EE-222: Microprocessor Systems

Course Introduction
&
Logistics

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NUST

SCHOOL OF ELECTRICAL ENGINEERING &
COMPUTER SCIENCE (SEECS)

Slides Credit: Dr. Rehan Ahmad

Why Do We Have Computers?

Why Do We Do Computing?

Why Do We Have Computers?

To Solve Problems …

Why Do We Do Computing?

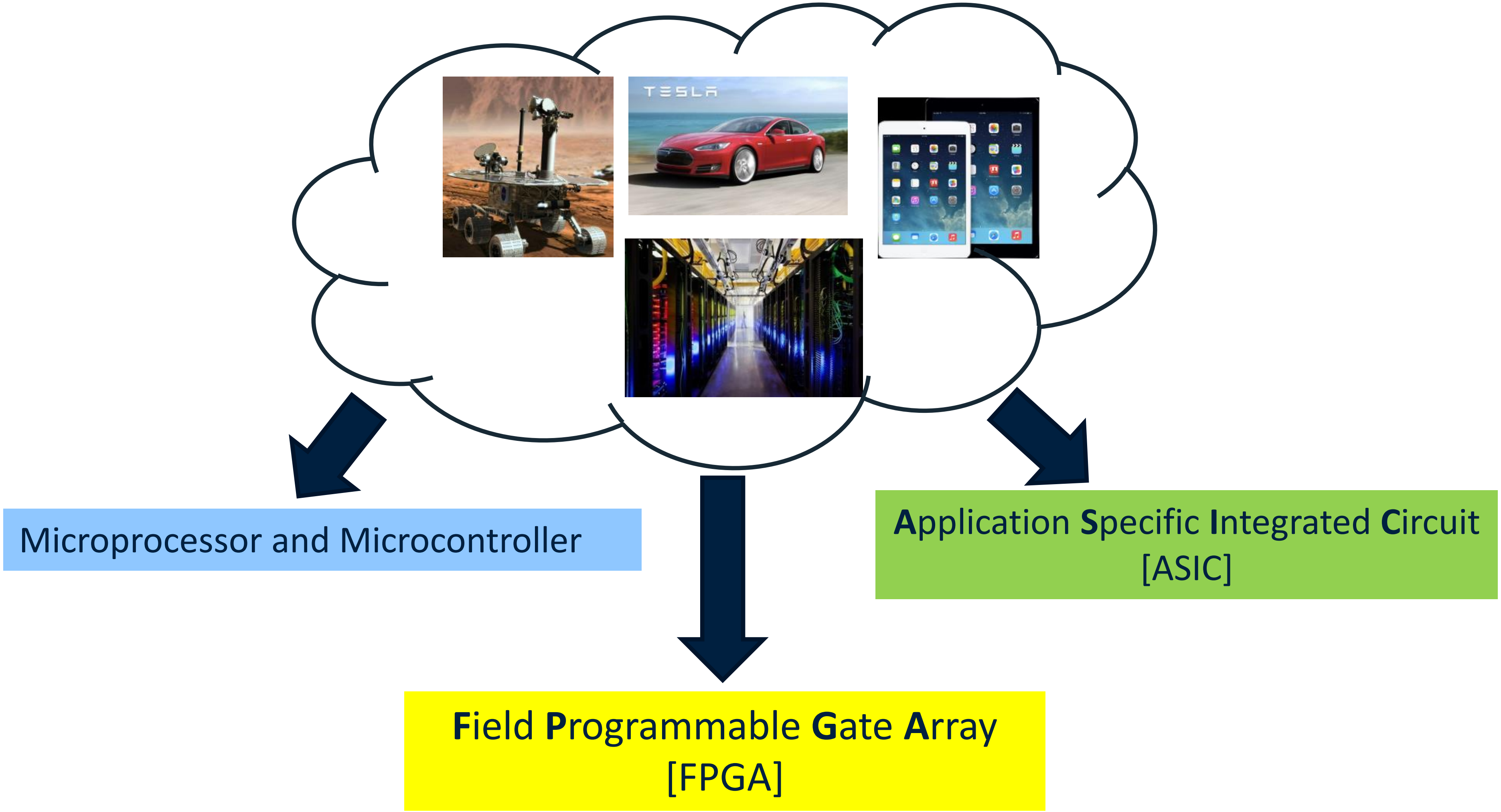
To Gain Insight …

Why Do We Have Computers?

Why Do We Do Computing?

Overall, To Enable a Better Life and Future

Target Computing Platforms for Digital Systems



Microprocessor and Microcontroller

Application **S**pecific **I**ntegrated **C**ircuit [ASIC]

Field **P**rogrammable **G**ate **A**rray [FPGA]

Why are there different computing platforms?

Different Platforms, Different Goals

Different Platforms, Different Goals

Slide Crefit: Prof. Onur Mutlu, Source: https://iq.intel.com/5-awesome-uses-for-drone-technology/

Different Platforms, Different Goals

Slide Crefit: Prof. Onur Mutlu, Source: https://taxistartup.com/wp-content/uploads/2015/03/UK-Self-Driving-Cars.jpg

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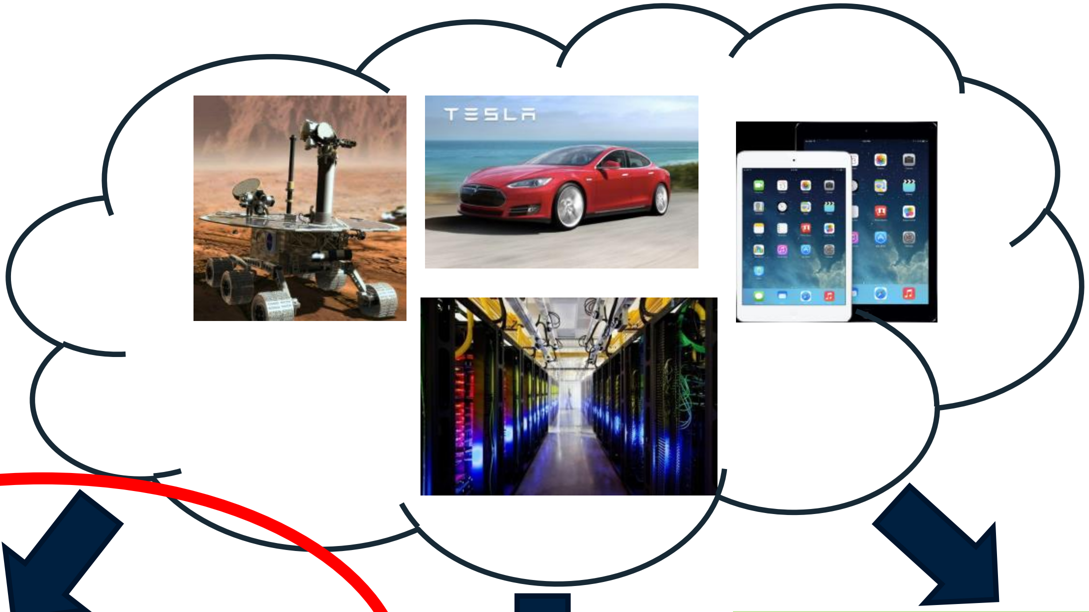
Revisit: Target Computing Platforms for Digital Systems



Microprocessor and Microcontroller
- Flexible: General Workload
- Low Performance

This semester

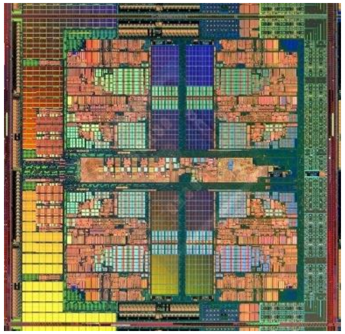
Application **S**pecific **I**ntegrated **C**ircuit [ASIC]
- Fixed: No Hardware Updates
- Low Power
- Expensive to fabricate: >1M$

Field **P**rogrammable **G**ate **A**rray [FPGA]
- Programmable after Fabrication
- Software like Flexibility
- ASIC like Performance

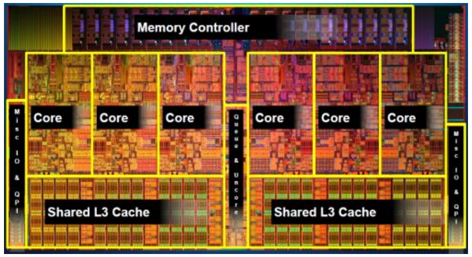
Different Platforms, Different Goals

Microprocessors

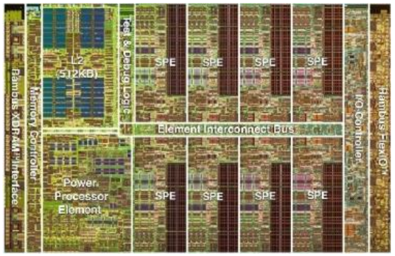
Microprocessor Chips



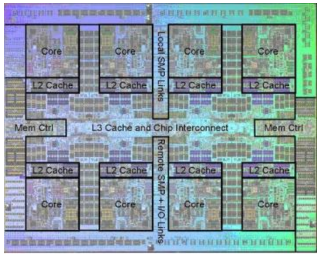
AMD Barcelona
4 cores



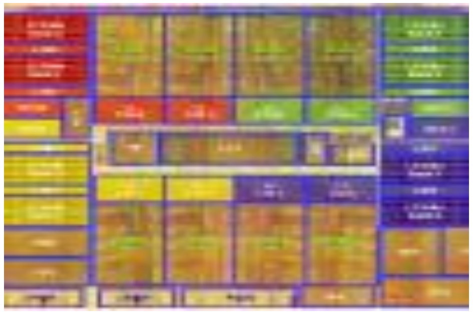
Intel Core i7
8 cores



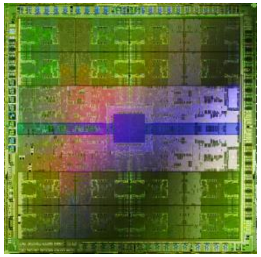
IBM Cell BE
8+1 cores



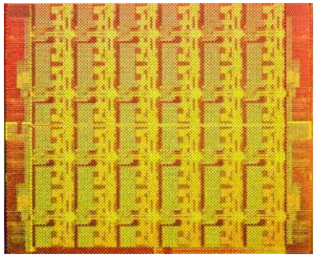
IBM POWER7
8 cores



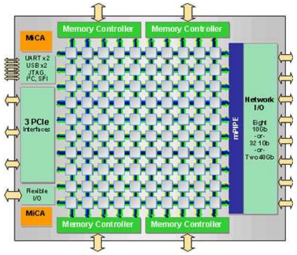
Sun Niagara II
8 cores



Nvidia Fermi
448 “cores”



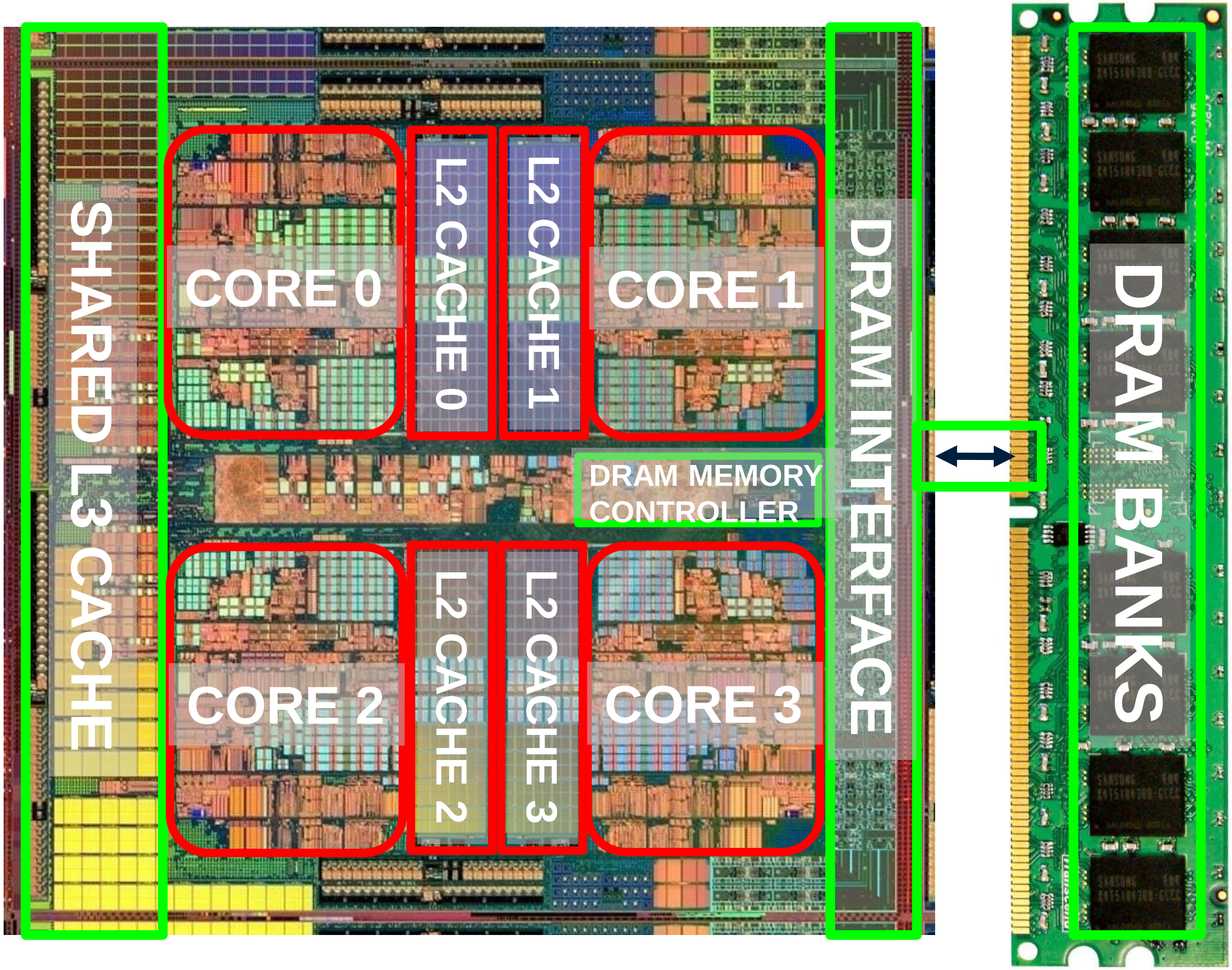
Intel SCC
48 cores, networked



Tilera TILE Gx
100 cores, networked

Slide credit: Prof. Onur Mutlu

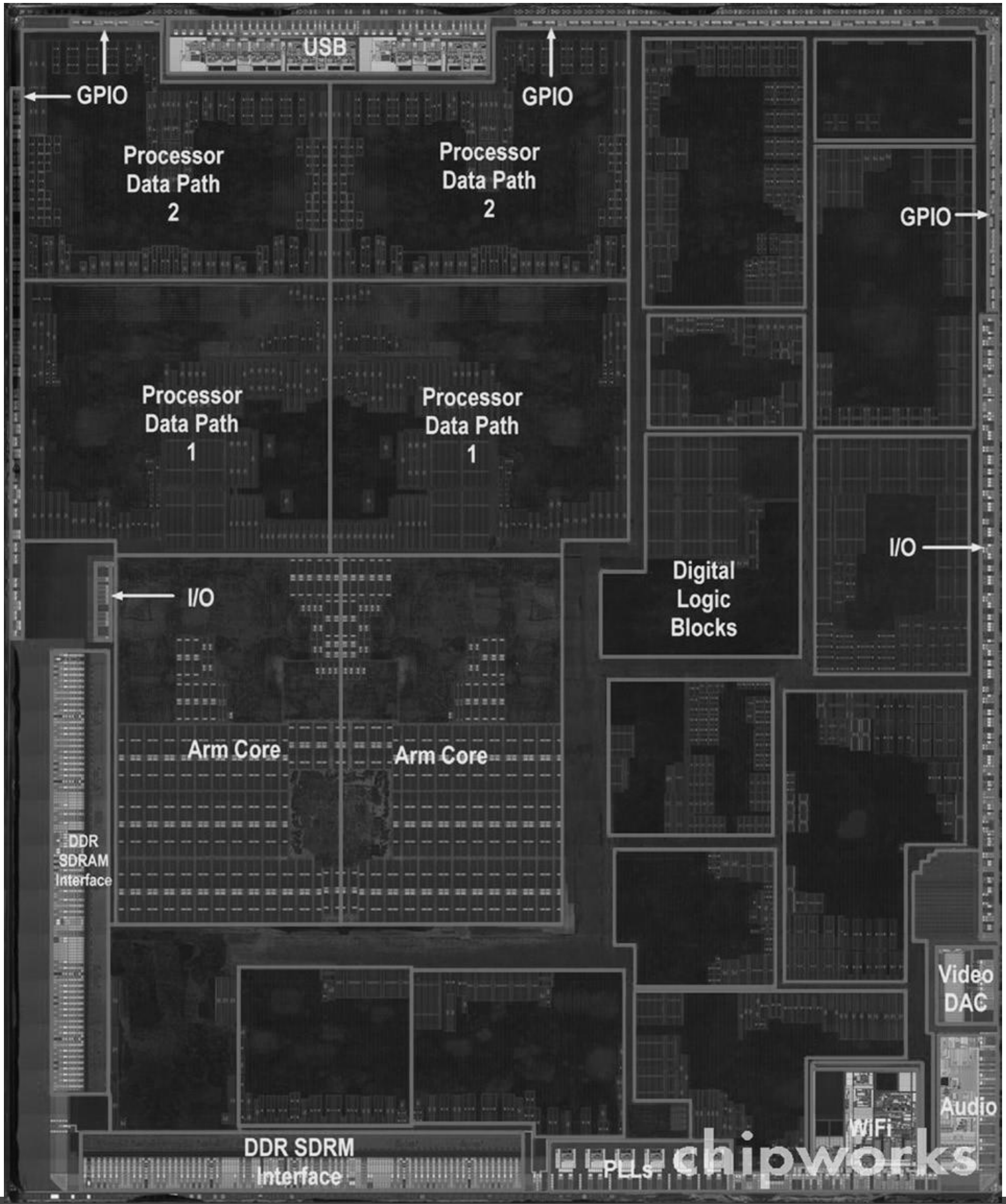
Inside a Microprocessor



What do you observe?

Die photo credit: AMD Barcelona

Inside your iPhone



What do you observe?

Basic Ingredients of a μ-Processor

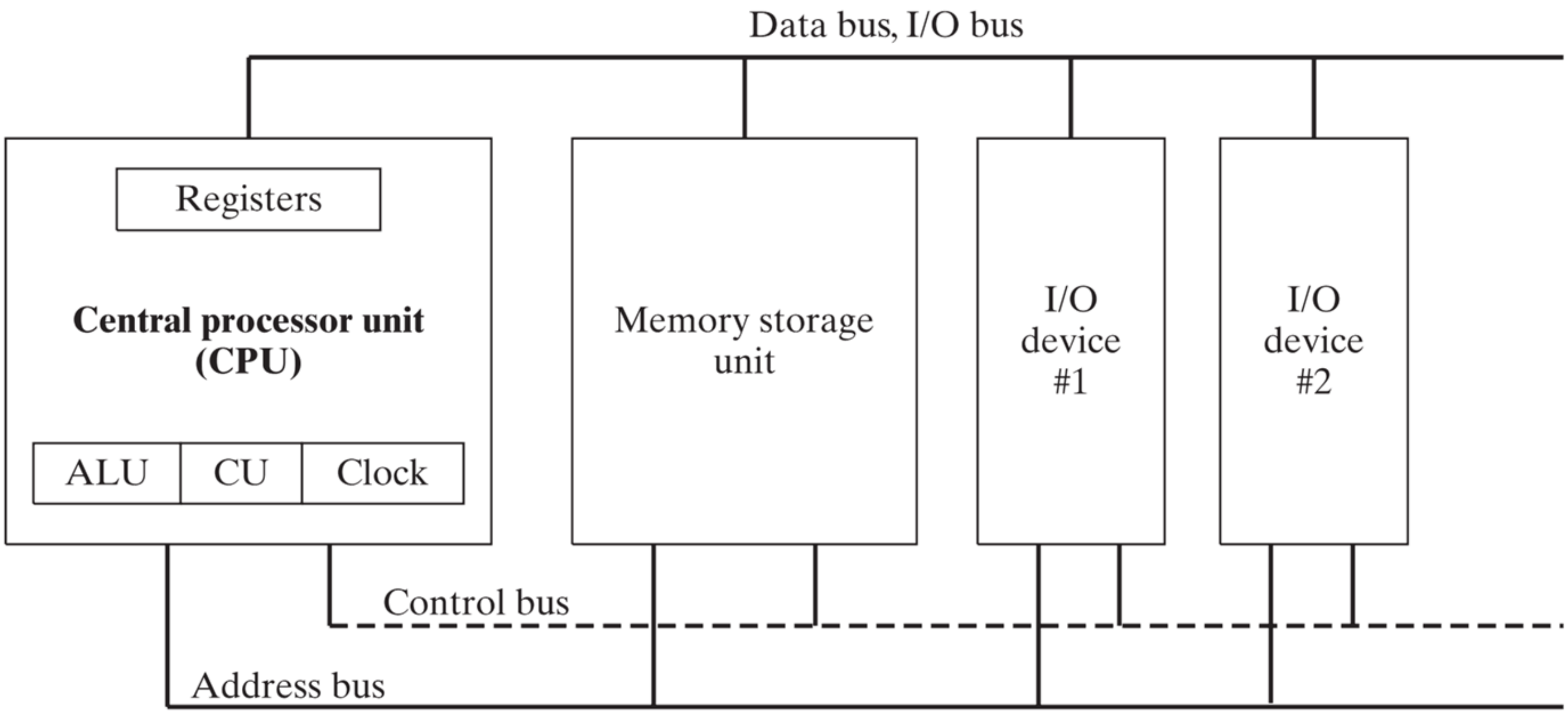
- Any useful microprocessor-based computing system must have:

1. **A Processing Unit:**
   - complex circuitry that manipulates data and controls I/O devices according to the program stored in memory

2. **Memory:**
   - To store programs.
   - To store data.

3. **I/O Devices:**
   - To allow information to be input and output
   - LEDs, 7-Segment Displays, Video Monitors, Keyboards, Motors, Relays

Block Representation of a Microprocessor



Central processing unit

Memory/Registers

Arithmetic logic unitB

I/O port & buses

Review:
High-Level Language Vs. Assembly Language

Each of these lines translate to several ML instructions

C++ Code

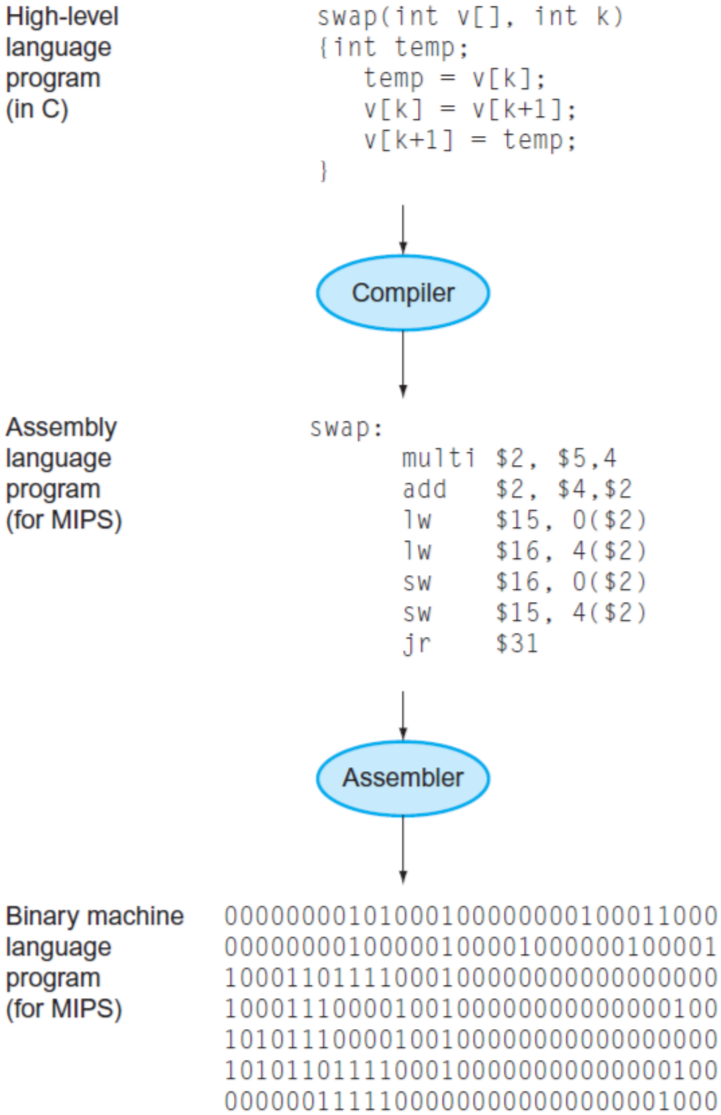
```
int    Y;
int    X = (Y + 4) * 3;
```

Assembly Code

```
mov    eax,Y          ; move Y to the EAX register
add    eax,4          ; add 4 to the EAX register
mov    ebx,3          ; move 3 to the EBX register
imul   ebx            ; multiply EAX by EBX
mov    X,eax          ; move EAX to X
```

Whereas, each one of these lines has direct mapping to an ML instruction

Review: Compiler vs. Assembler



High-level language program (in C)

```
swap(int v[], int k)
{int temp;
   temp = v[k];
   v[k] = v[k+1];
   v[k+1] = temp;
}
```

Assembly language program (for MIPS)

```
swap:
      multi $2, $5,4
      add   $2, $4,$2
      lw    $15, 0($2)
      lw    $16, 4($2)
      sw    $16, 0($2)
      sw    $15, 4($2)
      jr    $31
```

Binary machine language program (for MIPS)

```
00000000101000100000000100011000
00000000100000100001000000100001
10001101111000100000000000000000
10001110000100100000000000000100
10101110000100100000000000000000
10101101111000100000000000000100
00000011111000000000000000001000
```

Compiler: A program that translates high-level language statements into assembly language statements.

Assembler: A program that translates a symbolic version of instructions into the binary version.

Figure taken from Computer Organization and Design (COD) 5th Ed.

Course Plan

Hardware

- What is **microprocessor**?
- How it works?
- Computer memory system & its interfacing
- I/O interfacing
- Computer busses and bus protocol concepts

- What microcontroller is?
- how it works?
- Interfacing techniques with microcontrollers
- How to build real time systems using microcontrollers

Software

- Assembly language for micro-processor/controllers.

- C language for micro-controllers

Course Plan

- More specifically, we'll look at:
  - ATmega16/32 Microcontroller by Atmel
    - Download Atmel Studio development IDE on your machines:
      - https://www.microchip.com/mplab/avr-support/atmel-studio-7
  - RISCV Microprocessor Architecture
    - Take a look at https://riscv.org/
- Take a look at the course outline on LMS
  - While the topics will remain the same mostly, the sequence might change
  - Also, new topics might be introduced depending on the flow of the course

Course Logistics

Course Logistics

- Lectures:
  - By Dr. Arbab Latif[Assist. Prof at SEECS]
    - Office: Knowledge Hub 1
    - Office Hours: By appointment
    - Email: arbab.latif@seecs.edu.pk
  - BEE-10C:
    - Tue:10:00am – 10:50pm [CR-13]
    - Fri: 11:00am – 11:50pm [CR-13]
    - Fri: 12:00pm – 12:50pm [CR-13]
  - BEE-10D:
    - Tue: 12:00pm – 12:50pm [CR-14]
    - Tue: 10:00am – 10:50am [CR-14]
    - Wed:11:00am – 11:50am [CR-14]
  - Course Website: http://lms.nust.edu.pk/
  - Self Enrollment Key: **053271698**
- Labs:
  - Conducted by Mr. Abrar

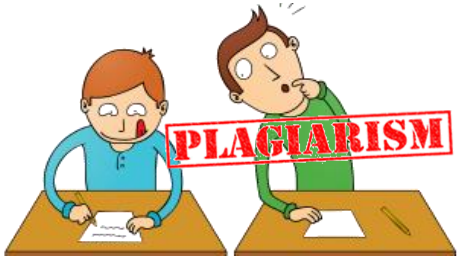
Tentative Grading Scheme

Type	Weight (%)
Assignments	10
Quizzes (Un-announced)	10
OHTs	30
Labs	15
Project	10
Final	50

- This scheme may be adjusted during the semester without giving any prior notice.

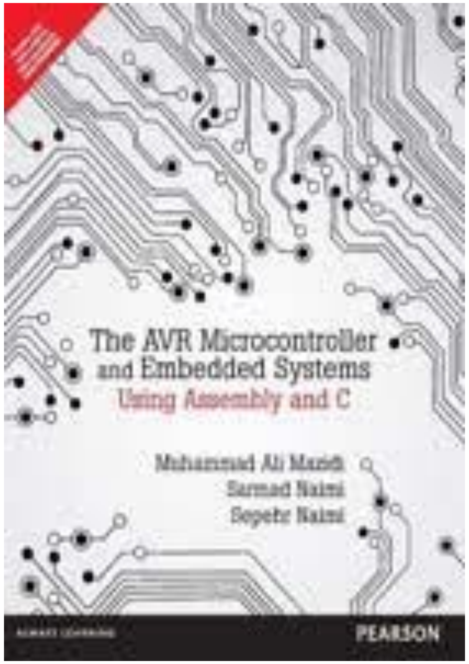
Course Discipline: Ground Rules

- Classroom Etiquettes:
  - Students will be punctual for the class.
    - No attendance if you are late more than 5 mins.
  - If a student decides to attend the class, he or she will not disrupt class by leaving before the lecture has ended.
  - All the cell phones must be switched OFF prior to entering the class room.
- Academic Honesty and Plagiarism: [Both in Class and Labs]
  - Plagiarism is considered a serious offence by the university and severe penalties apply.
  - ZERO tolerance. Subject activity will be nullified.



Reading Assignment

- The AVR Microcontroller and Embedded Systems: Using Assembly and C by Mazidi et al., Prentice Hall
  - Section 0.4



THANK YOU