컴퓨터구조
Computer Architecture

2020년 2학기

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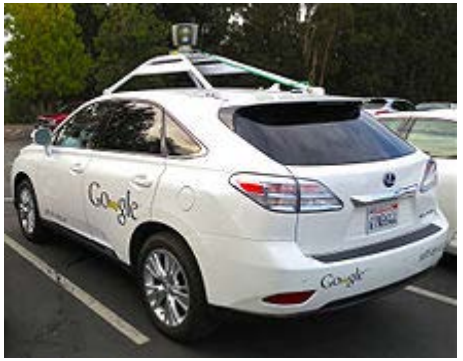
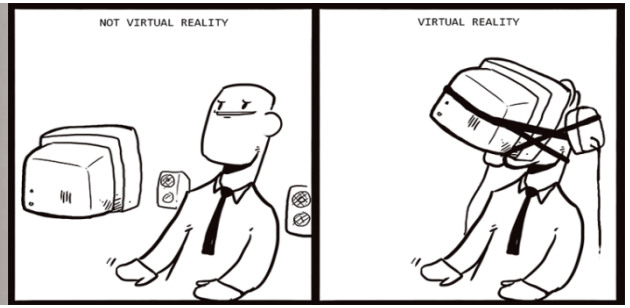
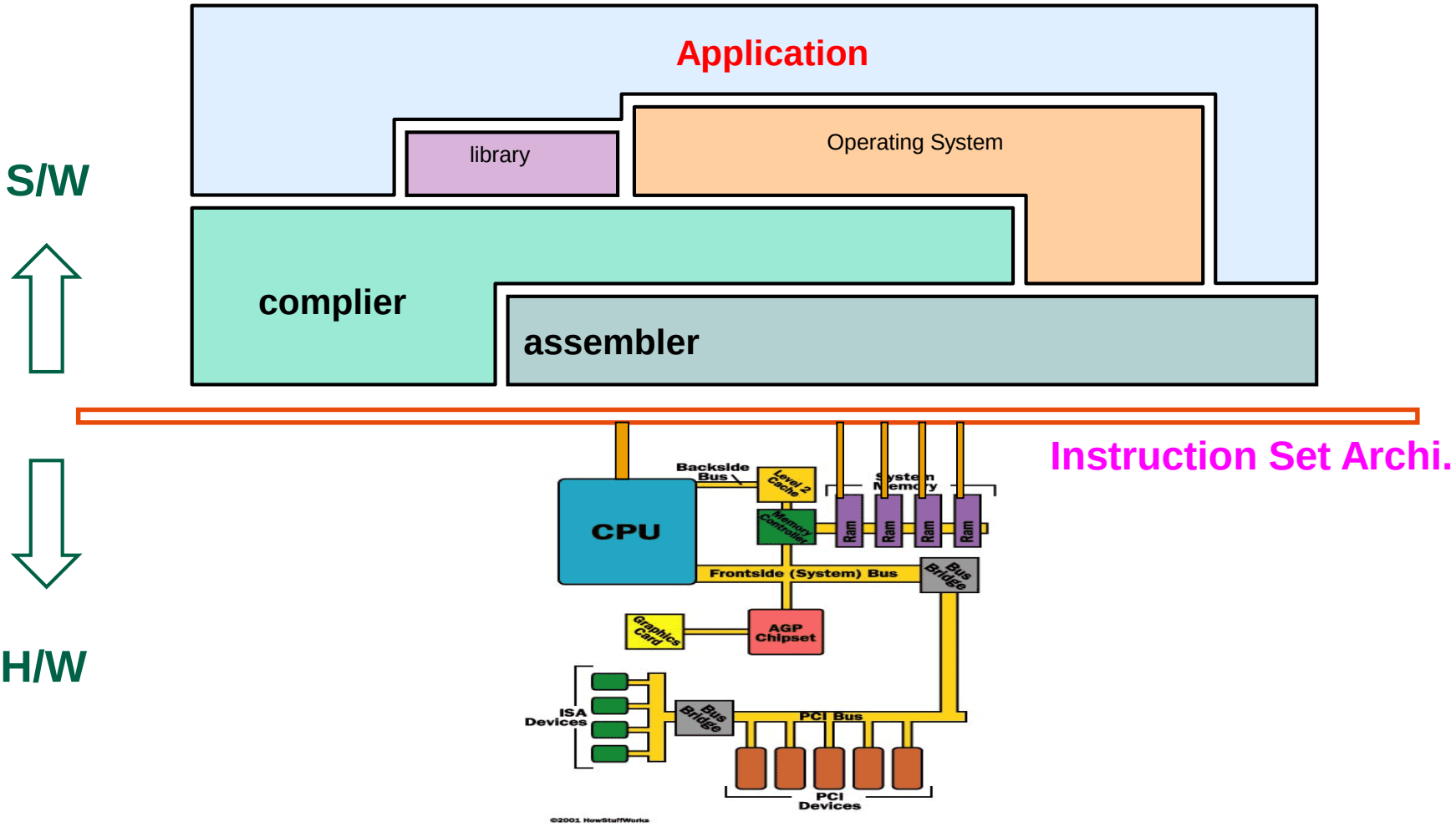
Computer Applications and Revolution

- WWW
- Search Engines
- Scientific/Engineering vs. Business
- Smartphones
- Social Media Services
- IT Convergences : Automobiles,,,,
- Client Server Computing
- Computers are pervasive!
- On-device Machine Learning
- ,,,,,,,

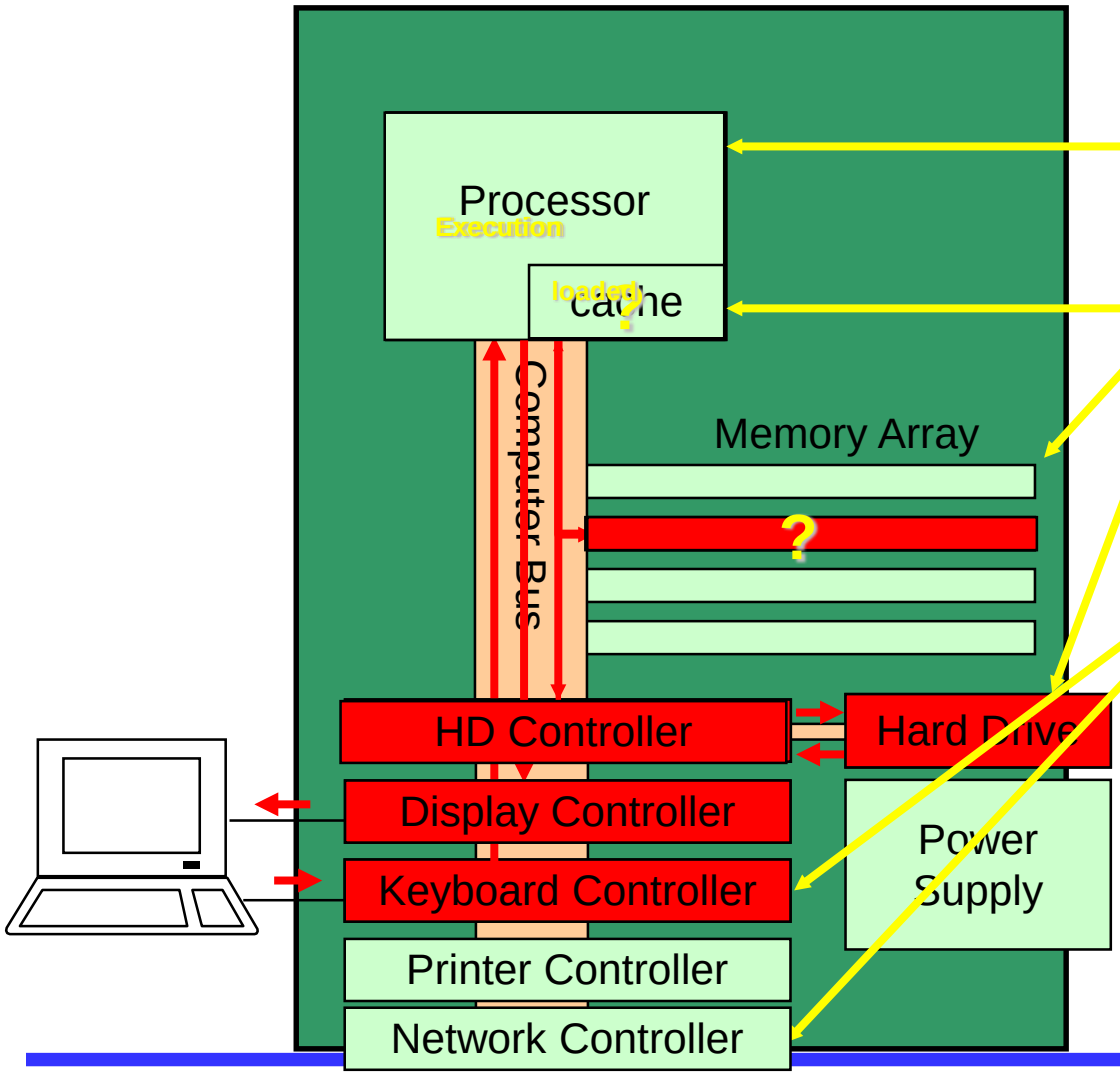




The Hardware/Software Interface



Computing Scenario



주요이슈 :

- 프로그램 실행원리와 프로세서/**ISA** 종류와 설계
- 프로세서에게 명령어와 데이터를 가능한한 빠르게 공급하는 메모리계층
- 컴퓨터시스템의 입출력과 통신방식
- 하드웨어-소프트웨어간 이해득실관계 (tradeoffs)
- 복잡한 시스템의 설계방법

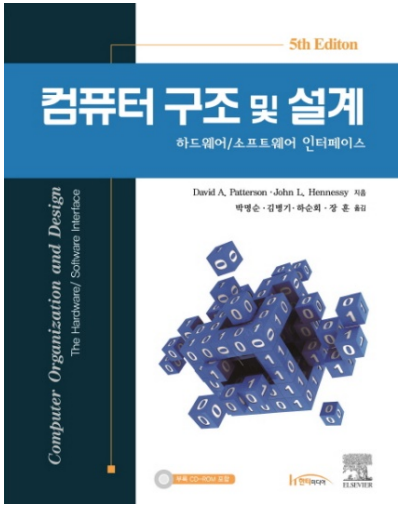
과목개요(1)

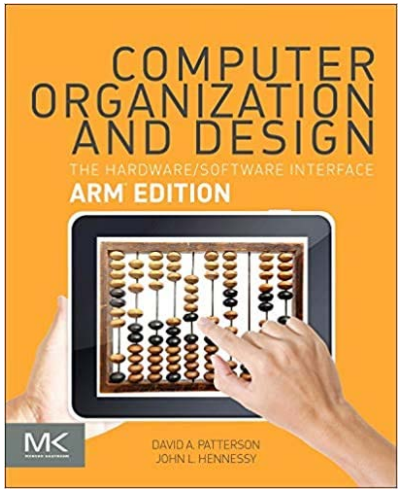
- 목표
  - 컴퓨터의 구성과 작동, 프로그램실행 메커니즘, 하드웨어-소프트웨어 인터페이스를 이해하고 컴퓨터시스템의 설계 및 평가방법을 습득함
  - 기술동향분석, 프로그램성능과 Instruction Set Archi., 프로세서설계, 파이프라이닝, 메모리계층과 입출력, 멀티코어와 병렬프로세서, 그리고 최근이슈를 다룸
  - 수업계획서 참조

- 운영 및 평가 (코로나 상황에 따라 바뀔 수 있음)
  - 교재 위주의 이론강의, TA
  - e-루리에 공지사항, 강의자료 등을 수시로 update하니 적시에 확인 요망
  - 분반별 office hour(매주 50분, ZOOM)를 적극 활용하여 질의응답, 심화학습 요망
    - 1분반 : 화 13:00~ , 2분반 : 목 15:00~ , 3분반 : 화 16:00~
  - 시험 2회(대면 예정), 과제(추후 확정), 수업참여도 등을 종합해서 최종성적 부여
  - 일정횟수 이상 결석하면 “F”

과목개요(2)

- 교재 : David A. Patterson and John L. Hennessy, *Computer Organization and Design – The Hardware / Software Interface,* 5th Ed., 2014. *(MIPS, ARM, RiSC-V Edtion)*





- Bryant and O'Hallaron, *Computer Systems A Programmer's Perspective*, Third Edition, 2016.
- Luiz Andre Barroso, Jimmy Clidaras, and Urs Holzle, *The Datacenter as a Computer : An Introduction to the Design of Warehouse-Scale Machines*, Second Edition, 2013.

새 학기 새 마음 : 전과목 A+ 졸업생의 공부의 기술

➢ 공강을 활용하라!

공강 시간이면 도서관에 많이 갔다. 자투리 시간이라고 내버리면 다 없어진다. 시간에 맞춰 끝낼 수 있는 공부를 한다.

➢ 책은 반드시 내 것으로!

기본 교과서는 반드시 산다. 참고 도서도 적어도 10권씩은 샀다. 못 사면 도서관에서 빌려서 읽었다.

➢ 지식을 네트워킹하라!!

자료 하나만 읽으면 모르니까 교과서에서 찾아보고 참고자료도 찾아보고 인터넷도 뒤져 본다. 이처럼 지식을 네트워킹하여 기본 개념을 자신의 언어로 정리한다. 수업시간에 주는 강의자료와 텍스트를 비교하면서 읽고 서로 다른 저자의 글을 통해 **기본 개념을 정리할** 수 있는 최적의 방법이다.

➢ 질문하라.

열심히 필기해서 외우는 것만으로는 충분하지 않다. 물어보기 위해 질문을 만들어 보면 질문 속에서 스스로 답에 접근하게 된다.

➢ 적어도 한 가지 운동을 하라.

내 경우는 대학 1학년 때부터 검도를 해서 초단을 땄다.

운동도 기술적으로 발전해 가는 진도가 있어야 배우는 게 재미있다. **운동이 집중력을 길러준다.**

새 학기 새 마음

- 남 보다!　　=>　　前 보다!
- 不狂不及
  - 진리는 단순하고 , 실력은 꾸준함에서 나온다.

- Keep It Simple, Stupid.
- The important thing is to understand what you are doing, rather than to get the right answer.　　- Tom Lehrer

- *Top 10 Reasons to Major in Computing*

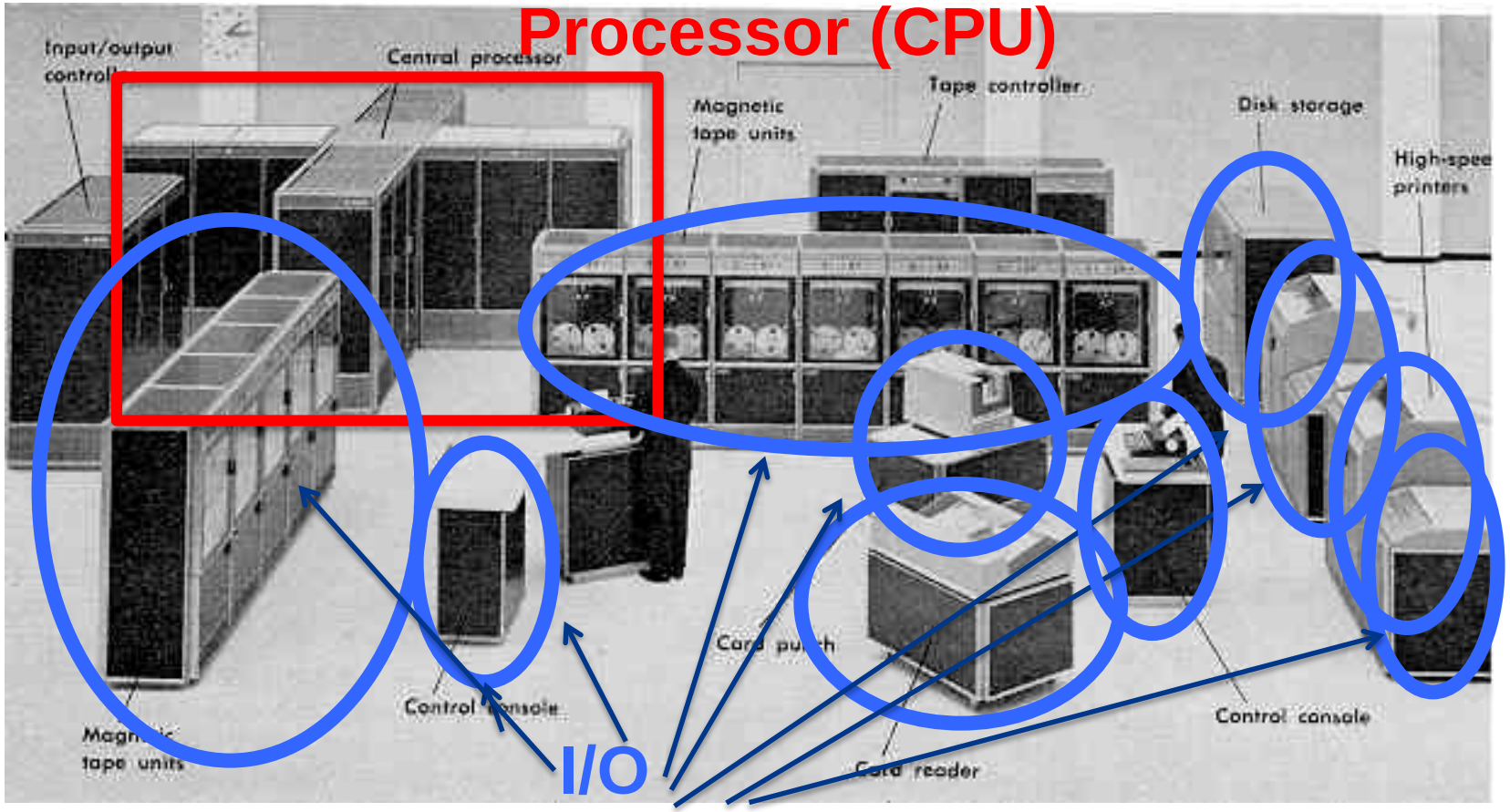
- The Big Picture
  - Brief History of Computer
  - Current Trend

- Brief History of Computer
- Current Trend
- What is Computer Architecture?

The Brief History of Computers

Year	Name	Speed	Remarks
1946	ENIAC	~1900 addition/sec	First electronic computer
1951	UNIVAC	~2000 addition/sec	First commercial computer
1964	IBM 360	500k ops/sec	Best known mainframe
1965	PDP-8	330k ops/sec	First minicomputer
1971	IBM 4004	100k ops/sec	First microprocessor
1977	Apple II	200k ops/sec	"First" PC
1981	IBM PC (Intel 8088 + MS-DOS)	240k ops/sec	Dominated market since then
2003	Intel Pentium 4	6G flops	"Last" unicore
2011	Intel Core i7	~120G flops	6 cores
	Intel Core i9		8 cores 16MBSmartCache

Computer Eras: Mainframe 1950s-60s



"Big Iron" : IBM, UNIVAC, … build $1M computers
for businesses => COBOL, Fortran, timesharing OS

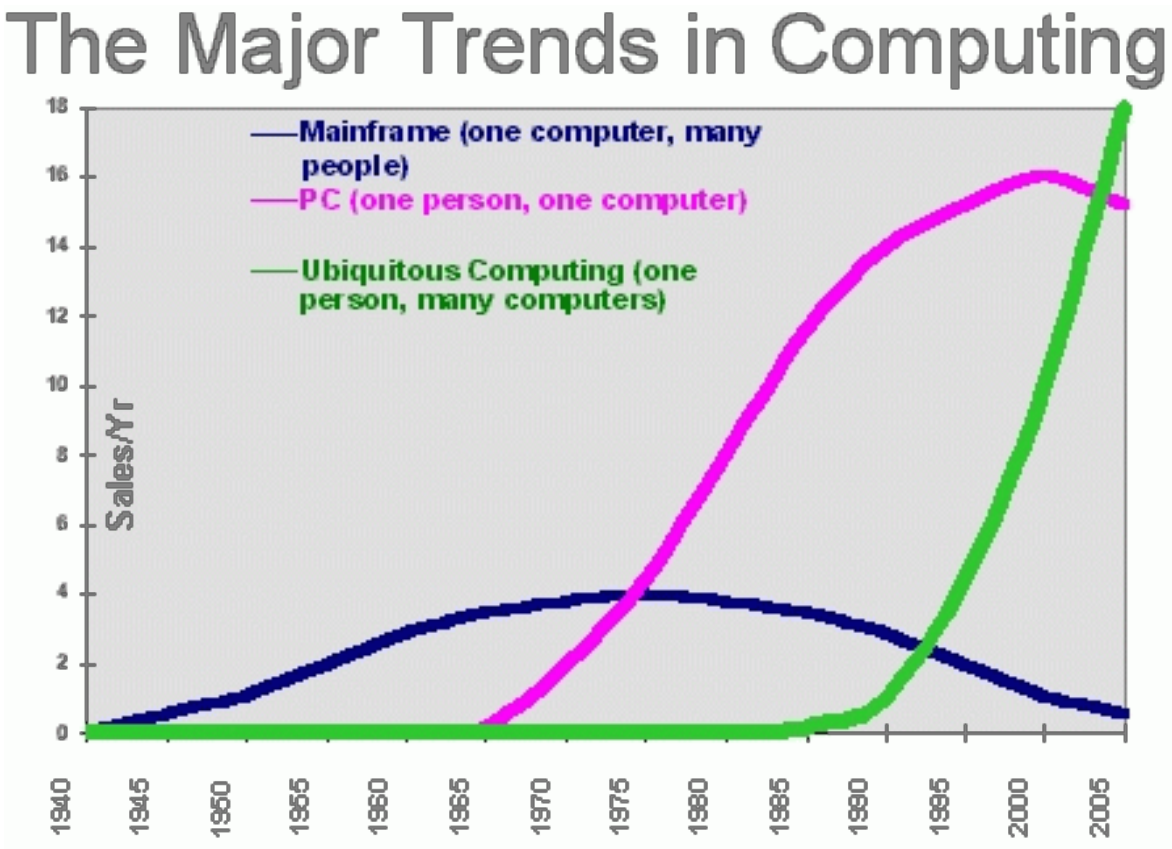
Minicomputer Eras: 1970s

Using integrated circuits, Digital, HP… build $10k computers for labs, universities => C, UNIX OS

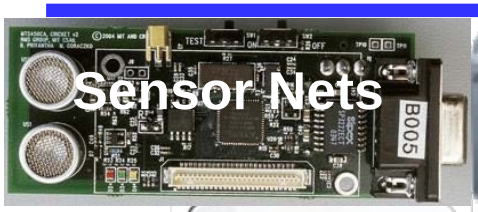
PC Era: Mid 1980s - Mid 2000s

Using microprocessors, Apple, IBM, … build $1k computer for 1 person
=> Basic, Java, Windows OS

PostPC Era: Late 2000s - ??



Computing Devices Now



PostPC Era: Late 2000s - ??

Personal Mobile Devices (PMD)

wireless networking,

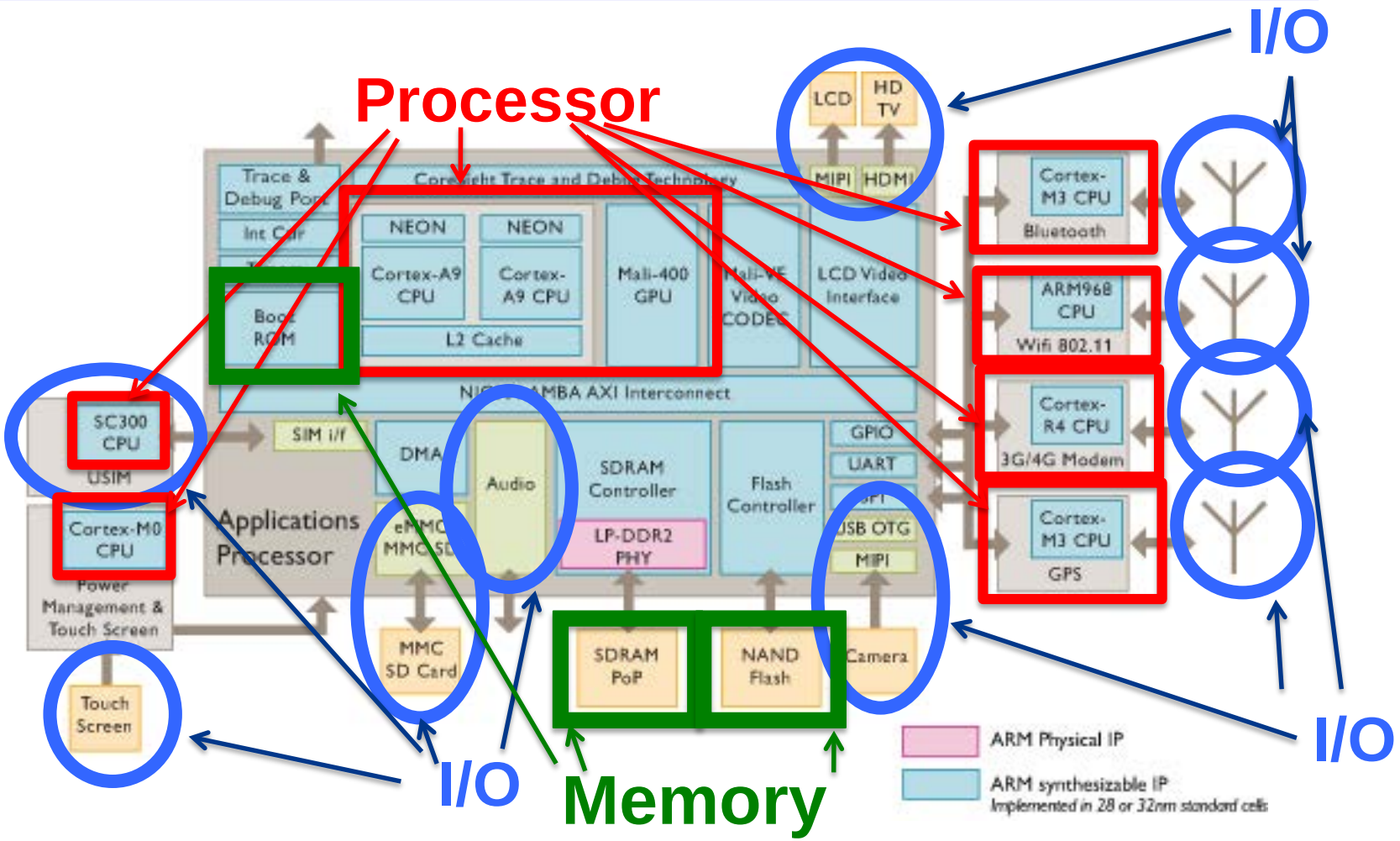
smartphone and tablet

computers for individuals

Cloud Computing

Amazon, Google, … build $200M Warehouse Scale Computers with 100,000 servers for Internet Services for PMDs

iPhone Innards



You will about multiple processors, data level parallelism, caches

Smartphone Processors

- Many companies and parts but some common features:
  - ARM ISA for application processors(AP)
  - Lots of dedicated accelerator blocks, especially image processors for cameras and GPUs for graphics
  - Only ~2W max power dissipation!

- Continual rapid change in architecture
  - Mobile and server processors include large and increasing number of processors on single chip
  - More specialized processors common
  - New architectural concepts (transactional memory)

Server, Rack, Array

8 cores, 16 GB DRAM, 4x1 TB disk

40-80 servers + Ethernet LAN (1-10 Gbps)

Array(aka cluster):
16-32 server racks + larger LAN (“array switch”)

E.g., Google's Oregon WSC

Summary: The Age of Computer

- **Unprecedented** progress since late 1940s
  - From a few to many ^{n}
  - From **BIG** to small
  - From S-L-O-W to *fast*
- Performance doubling ~2 years (1971-2005):
  - Total of 36,000X improvement!
- Incredible amount of innovations to revolutionize the computing industry again and again

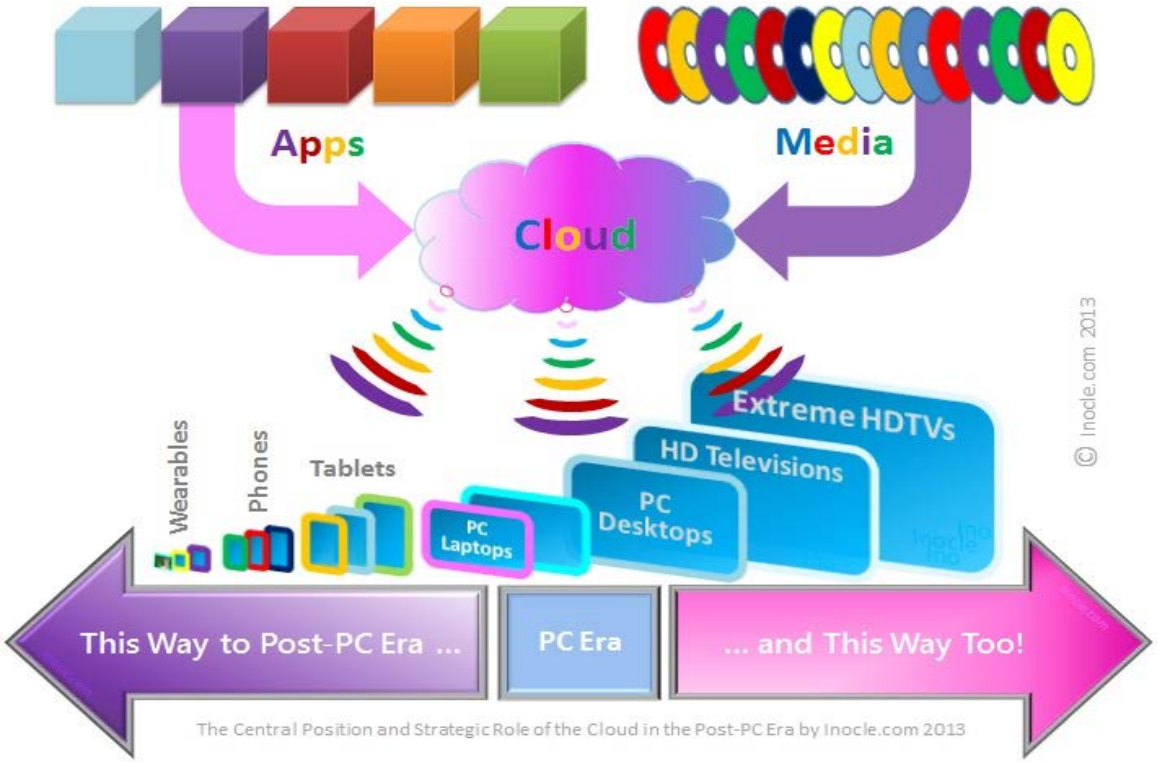
- Brief History of Computer

- Current Trend

- What is Computer Architecture?

The Computer Revolution

- Progress in computer technology
- Makes novel applications feasible
- Computers are pervasive *(The PostPC Era)*



Current State of Computer(1)

Application Domains for Multiprocessors

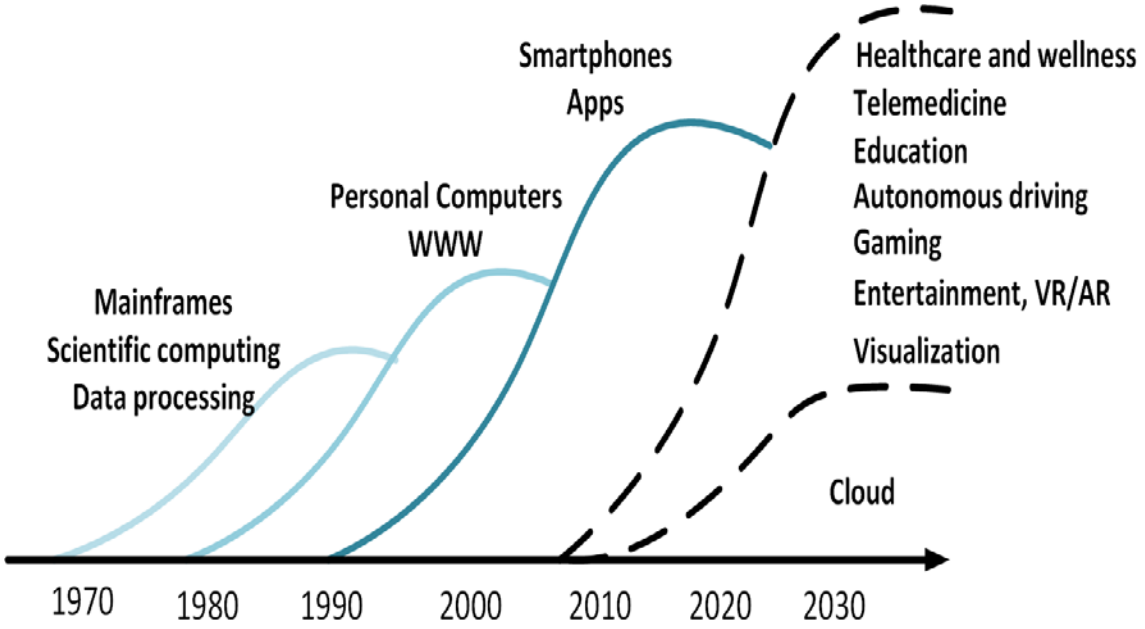
- Scientific computing / supercomputing
  - Examples: weather simulation, aerodynamics, protein folding
  - Large grids, integrating changes over time
  - Each processor computes for a part of the grid
- Server workloads
  - Example: airline reservation database
  - Many concurrent updates, searches, lookups, queries
  - Processors handle different requests
- Media workloads
  - Processors compress/decompress different parts of image/frames

- Desktop workloads… Gaming workloads…

Current State of Computer(2)

- Multicore (Mainstream Multiprocessors) is the future
  - Expect to have more cores in a single chip
  - Parallel programming is more important than ever
- GPGPU
- On-device Machine Learning
- Great opportunity for computing professional
  - New programming model is required
  - Parallelizing existing software
  - Innovative ways to tap into the computing power

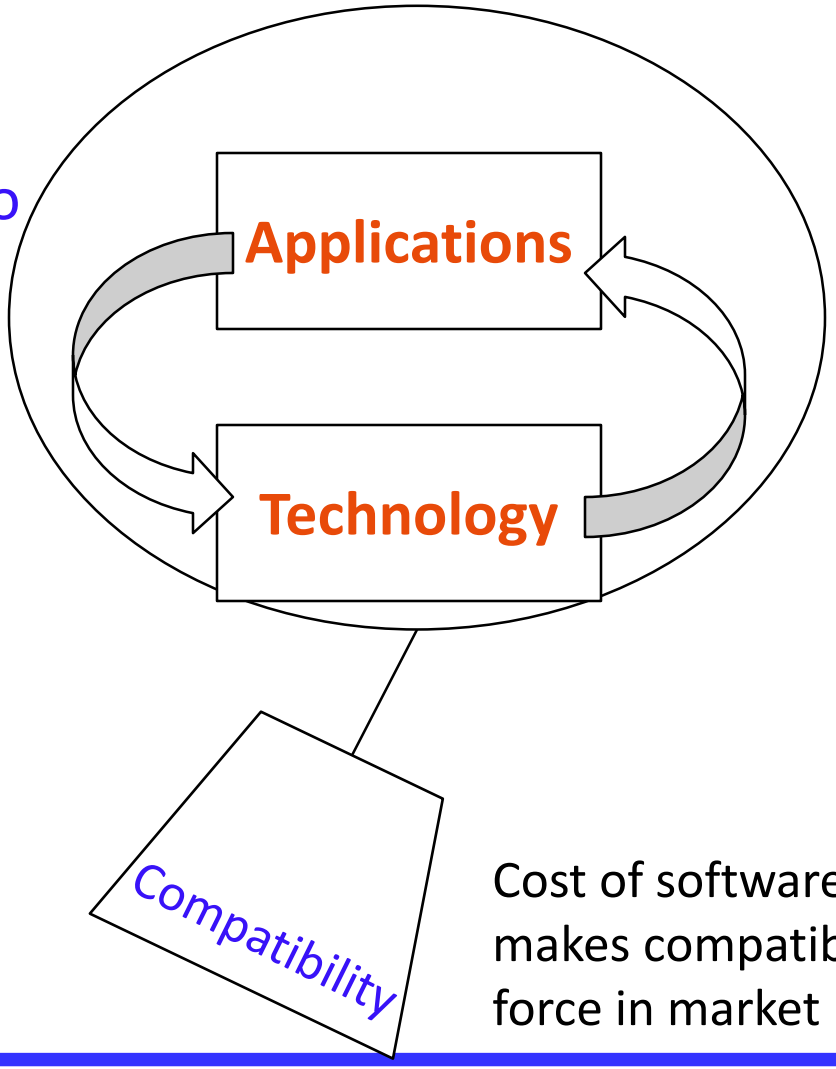
Why is Architecture Exciting Today?



- Number of deployed devices continues growing, but no single killer app
  - Diversification of needs, architectures

Architecture Continually Changing

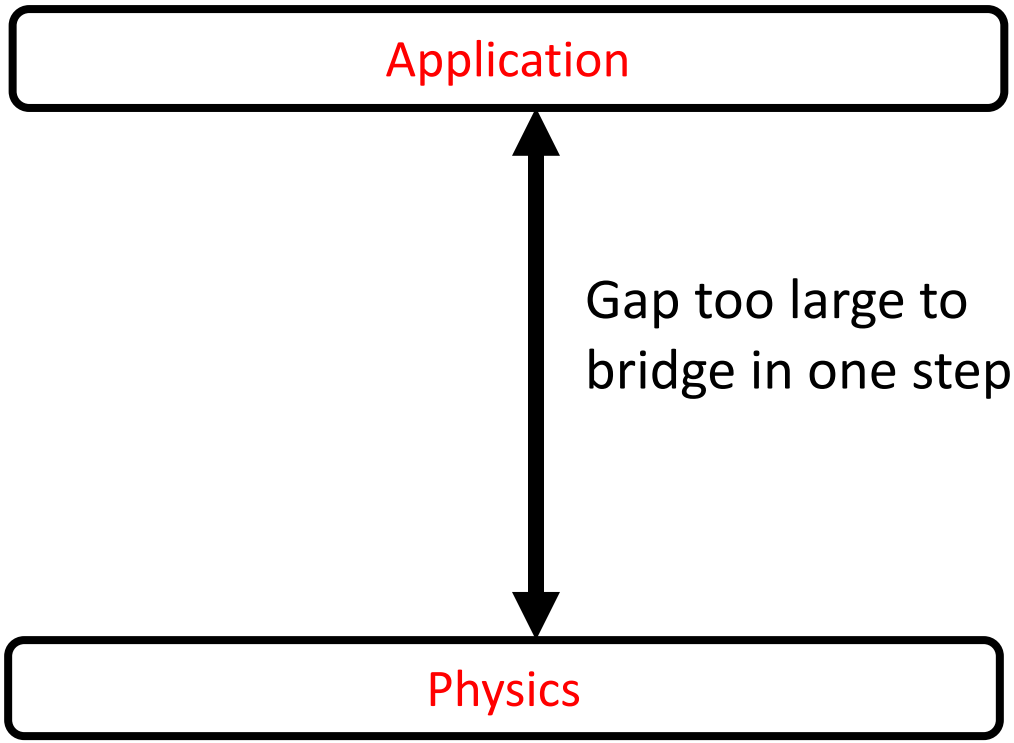
Applications suggest how to improve technology, provide revenue to fund development



Improved technologies make new applications possible

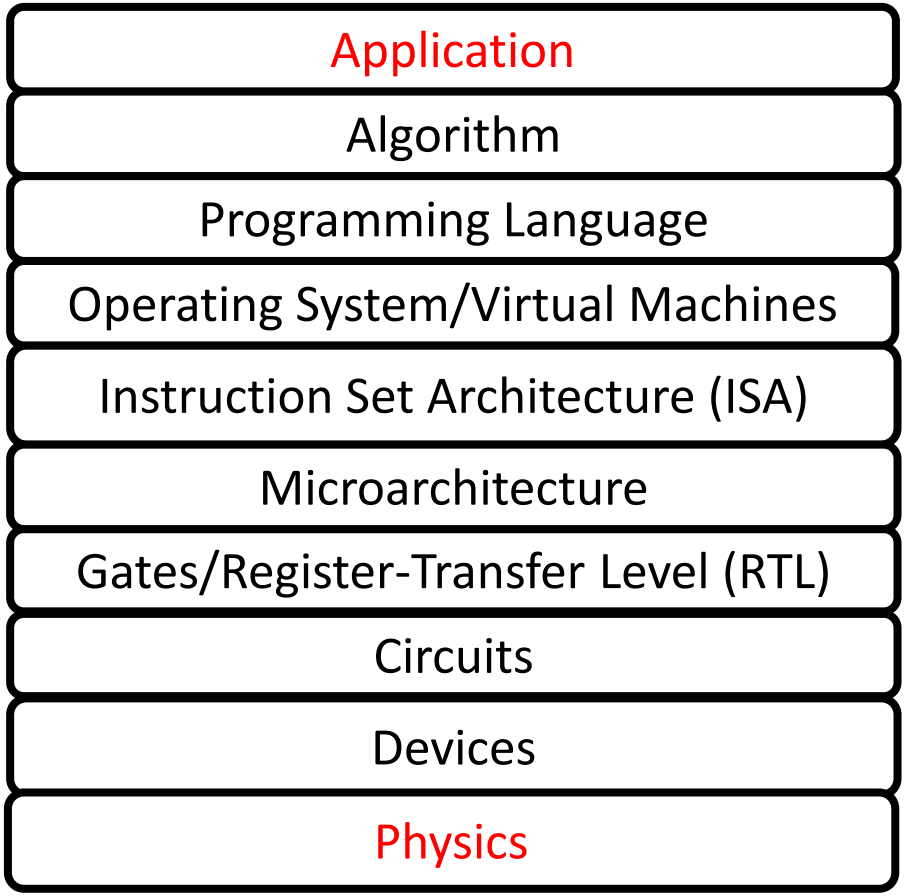
Cost of software development makes compatibility a major force in market

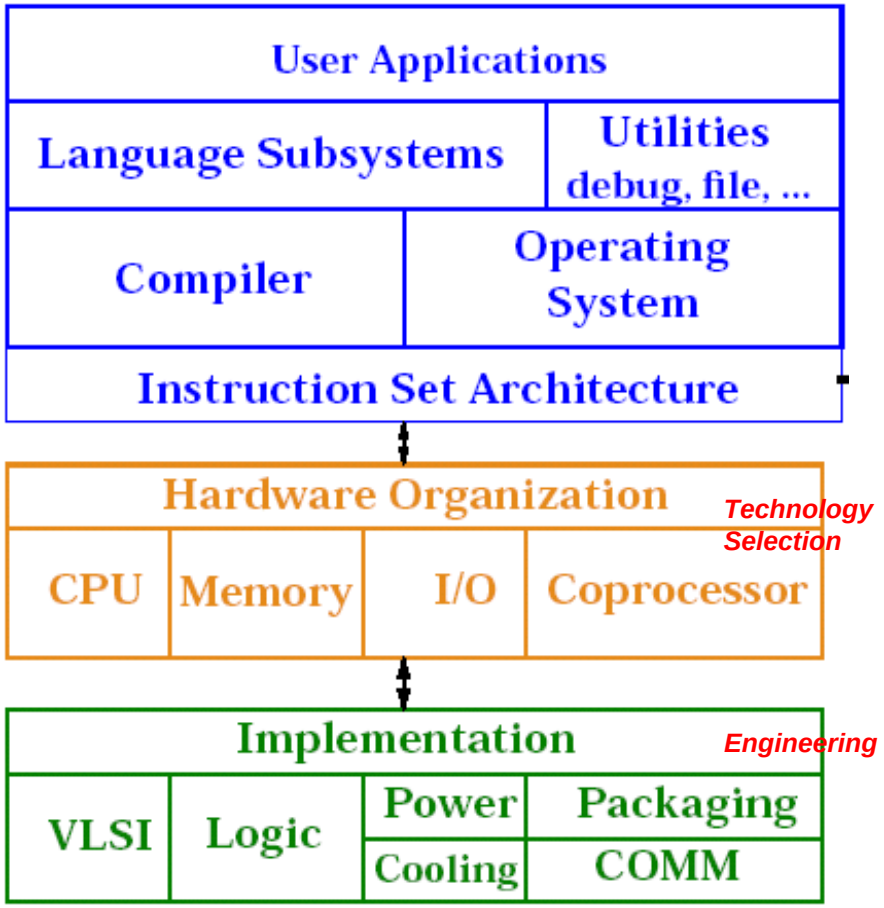
What is Computer Architecture? (1)



In its broadest definition, computer architecture is the *design of the abstraction layers* that allow us to implement information processing applications efficiently using available manufacturing technologies.

Abstraction Layers in Modern Systems





What is Computer Architecture? (2)

"*Computer architecture, like any other architecture, is the **art** of determining the needs of the user of a structure and then designing to meet those needs as effectively as possible within economic and technological constraints.*"

- It is an important and exciting subject
  - A combination between Science and **Art**
    - How to **utilize** technology appropriately
    - Performance can be enhanced by creativity
  - Many assessment goals
    - Performance (goal: increase)
    - Cost (goal: decrease)
    - Scalability (goal: improve)
    - Power/Heat (goal: decrease)
    - Reliability (goal: improve)
- Fact : Good programmers tend to write efficient software!
  - To do that, you need to understand the hardware, the architecture, and know how your program is executed…
    - knowing architecture will help you write more efficient programs
  - Today, we are entering multicore era, acclerators, ARM, cloud, etc…

Summary