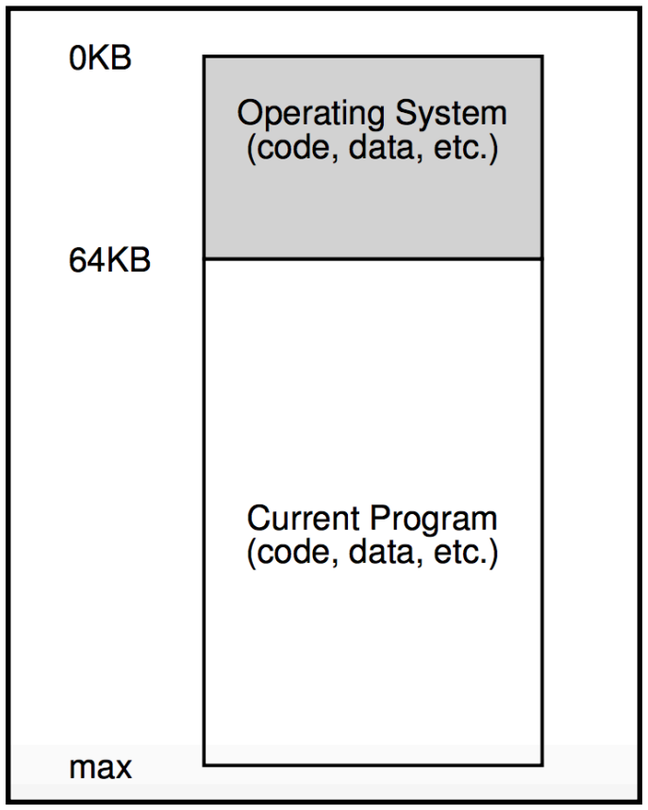
Memory Virtualisation



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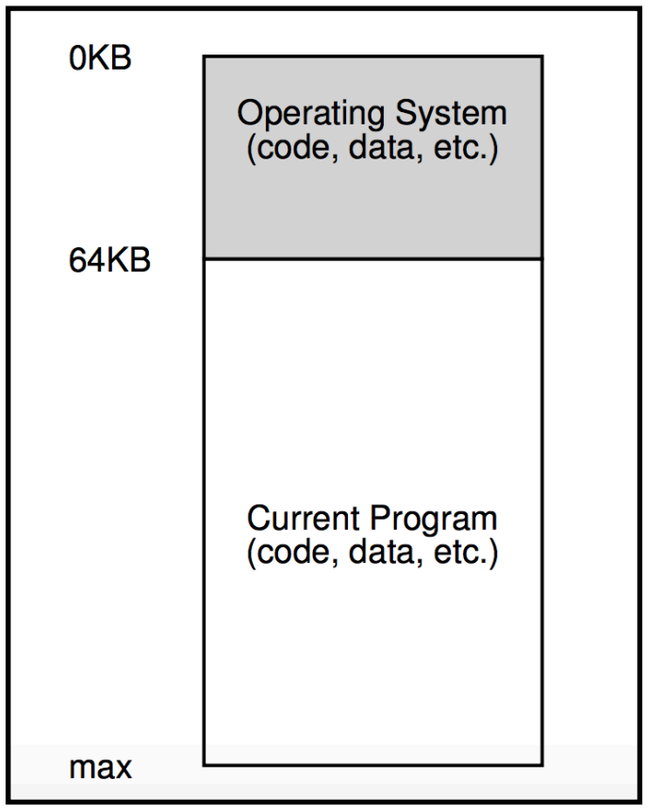

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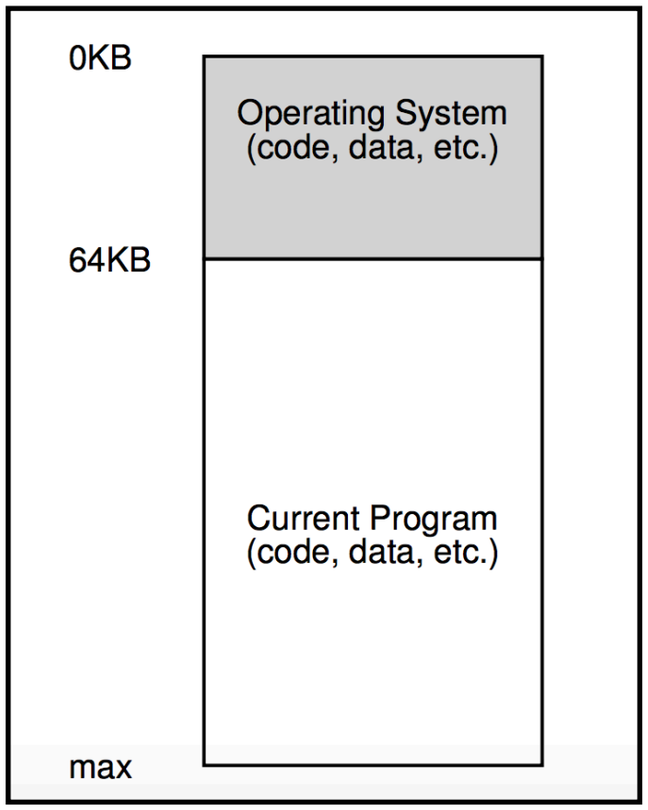

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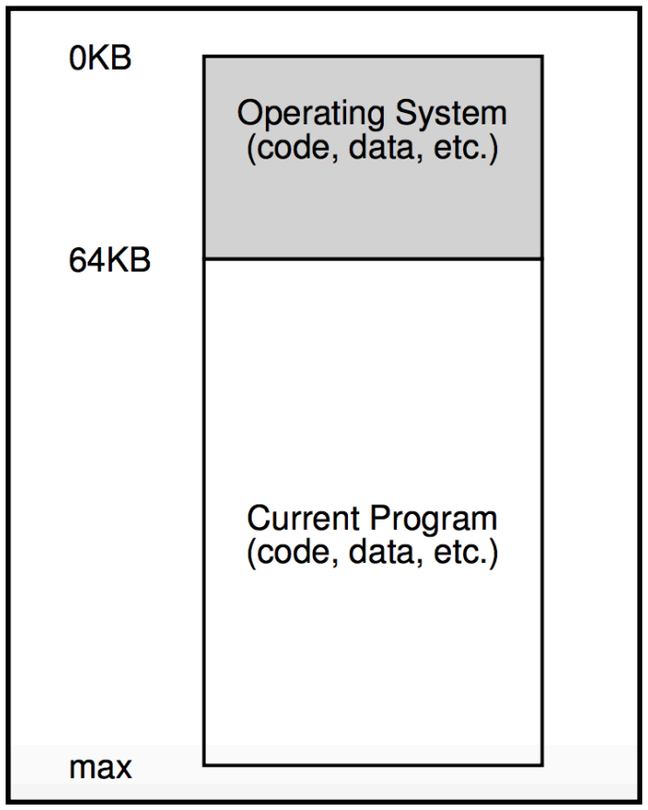

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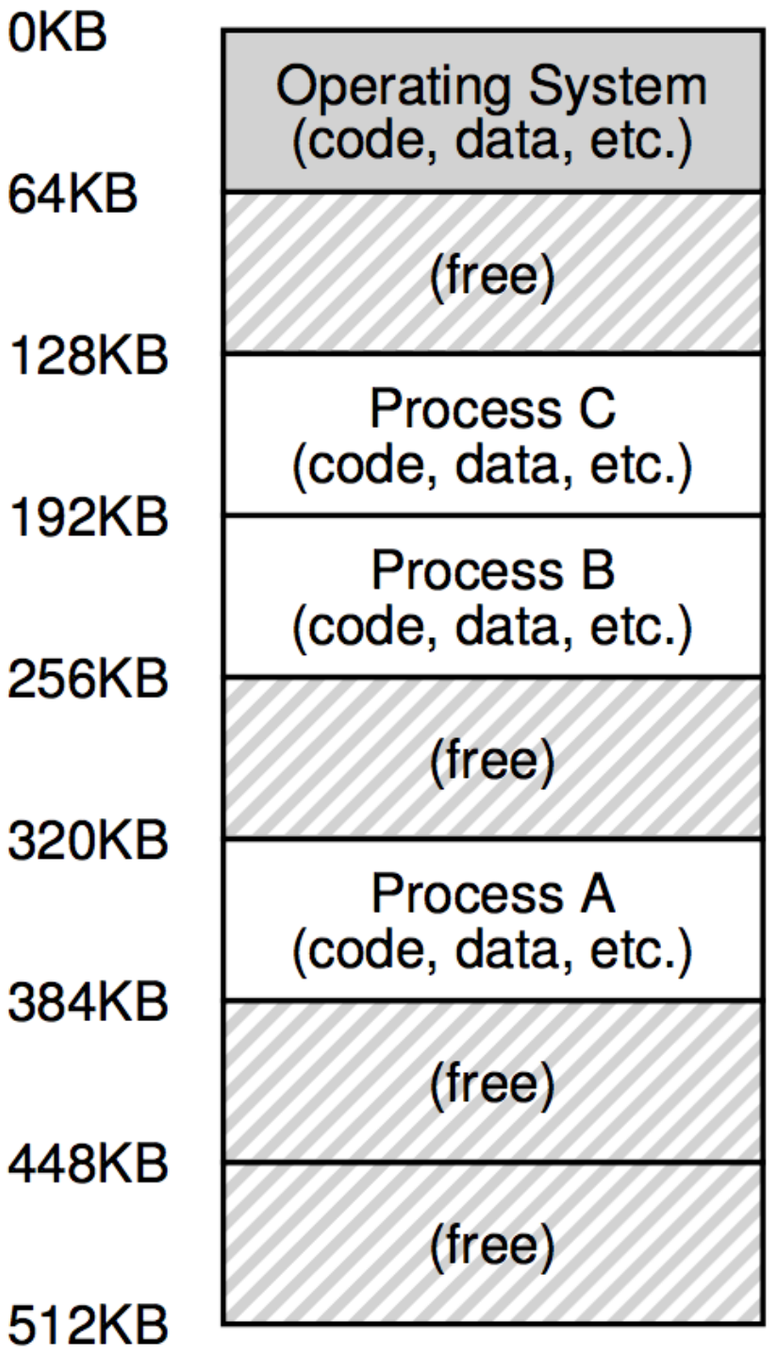
Shared Memory



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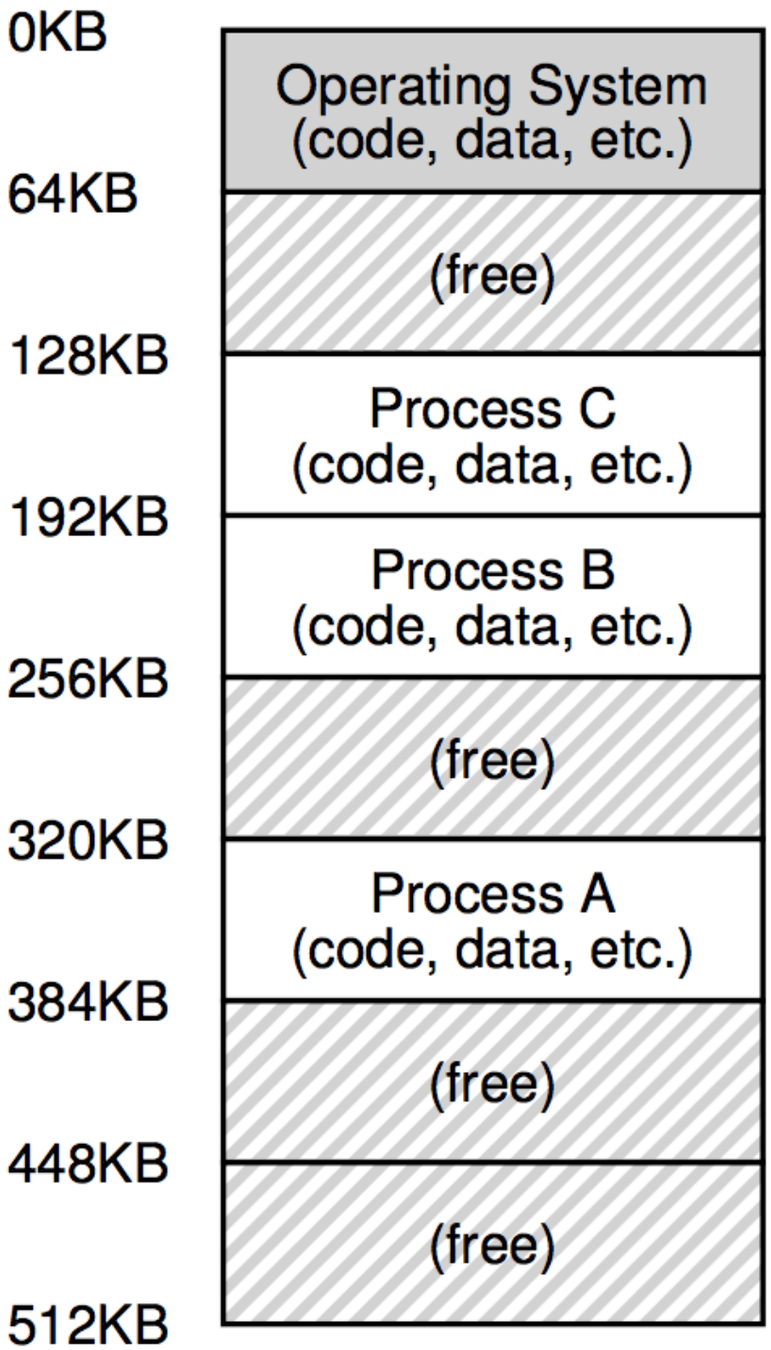
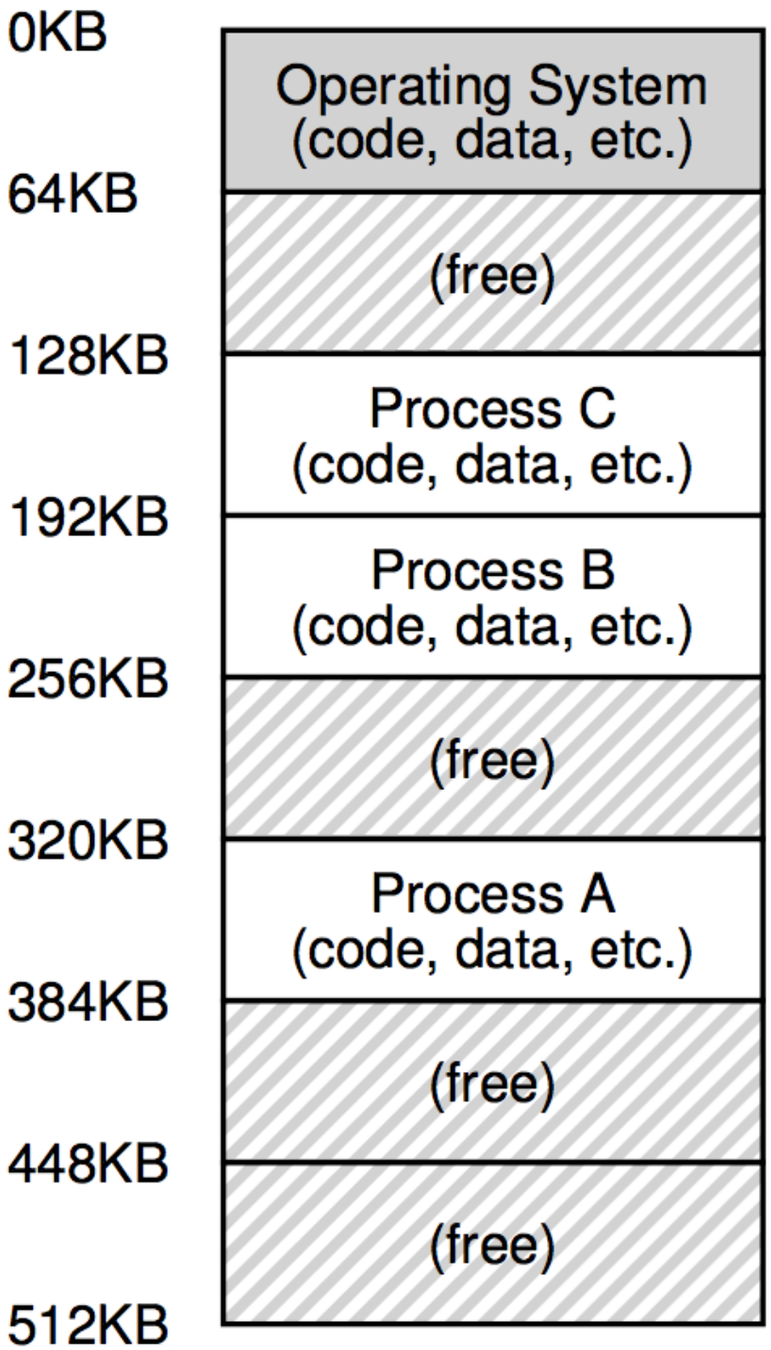


Risk

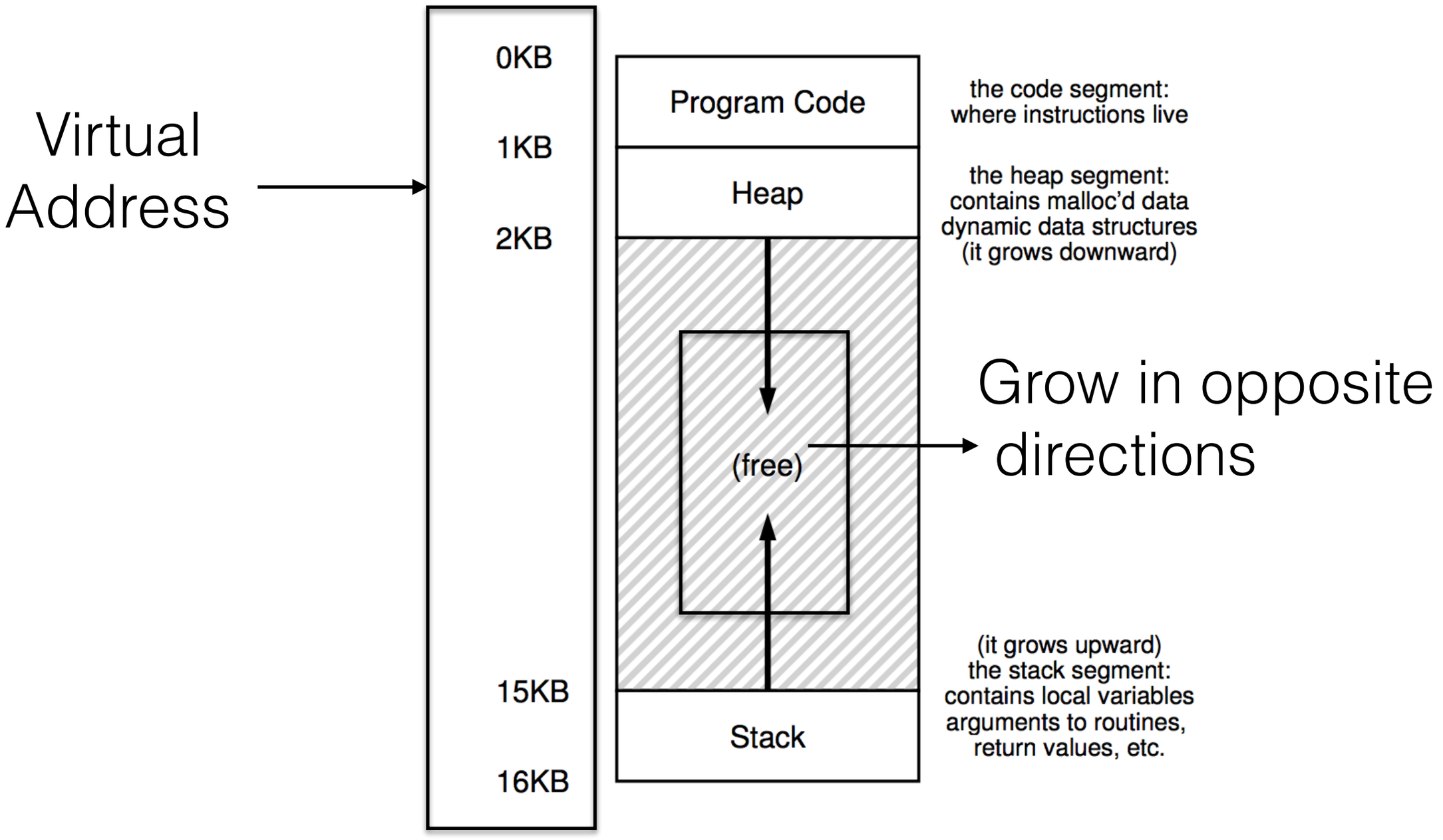
Shared Memory



Risk

- Programs accessing others' memory

Address Space



Goals of OS for Memory Virtualisation

1. Transparency
    1. Virtual memory is invisible to user program
    2. Program thinks it has own private large memory
2. Efficiency
    1. Not taking very long
    2. Not taking too much space
3. Protection/Isolation
    1. Protect processes from each other