CSC 411

Computer Organization (Spring 2022)
Lecture 1: Introduction, Class Logistics

Prof. Marco Alvarez, University of Rhode Island

Welcome !

- Lectures
  - TTh 5-6:15p @ Tyler 108
- Lab
  - W 5-5:50p @ Zoom
- Office Hours
  - TBA
- Team
  - Marco Alvarez, Instructor
  - Alfred Timperley, TA
- Course Website
  - https://homepage.cs.uri.edu/~malvarez/teaching/csc-411/

From the 2020-21 catalog …

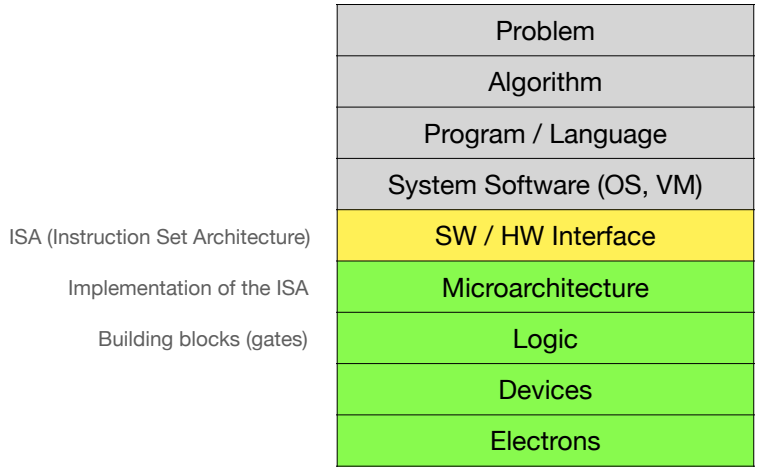
CSC 411: Computer Organization
LEC: (4 crs.) Logical structure of computer systems viewed as a hierarchy of levels. Assembly language programming, assemblers, linkers, loaders. Computer architecture including digital logic, processor organization, instruction sets, addressing techniques, virtual memory, microprogramming. (Lec. 3, Project 3) Pre: CSC 212 and student must be admitted to a degree-granting college.

How computers work?

What you will learn?

- How programs are translated into machine language?
  - how the hardware executes them?
- The hardware/software interface
- What determines program performance?
  - how it can be improved?
- How hardware designers improve performance?
- What is parallel processing?

Abstraction layers (computing system)



Why do we care?

Computer architecture

- Science of designing and implementing computing systems
  - HW/SW interface and below
  - expanding to upper layers
- Design goals
  - highest performance
  - optimizing for energy efficiency
  - best performance/cost ratio
- Think about design goals for a supercomputer vs an smartphone
  - fundamental principles are similar

Why study computer architecture?

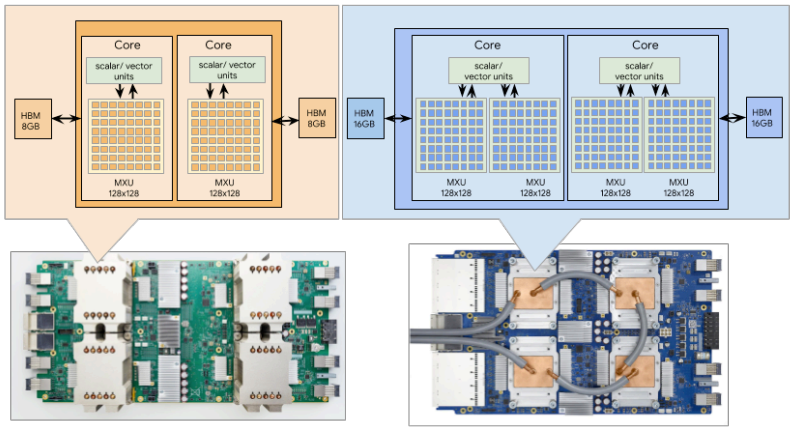
- Understanding future capabilities of computing systems
- Developing better software
  - best system programmers understand all abstraction levels and the underlying hardware
- Understanding computer performance
  - writing well tuned software requires knowing what's under the hood
- Setting up the fundamentals for further work on hardware design

Fugaku

Fugaku remains the No. 1 system. It has 7,630,848 cores which allowed it to achieve an HPL benchmark score of 442 Pflop/s. This puts it 3x ahead of the No. 2 system in the list. Fujitsu RIKEN Center for Computational Science, Japan.

https://www.top500.org/lists/top500/2021/11/

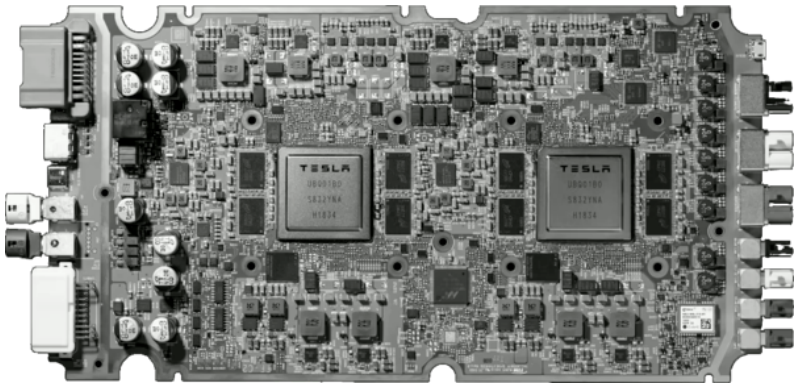
TPU (Tensor Processing Unit)



TPU v2 - 4 chips, 2 cores per chip

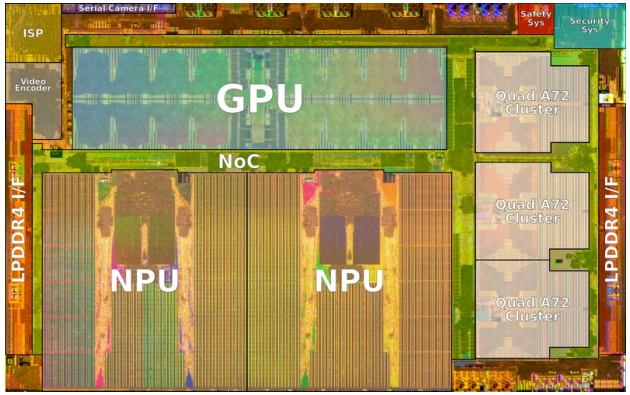
TPU v3 - 4 chips, 2 cores per chip

Tesla's Computer



https://en.wikichip.org/wiki/tesla_(car_company)/fsd_chip

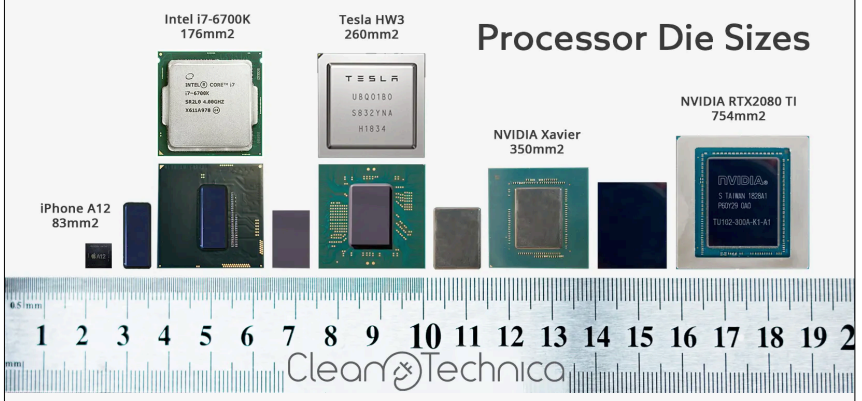
Tesla's Computer (Full Self-Driving Chip)



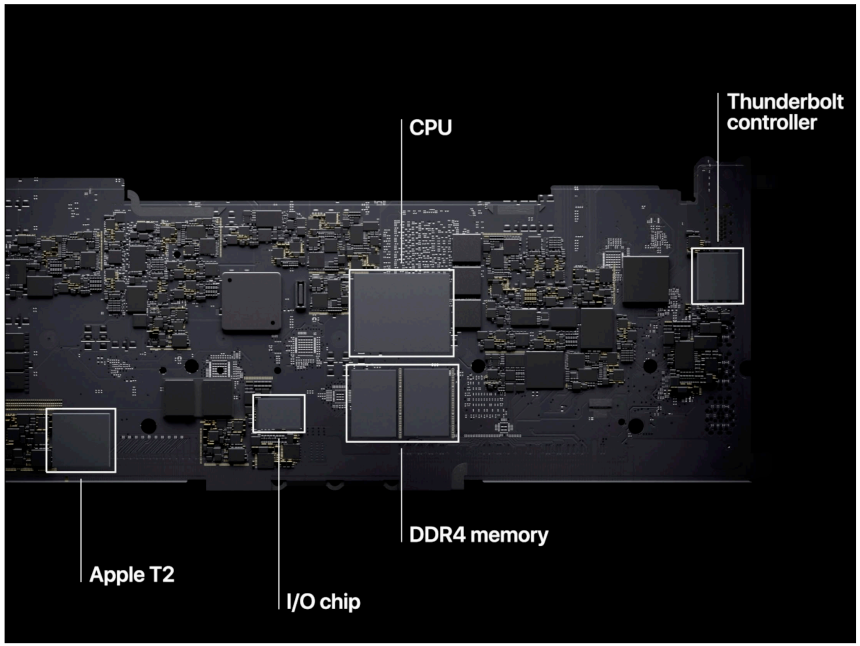
At a high level, the chip is a **full system-on-a-chip** capable of booting a standard operating system. It is manufactured on Samsung's 14-nanometer process at their Austin, Texas fab, packing roughly six billion transistors on a 260 millimeter squared silicon die.

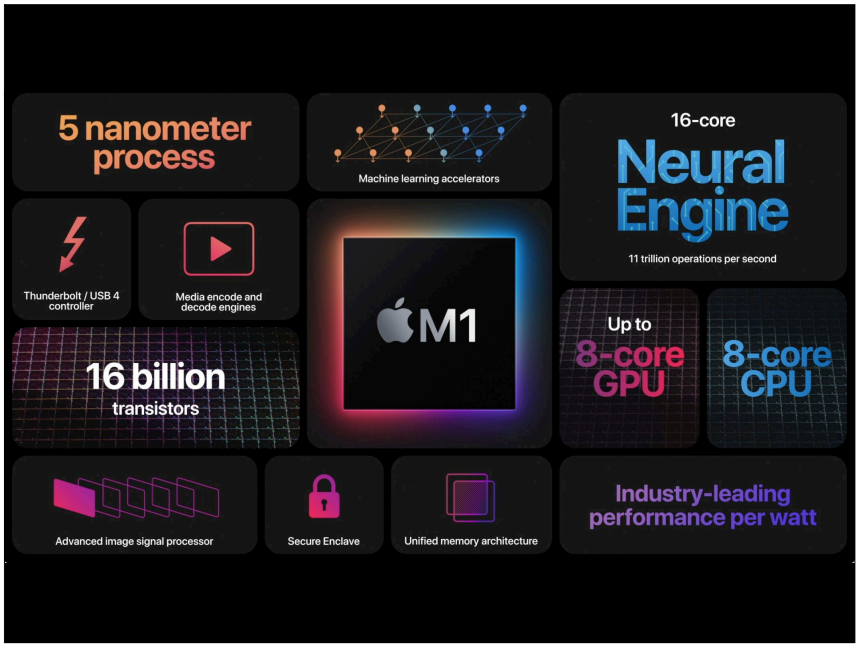
https://en.wikichip.org/wiki/tesla_(car_company)/fsd_chip

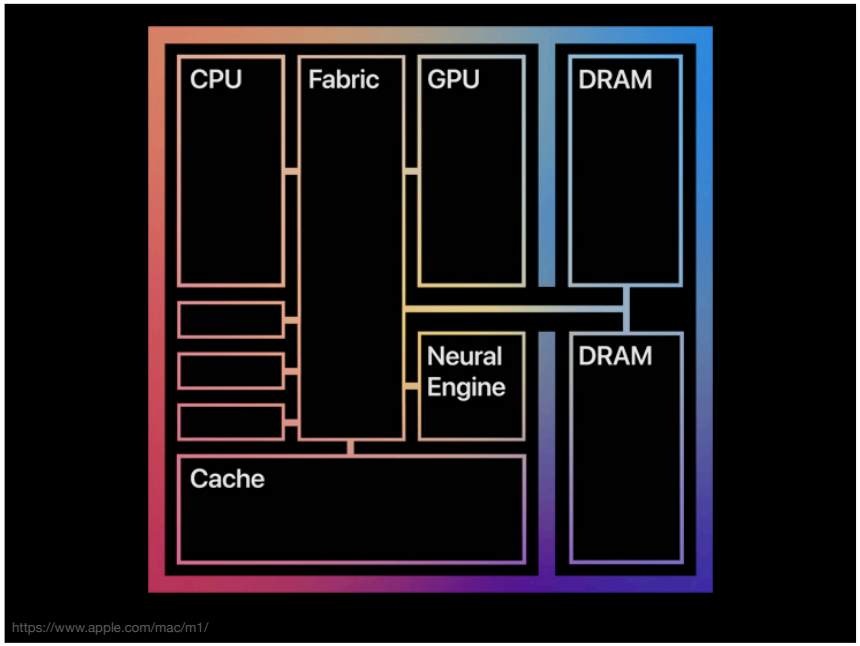
Getting a sense of size

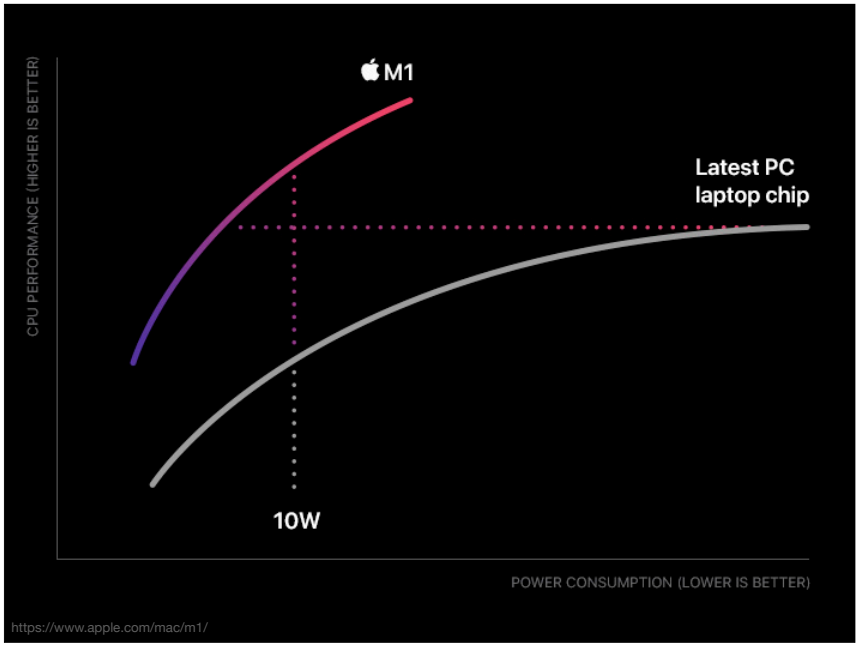


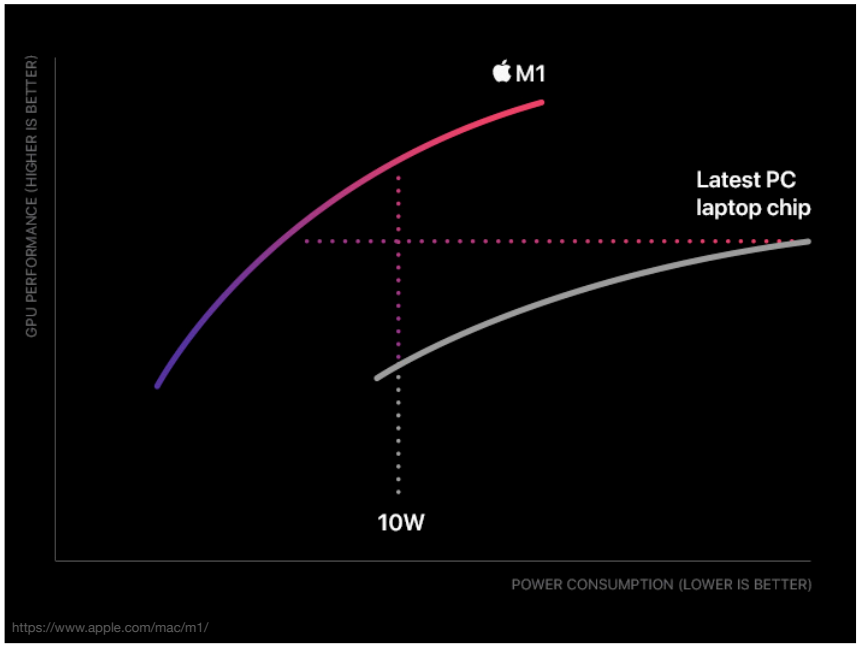
https://cleantechnica.com/2019/06/15/teslas-new-hw3-self-driving-computer-its-a-beast-cleantechnica-deep-dive/









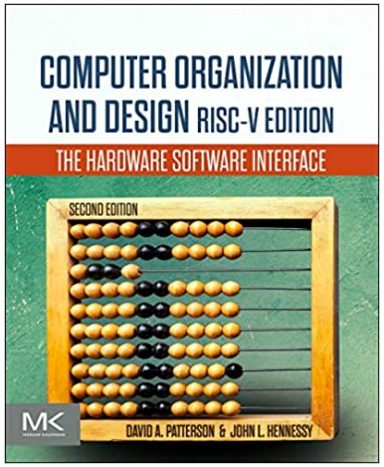


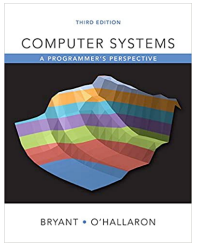
Modern computer architecture

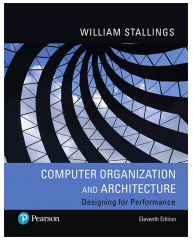
- Achieving higher performance and efficiency
  - co-design across the hierarchy (bring algorithms to devices)
  - specialize as much as possible
- Looking forward …
  - same basic building blocks and design principles

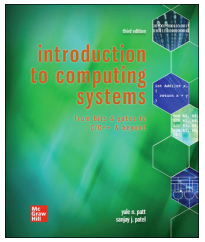
Course organization

Recommended textbooks









Grading

- Assignments (25%)
  - programming
  - problem sets (mostly from the textbook)
- Technical Presentation (30%)
  - teams of 2
- Exams
  - 1 midterm (20%)
  - 1 final (25%)

gradescope

Assignments

- Discussions and collaboration are allowed
  - you must write your own code and solutions
- Late submissions **NOT** accepted
  - ample time given for assignments (~9 days)
  - start and submit early, leaving plenty of time for updates
- Plagiarism?
  - just don't do it
  - reports are sent to the chair with copies to your dean, the student's dean, and the office of student life

How to succeed?

- Attend all lectures/labs
  - lectures run synchronously and are not being recorded
  - attendance usually correlates with higher grades
- Participate and think critically
  - turn on your cameras during lectures and feel free to ask questions
  - use the online forum (EdStem)
  - use office hours regularly
- Start working on assignments early
  - avoid copying/pasting or google'ing answers