Architecture Overview

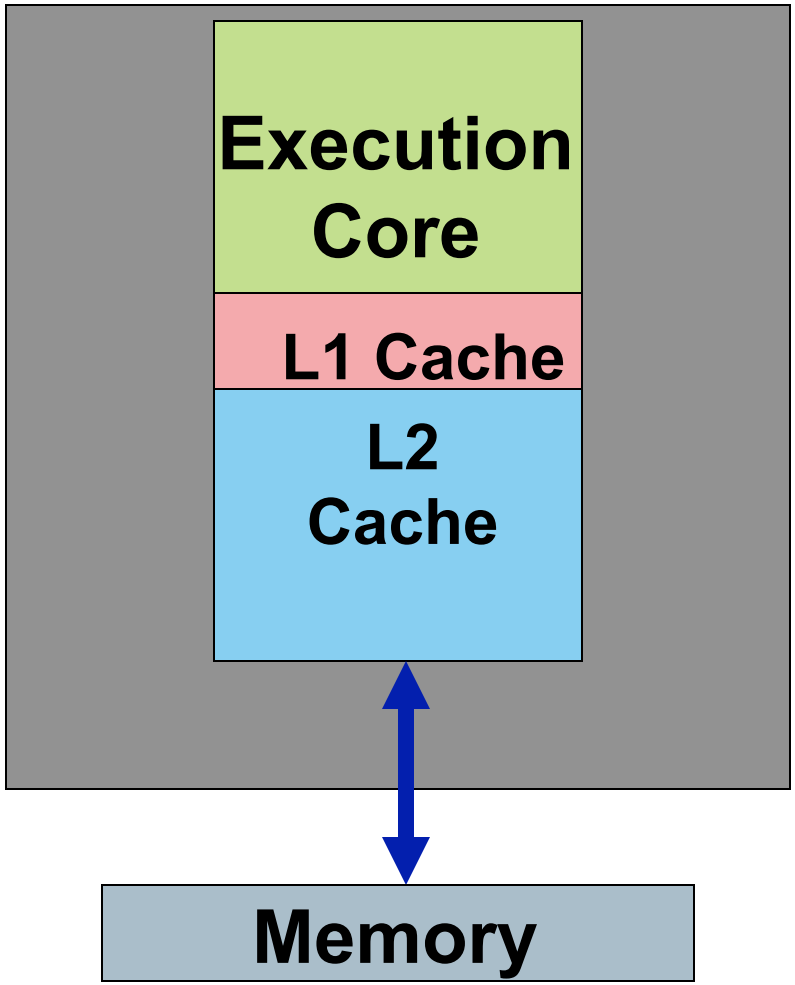
- Topics
  - Processors, cores, and threads
  - Hardware architectures
- Learning Objectives:
  - Explain the different ways in which parallelism emerges on today's hardware platforms.
  - Explain the difference between a thread context, a core and a processor.

Uniprogramming vs Multiprogramming

- Uniprogramming: a system runs only one "thing" (process or program) at a time.
  - MS-DOS
  - Old-batch systems
- Multiprogramming: a system that appears to run multiple "things" at once.
  - Also called multitasking.
  - Multiple programs run concurrently, even if there is only one program is running at a given instant.
- Multiprocessing: True concurrency
  - The hardware is actually capable of running things simultaneously, because it has multiple processing elements (intentionally ambiguous, to be defined later).
- Contrast:
  - Multiprogramming/multitasking refer to the number of programs running.
  - Multiprocessing refers to there being more than one processing element in the system (historically multiple processors; today multiple cores or multiple [hardware] threads)

Architecture 101 (1)

- Your basic processor:
  - 1 Chip
  - 1 Execution Core
  - 1 L1 Cache
  - 1 L2 Cache
  - 1 Memory

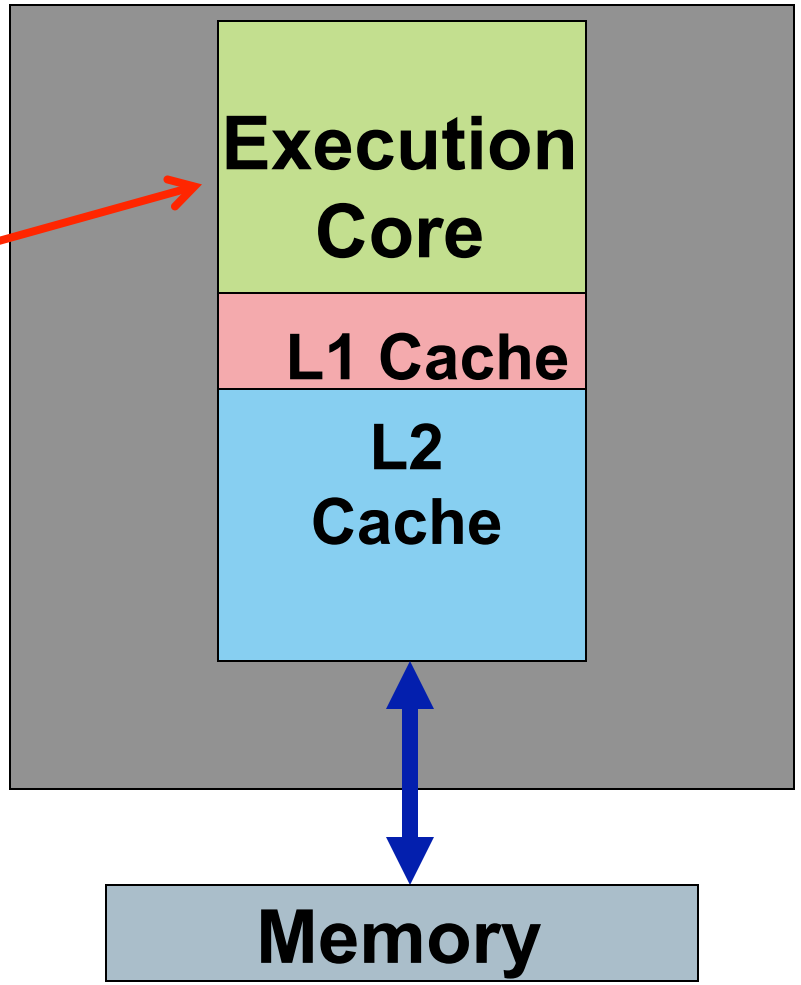


Architecture 101 (2)

Registers
- General purpose
- Program counter
- Stack Pointer

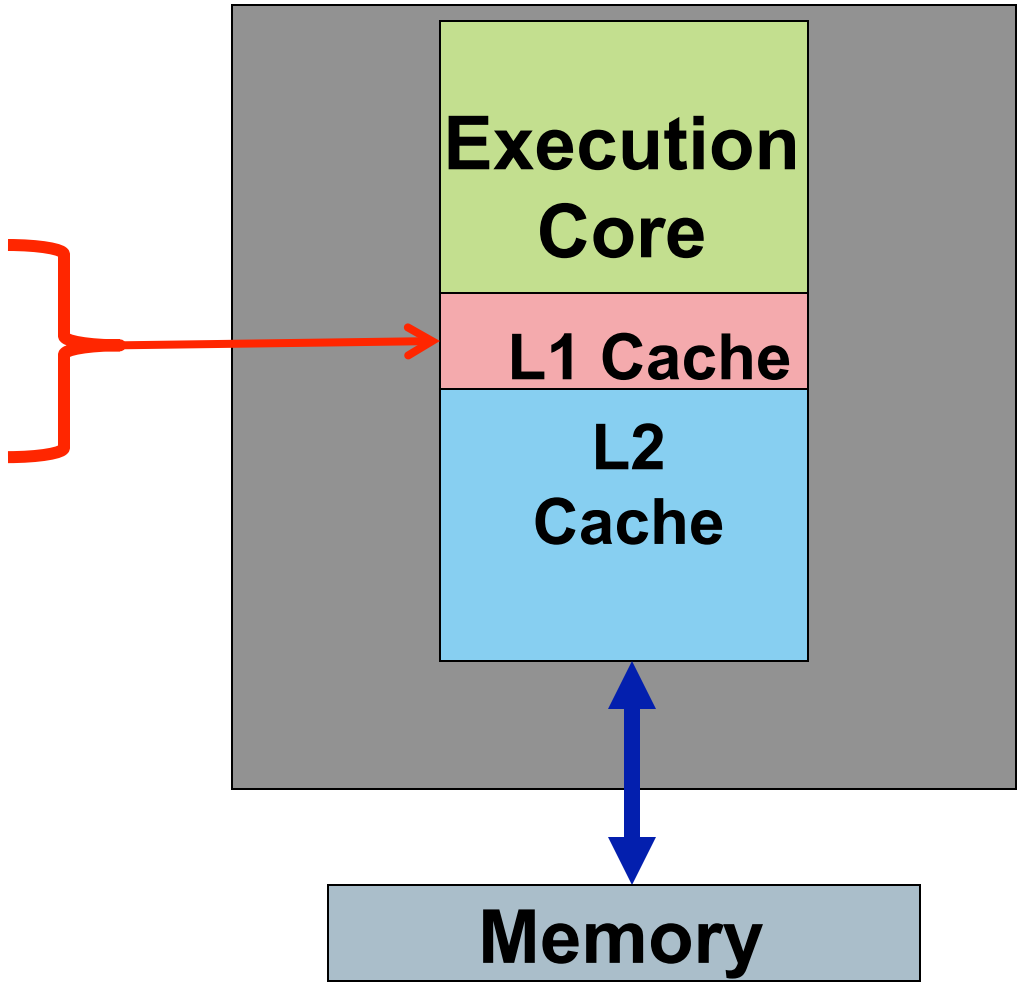
Arithmetic Logic Unit (ALU)
- Adder
- Multiplier

Floating Point Unit FPU
- (optional)



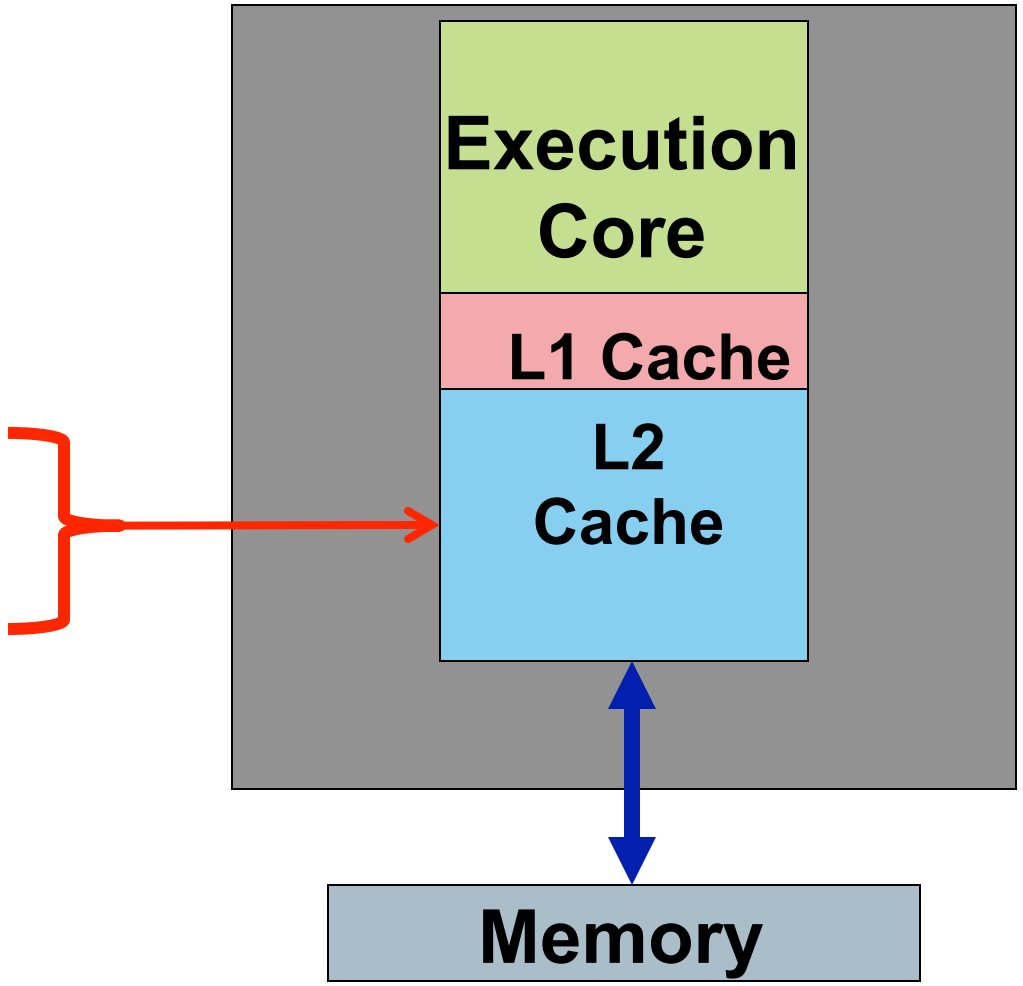
Architecture 101 (3)

Really fast memory.
~4 CPU cycles
Typically a few tens of KB.

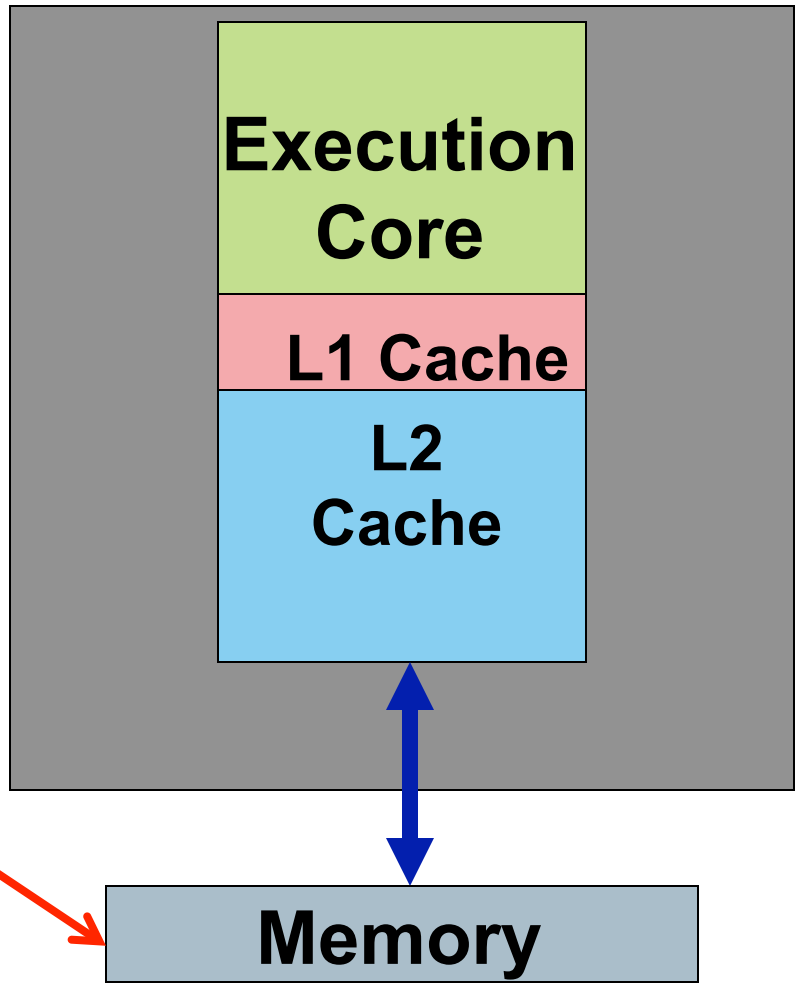


Architecture 101 (4)

Fast memory.
~10 CPU cycles.
Typically a few tens of MB.



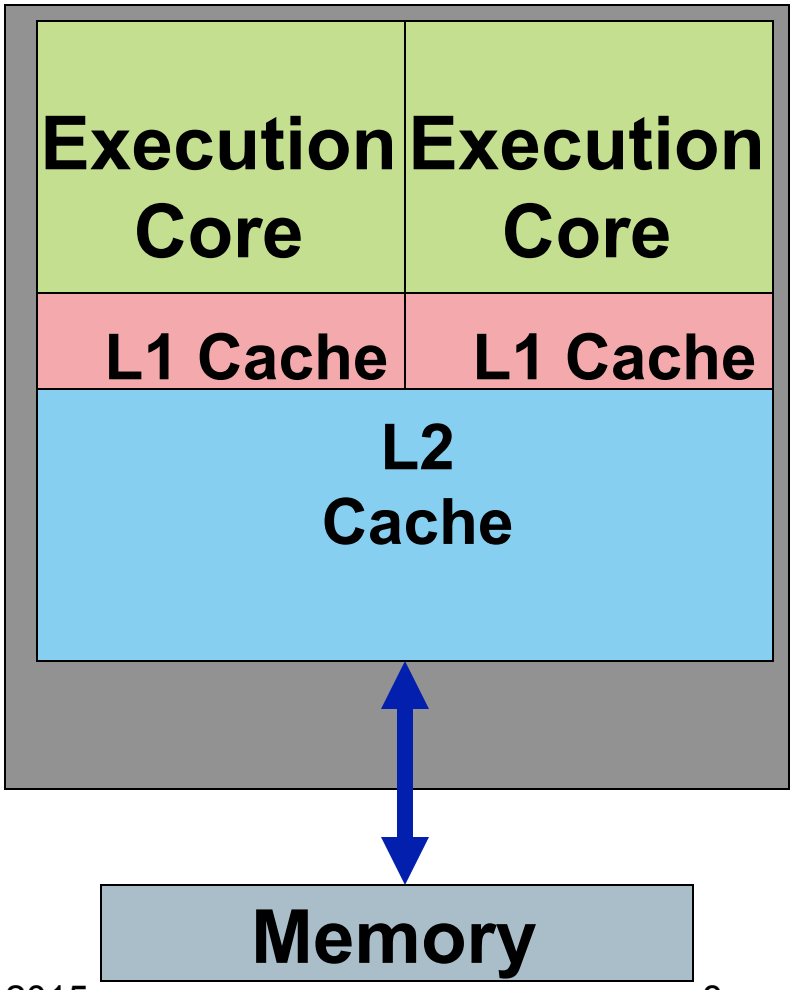
Architecture 101 (5)



Main memory.
~40-60 cycles
Typically several to many GB.

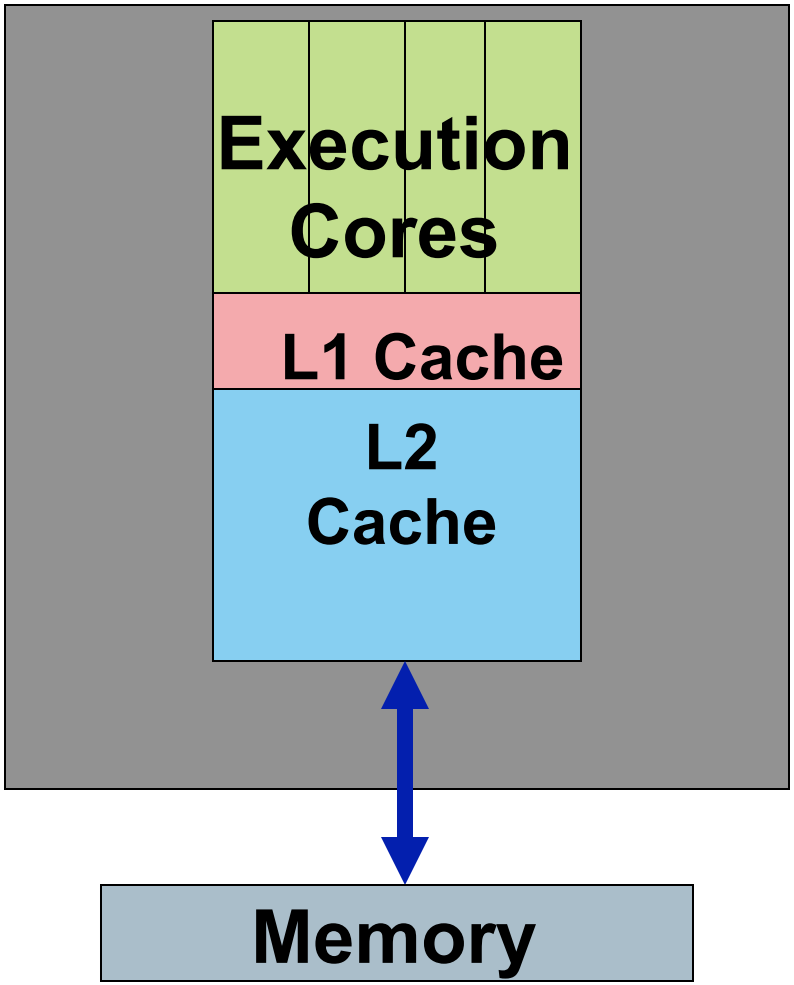
Architecture 101 (6)

- Multicore:
  - 1 chip
  - Multiple execution cores
  - Multiple L1 caches
  - Single L2 Cache
  - 1 Memory



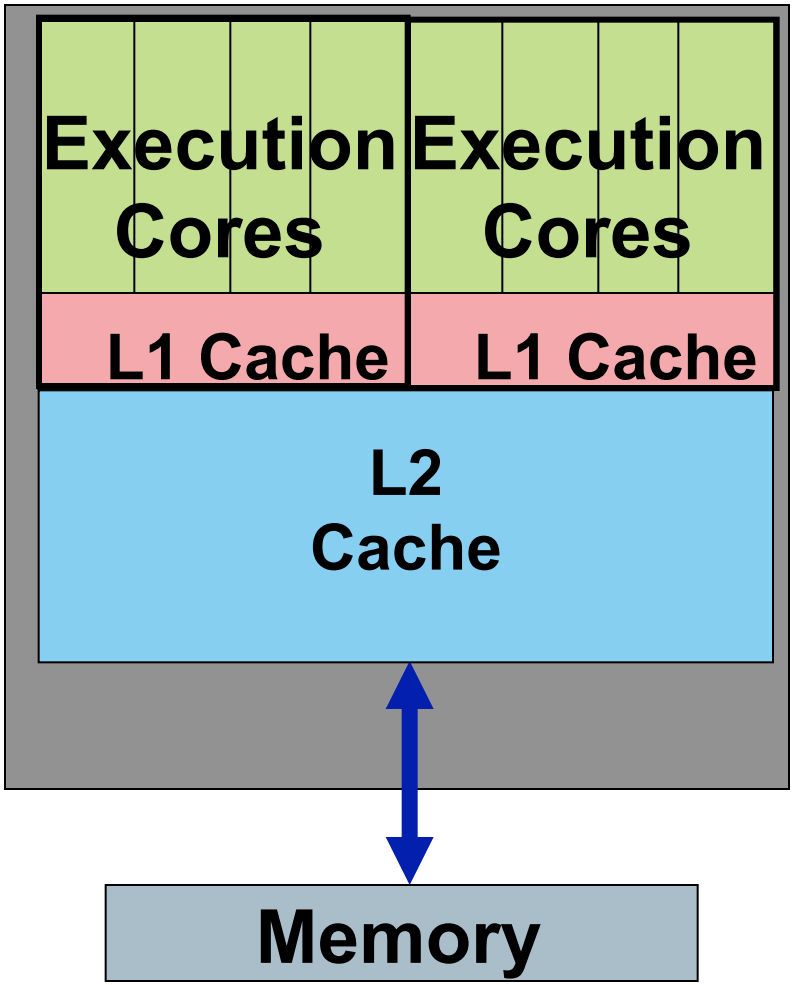
Architecture 101 (7)

- Multithreading
  - Hyperthreading
  - 1 Chip
  - Multiple execution cores
  - 1 L1 Cache
  - 1 L2 Cache
  - 1 Memory



Architecture 101 (8)

- Multithread/Multicore
  - 1 Chip
  - Multiple cores
  - Multiple L1 caches (1per core)
  - Multiple execution contexts per core
  - 1 L2 Cache
  - 1 Memory



Architecture 101 (9)

- Modern Multiprocessor
  - Multiple chips
  - Multiple cores per chip
  - Multiple threads per core
  - L1 Cache/core
  - L2 Cache/chip
  - Shared memory
- Sys/161
  - Not multithreaded
  - Does not distinguish cores from processors
  - Think of as N-way single-core, multiprocessors