K22 – Operating Systems: Design Principles and Internals

Fall 2025 @dit

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Lecture 02

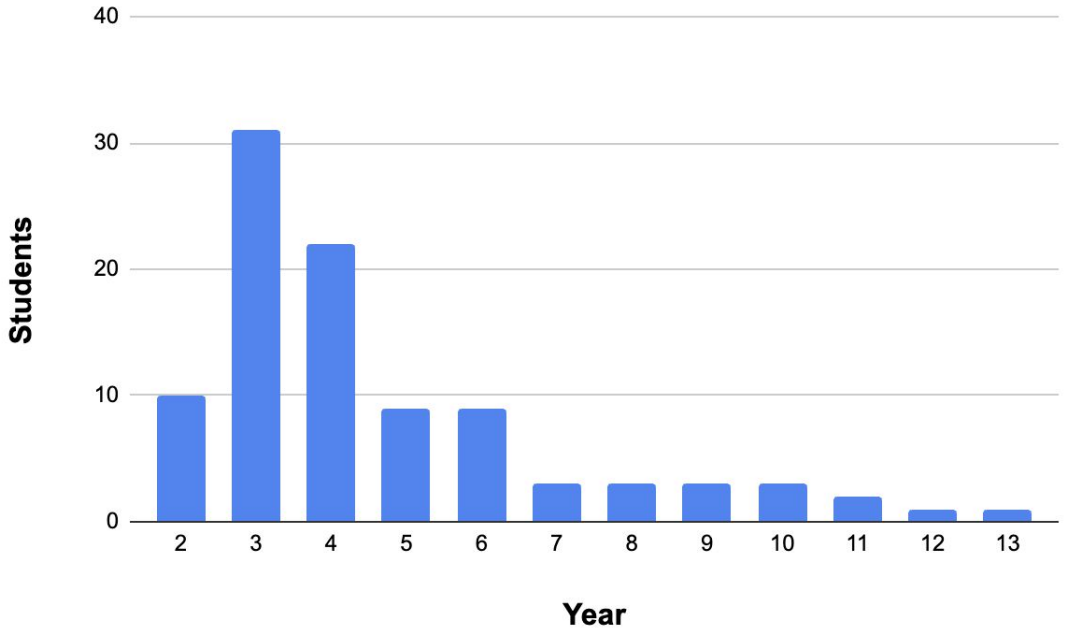
References: Similar OS courses @Columbia, @Stanford, @UC San Diego, @Brown, @di (previous years); and textbooks: Operating Systems: Three Easy Pieces, Operating Systems: Principles and Practice, Operating System Concepts, Linux Kernel Development, Understanding the Linux Kernel

Administrivia

- Register to eclass ASAP
  - Use your sdixxx@di.uoa.gr email (not gmail)
  - The registration will **not** remain open forever

Administrivia

- Where we are today? ~100 ppl.



Administrivia

- **Homework bonus (+0.5 / 10)**
  - +5%, if all homeworks submitted on time
  - +3.75%, if three homeworks submitted on time
  - +2.5%, if two homeworks submitted on time
  - +1.25%, if one homework submitted on time
- **Class attendance (+0.5 / 10)**
  - We' ll see how you get that…
- **Minimum grade requirements**
  - At least the base at final exam

Summary so far

- **Introduction (7/10)**
  - Q1: What is a OS?
  - Q2: Why do we need an OS?
  - Q3: Desirable properties for an OS?
  - Q4: Hardware model?
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What is an OS?

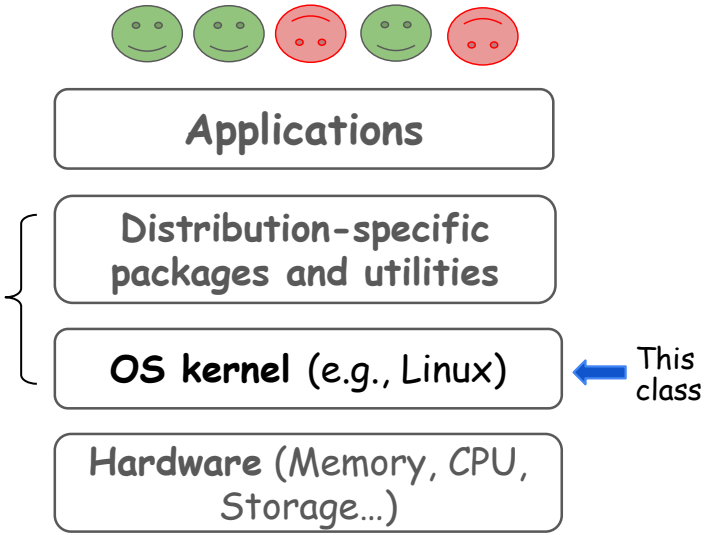
- A layer of abstraction that translates the hardware of a machine into (standardized) software concepts that applications use

Why need an OS?

- Multiple users not necessarily sane, build and run different applications, at the same time on shared hardware (design assumptions)

Desirable properties?

- ***Security***: Does the system behave as expected in adversarial contexts?
- ***Reliability***: Does the system behave as expected given benign failures?
- ***Portability***: Is it easy for developers to build and maintain apps?
- ***Fairness***: Is the system "pleasant" to use?



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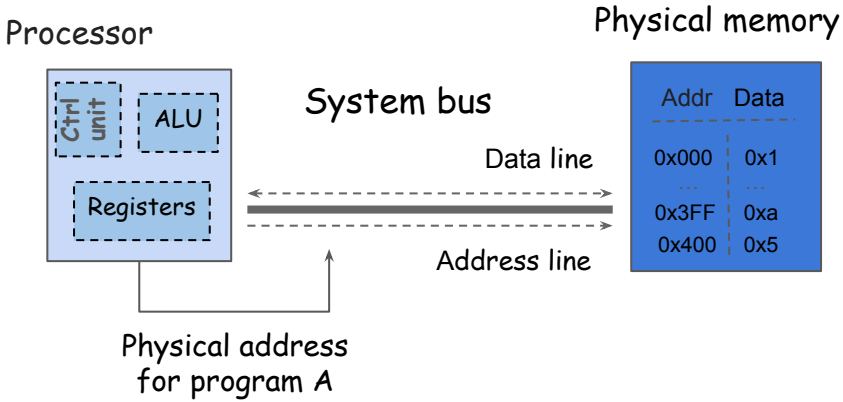
What is the hardware we build OSes for?



- **Physical Memory (PM)**
  - Stores data addressable on a byte granularity
- **Processor**
  - Reads data from memory to its registers
  - Performs computations
  - Writes the data from its registers to memory
- **System bus**
  - Memory and processor communication channel
- Is this model satisfactory?
- Reminds you of something?

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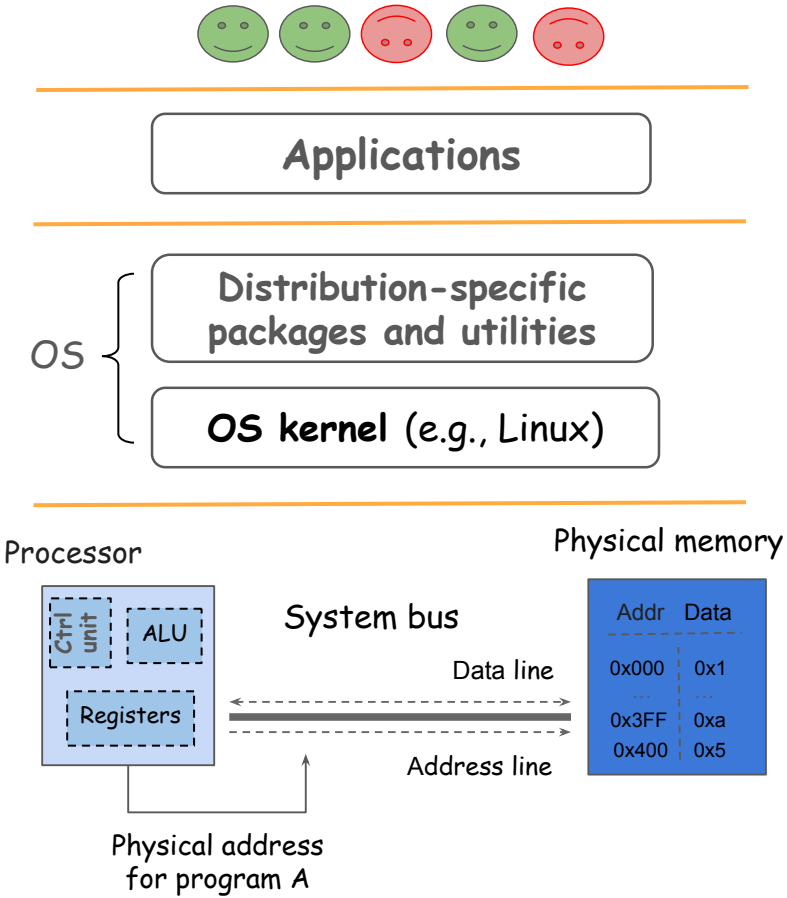
Designing an OS kernel

Desirable properties

1) Security, 2) Reliability, 3) Portability, 4) Fairness

From desirable properties to design principles

- ***Fault Isolation***: Errors in one running program do not affect any other program
- ***Principle of Least Privilege (PoLP)***: Any program has the minimum privileges necessary to perform its function
- ***Preemption***: The OS is always able to take control of the processor, regardless of what programs are running



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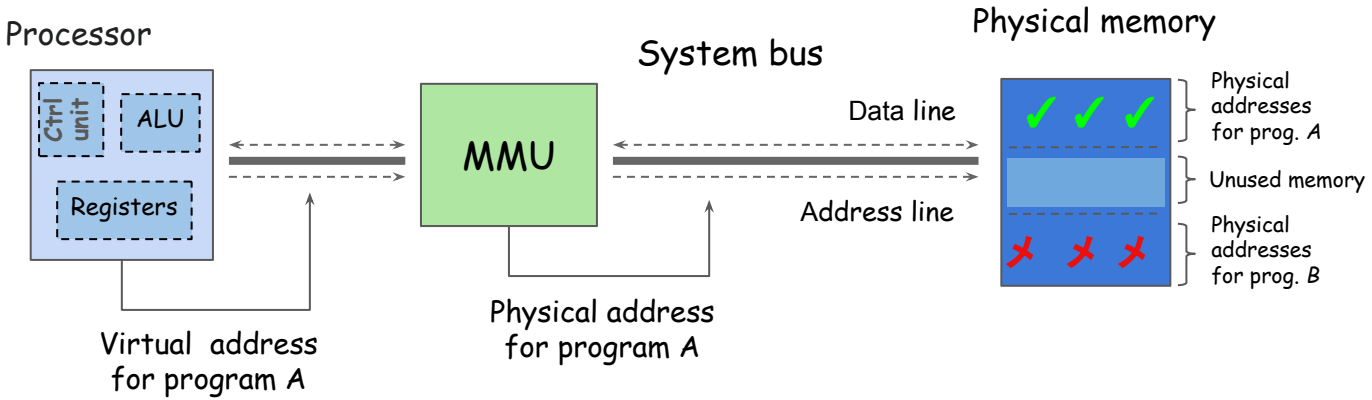
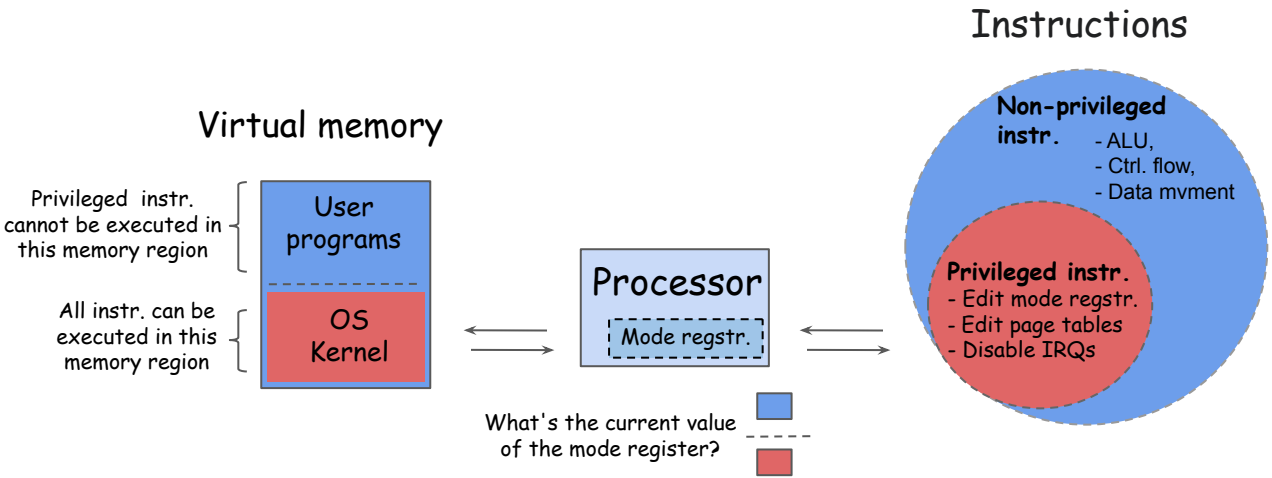
Implementing fault isolation

- In simple words: load/ store/ jmp instructions of a program cannot read, write, or jump to another program's memory



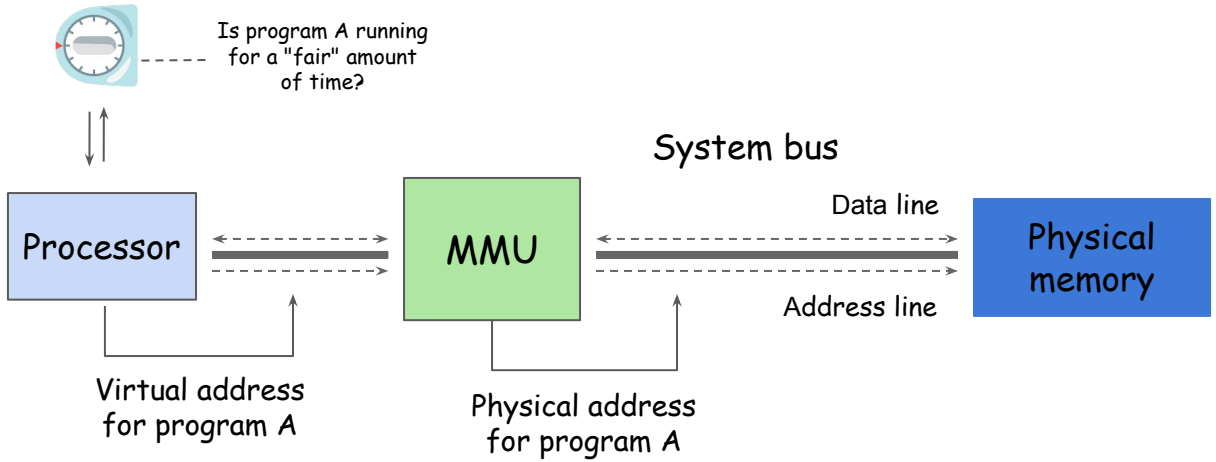
Implementing dual-mode execution

- In simple words: A trusted portion of the code (the OS) must have full control of the hardware



Implementing preemption

- In simple words: The OS should be able to periodically gain control of the processor regardless of what programs are executing



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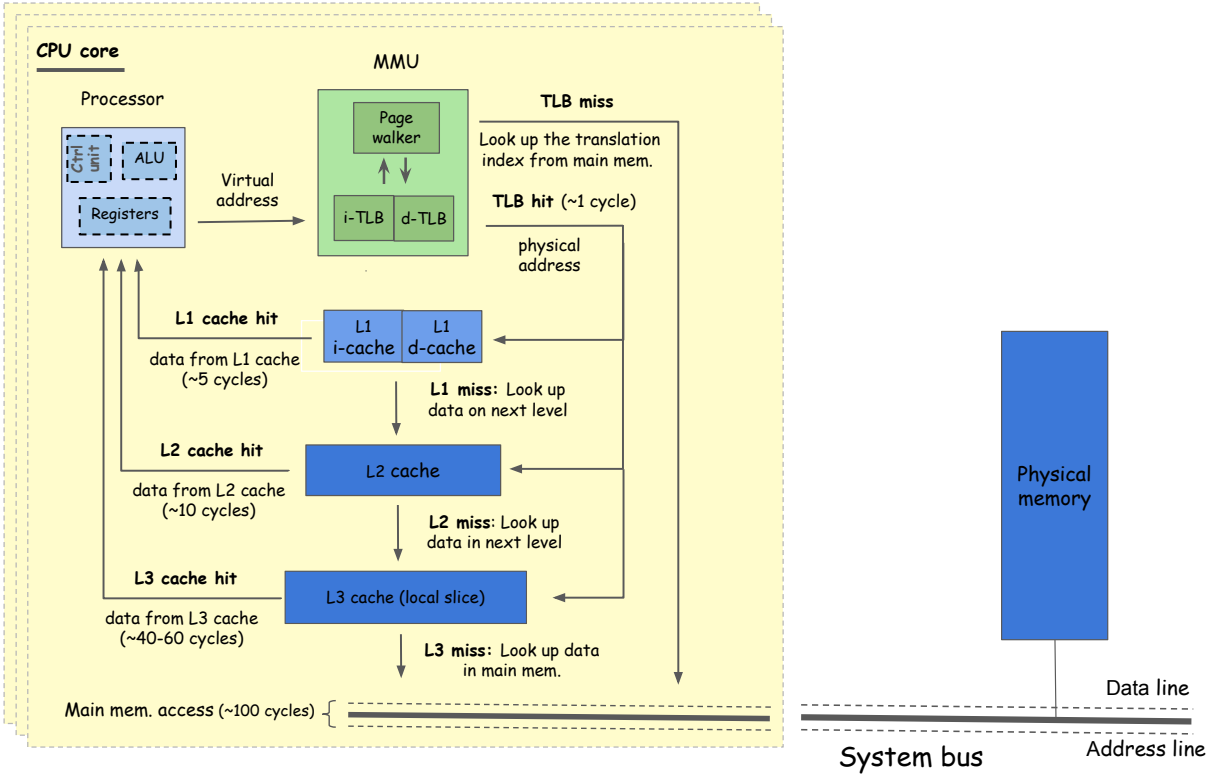
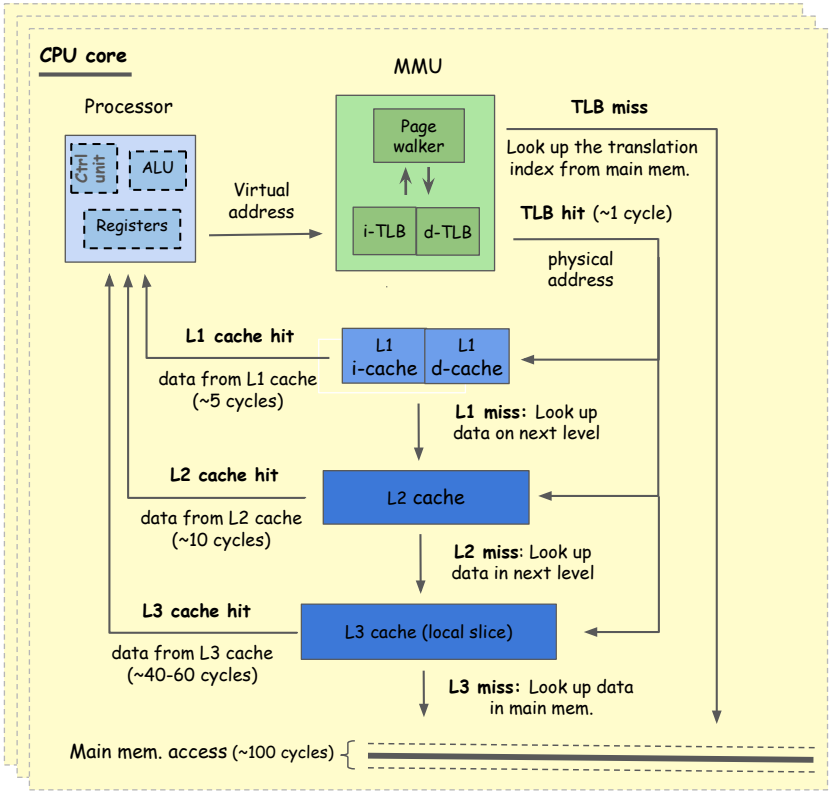
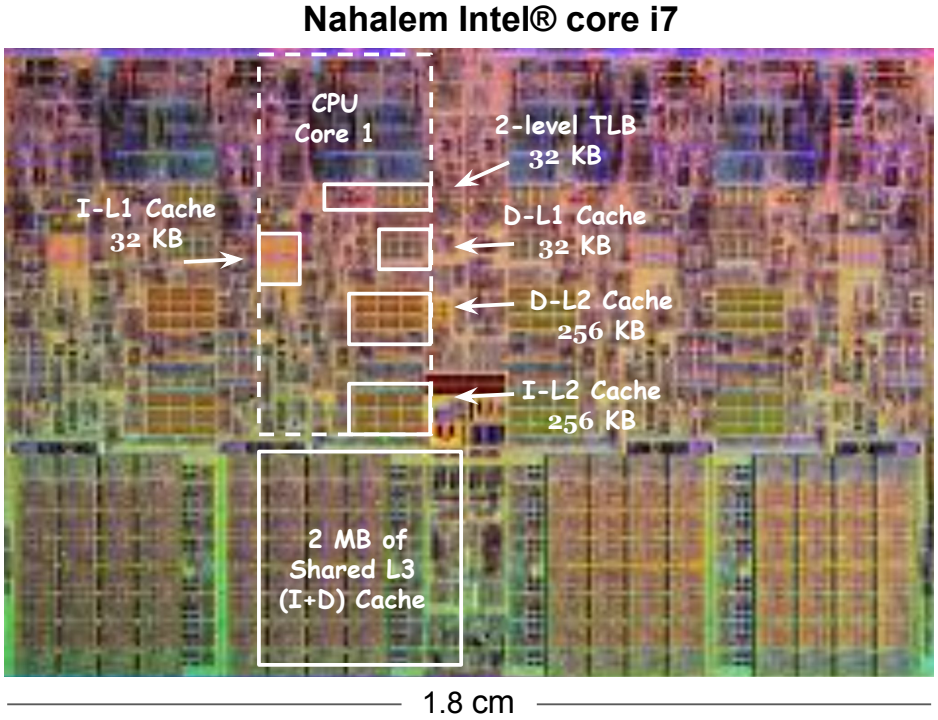
Hardware components leveraged by OS mechanisms



Reality check on hardware's scale and access times





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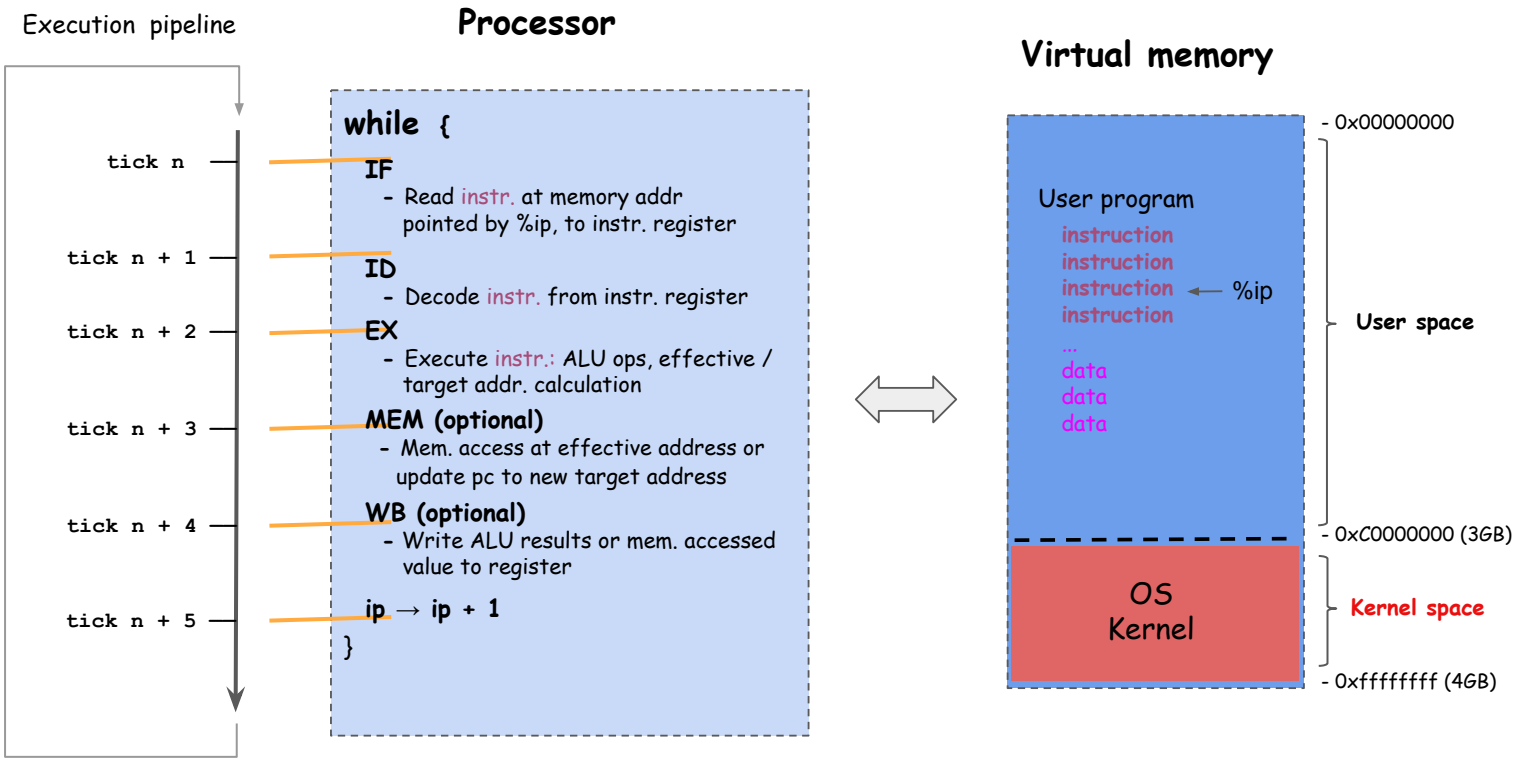
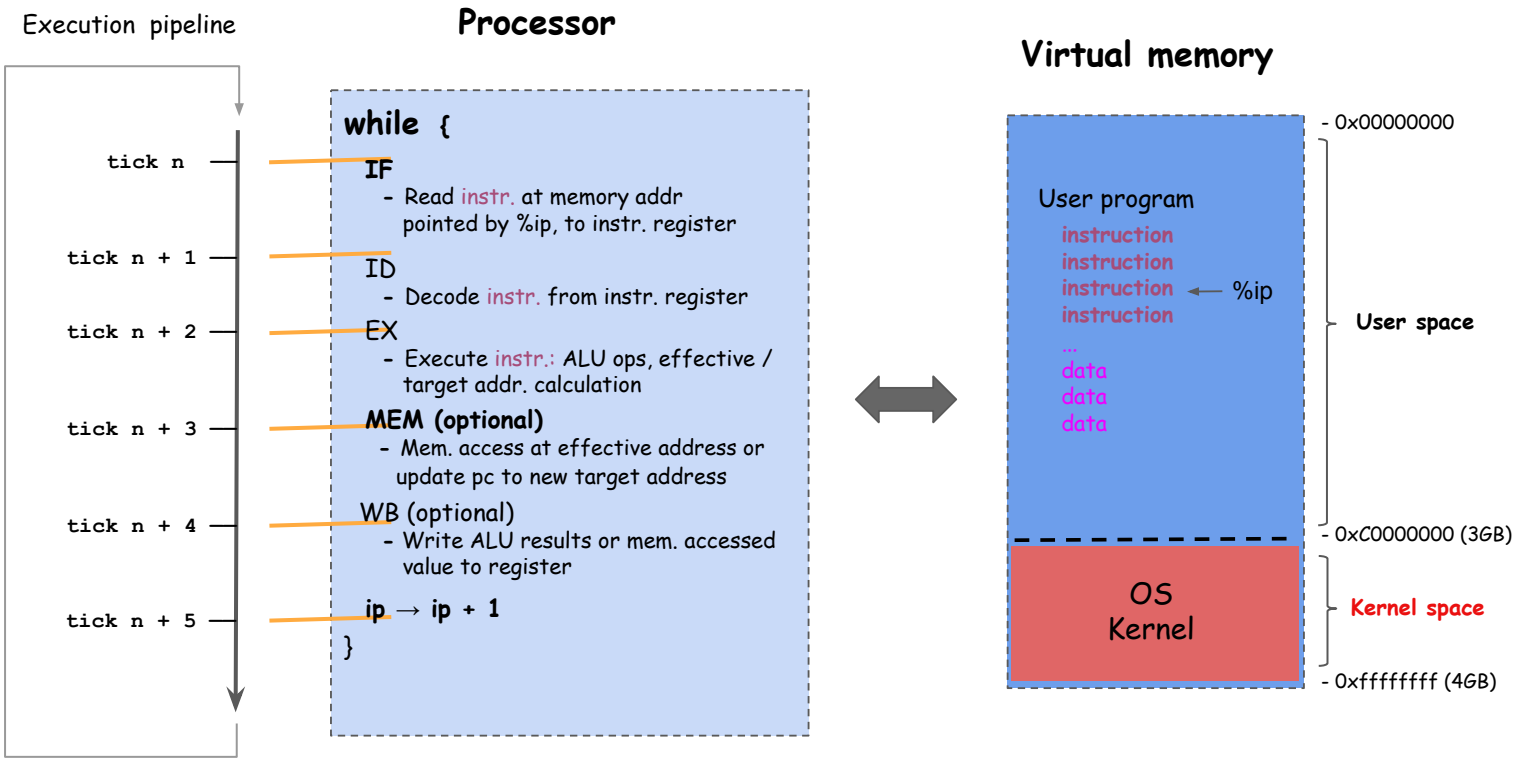
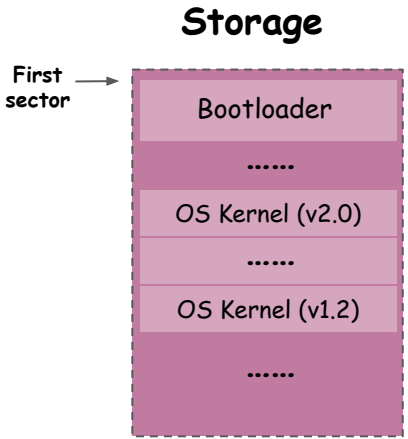
How does the processor execute programs?



When may the processor access memory?



How does the system boot?



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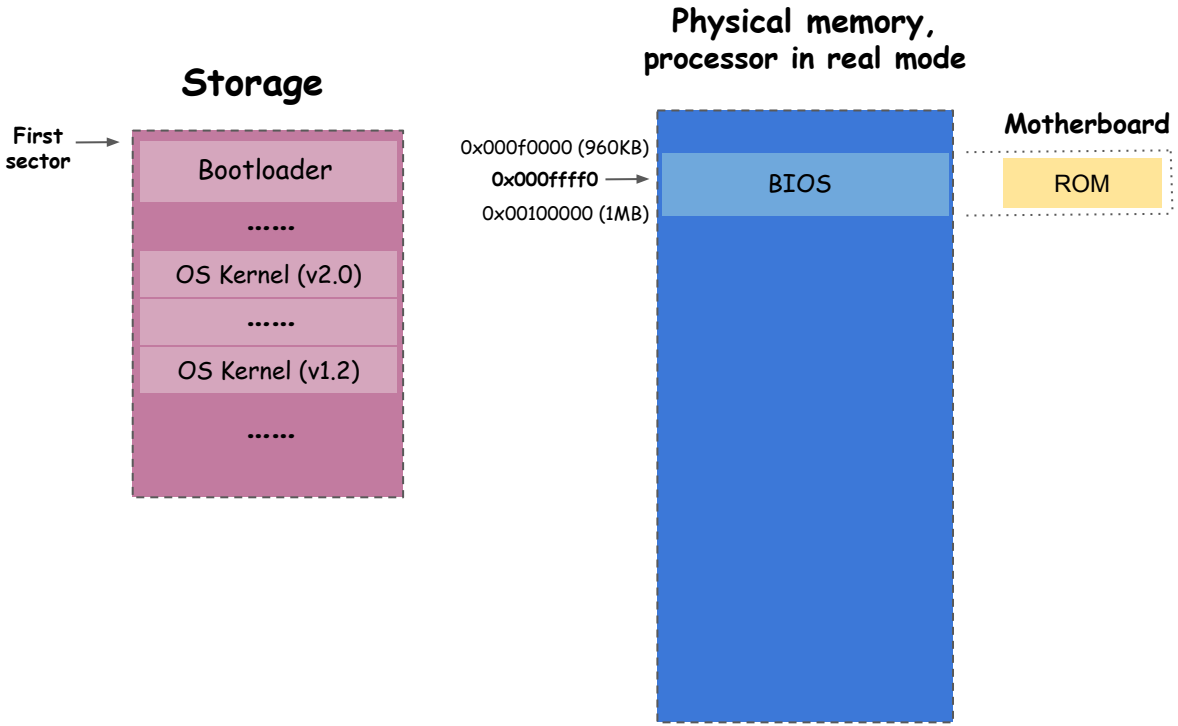

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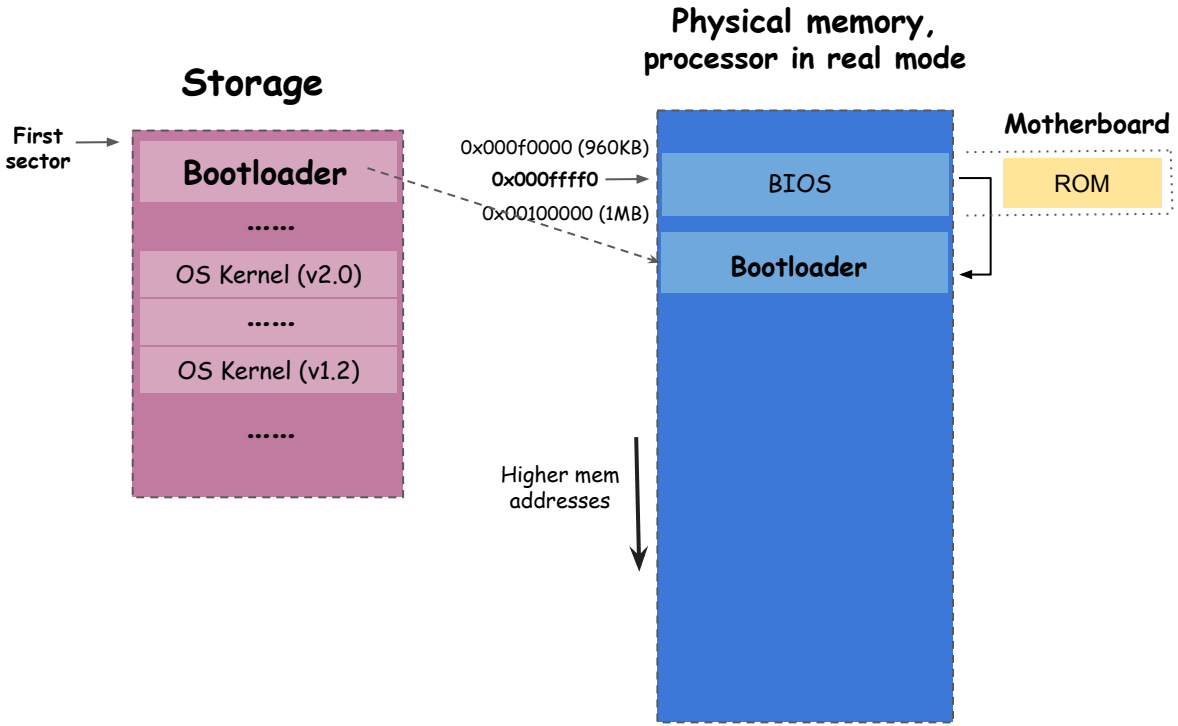

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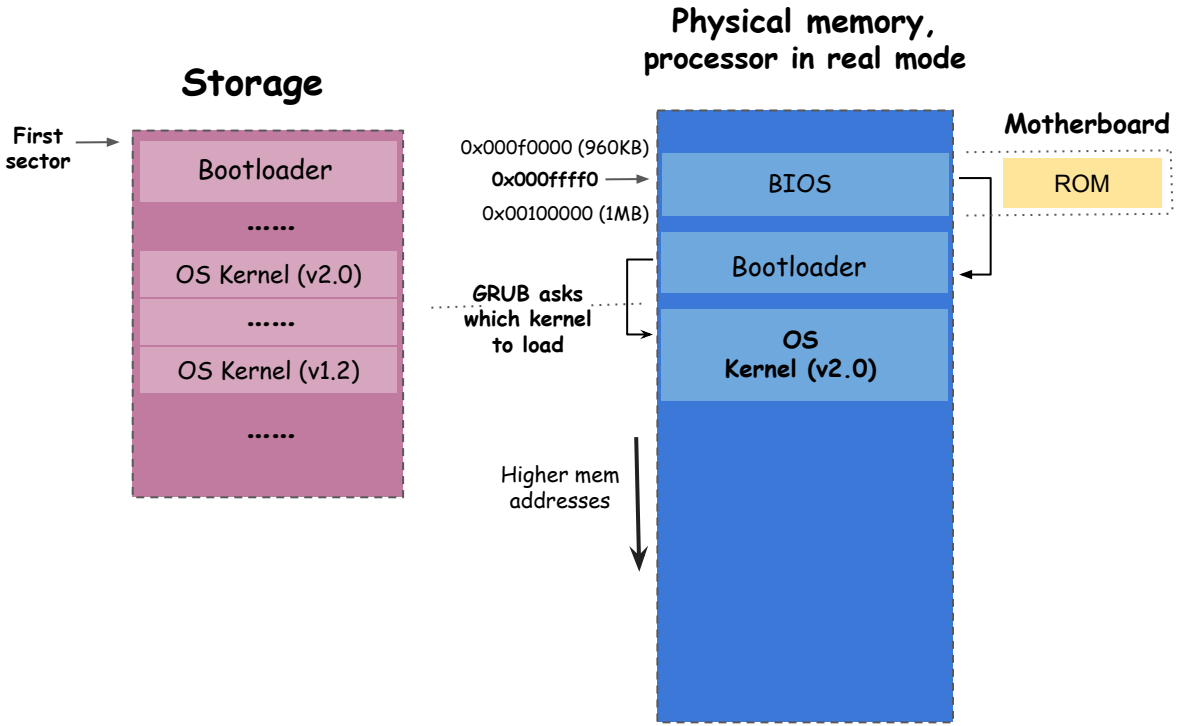

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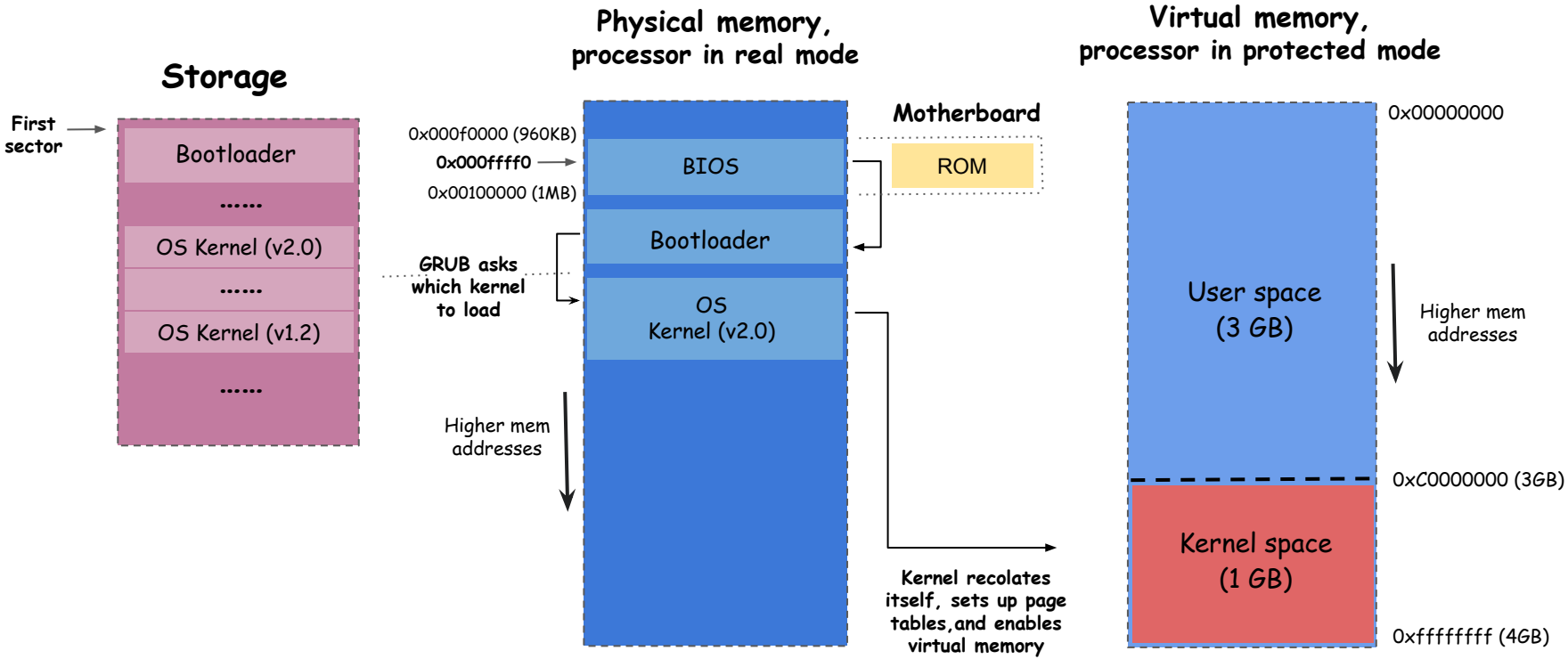

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  - Q8: Reality check on hardware's scale and access times?
  - Q9: How does the processor execute programs?
  - Q10: How does the system boot?