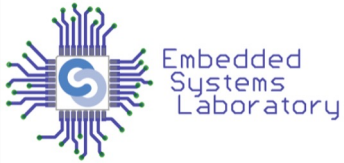
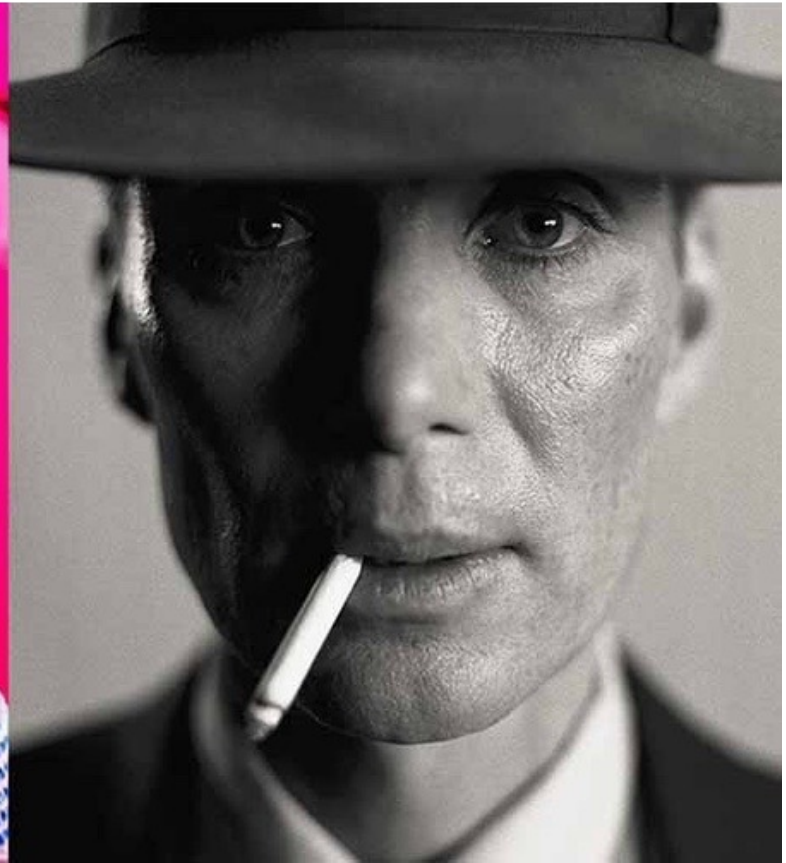


PROIECTAREA CU MICROPROCESOARE

Facultatea de Automatică și Calculatoare
Universitatea Politehnica București

Web Design

Design with Processors



proiectarea **CU** microprocesoare

Obiectivul cursului: introducere hands-on în proiectarea sistemelor de calcul cu microprocesoare.

Vom discuta pe larg la curs despre ce înseamnă să proiectezi un sistem de calcul iar la laborator și proiect veți aplica aceste cunoștințe și vă veți construi propriul sistem de calcul.

La finalul cursului ar trebui să fiți pregătiți să lucrați într-o echipă care construiește un produs care are încorporat un sistem de calcul.

About me

Associate Professor @ UPB

- Research & Teaching
  - Computer architecture, hardware/software interaction
  - Embedded and Pervasive Computing
  - Wireless Sensor Networks
  - Low Power Computing Architectures
  - Fault tolerance
- Office: ED422
- Office Hours: Mondays 11:00am - 12:00pm
  - (almost) anytime on Teams

dan.tudose@upb.ro

Start-ups → Vector Watch → Fitbit → Google

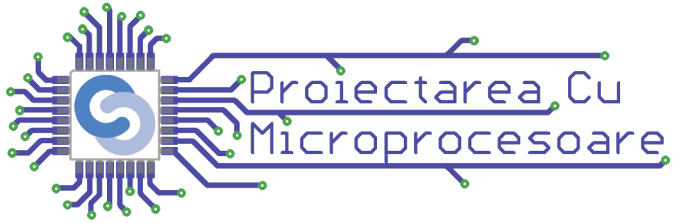
Asistenții (nu laboranții!)

Andrei Bîrlică
Alexandru Predescu
Alexandru Văduva
Florin-Alexandru Stancu
George-Cristian Pătru
Ionuț-Gabriel Oțelea
Narcis-Florin Căroi
Alexandru Mocanu
Adrian Mocanu
Victor Stoica
Cristi Tranca
Daniel-Florin DOSARU
Teodora-Catalina MIU
Irina Bradu
Andrei Sebastian DARMAZ

Alex Lucaci
Teodor Alexandru Dicu
Alexandru Ungureanu
Razvan Virtan
Sebastian Severin
Cristian Contasel
Mihnea Dinica
Ioana Dinu
Radu Constantin Rusu
Andrei Zamfir
Danut Aldea
Irina Nita
Farhad Ali Gul
Radu Pascale

Important Stuff

Curs & laboratoare: ocw.cs.pub.ro/pm



Notare:

- 1 punct activitate laborator
- 1 punct lucrare laborator (colocviu final)
- 3 puncte proiect
- 3 puncte examen final
- 2 puncte activitate curs (teste / activitate)

+ 0.75p bonus top 30 de proiecte din an (top 7%)

+ 0.75p bonus top 10 proiecte din an

Cerințe minime pentru a promova:

50% punctaj parcurs și 50% prezențe la laborator

50% examen;

7 prezențe la curs pentru a intra în examen;

Extra

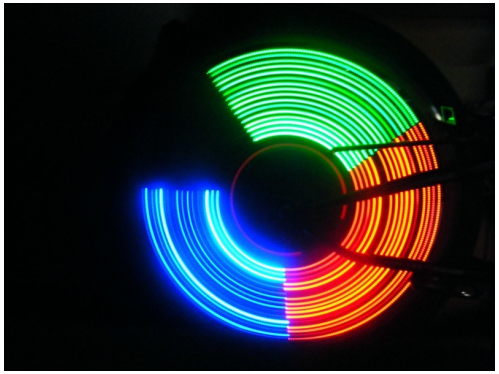
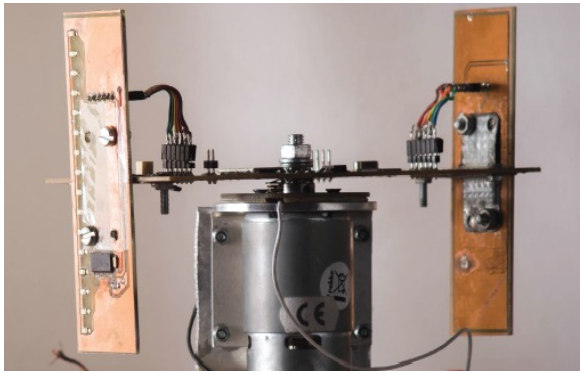
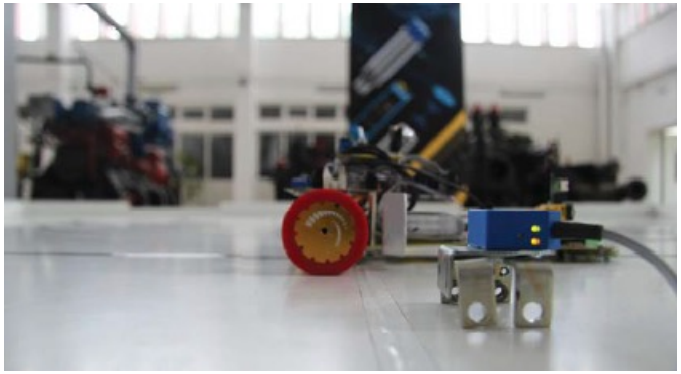
Bonus pentru rezultate la concursuri & activități

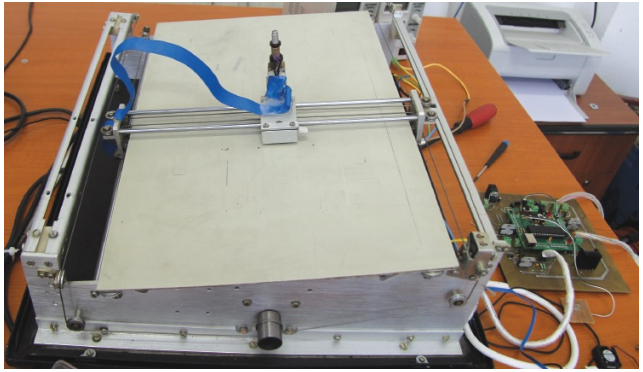
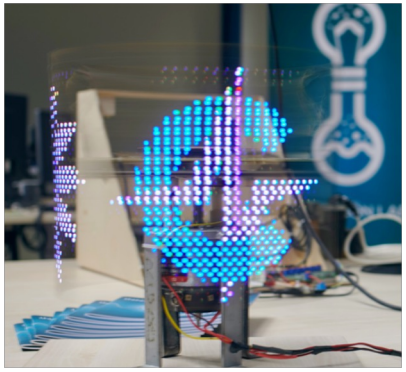
- până la 1 punct pentru rezulate in top la concursuri de profil tehnic
- *> mail în presesiune cu Subject: [Bonus_PM] Nume_Prenume_33xCA*

Echivalări

- Până la 3 puncte pentru rezultate la concursuri tehnice. Ex:
  - ACM (top 50% la world finals);
  - Innovation Labs (SemiFinale);
  - Suceava Hard and Soft (top 50% echipe);

Proiect

Structură punctaj proiect

3p din punctajul final!

22-Apr-2024	26-Apr-2024	Proiect	Confirmare tema proiect + cine vrea sa invete sa lipeasca
29-Apr-2024	3-May-2024	Proiect	Milestone - documentatie
6-May-2024	10-May-2024	Proiect	
13-May-2024	17-May-2024	Proiect	Milestone - Hard
20-May-2024	24-May-2024		Milestone - Soft, all done
27-May-2024	31-May-2024	Prezentare Proiecte	PM Fair

Pentru orice milestone întârziat – maxim 70% din punctaj

	"proiecte hardware heavy"	"proiecte software heavy"	proiect "echilibrat"
Milestone - documentatie	0.4	0.4	0.4
Milestone - Hard	0.9	0.7	0.8
Milestone - Soft, all done	0.7	0.9	0.8
PM Fair	1	1	1

Alegerea temei [cel târziu săpt 9]

Tema trebuie să fie aprobată de către asistentul de laborator

Nu se aprobă teme banale; ex:

- Ceas digital, termometru digital;
- Ca reguli de referință:
  - Nu poate să fie mai simplu decât un laborator de PM
  - Trebuie să înglobeze noțiuni din minim 3 lucrări de laborator
  - Nu poate să fie bazat pe un tutorial YouTube de 15 minute

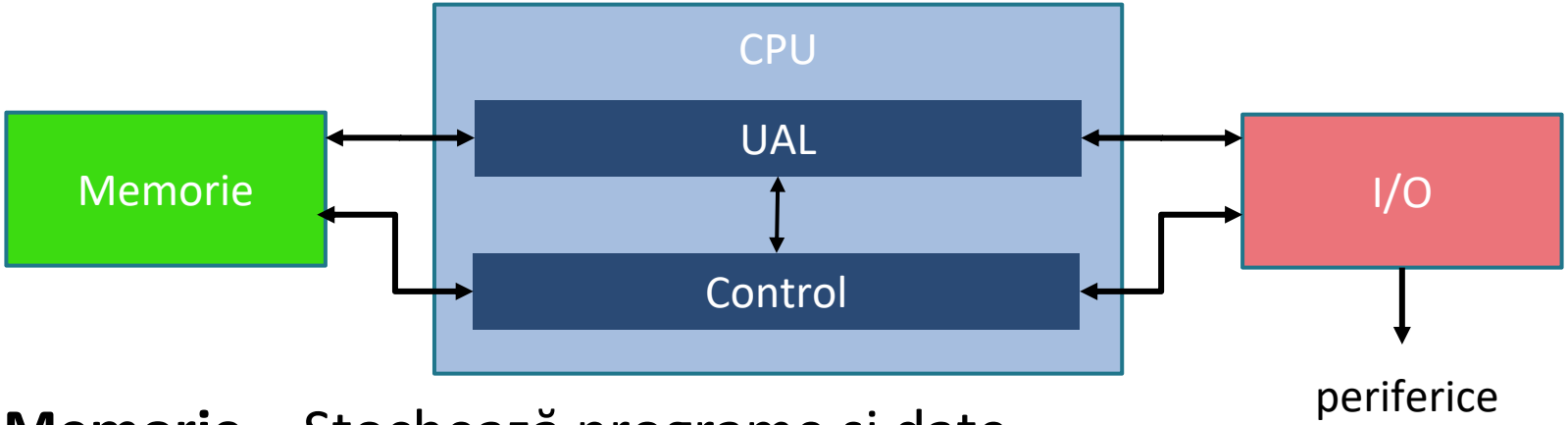
ToDo pentru săptămâna 9

- Temă
- Schemă bloc

Cu ce veți rămâne după proiect?

- Cunoștințe generale despre cum funcționează un sistem de calcul
  - GPIO, clocks & timers, întreruperi, DMA, ADC, SPI, I2C, UART etc.
- Low-level development in C
  - Device Drivers
  - Digital signal processing
- Hardware testing (and building)
  - Schematic & PCB design
  - Circuite analogice (osciloscop, multimetru)
  - Circuite digitale (analizor logic)
- Multe aminitiri (sper) plăcute

Organizarea generală a unui calculator



Memorie – Stochează programe și date
CPU – Central Processing Unit
UAL – Unitate Aritmetică și Logică
Control – Secvențiază transferurile de date
I/O – comunică cu exteriorul

Arhitectura sistemelor de calcul

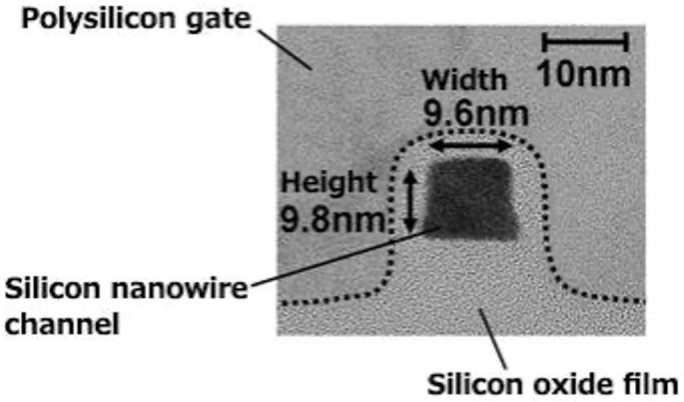
Organizarea clasică (von Neumann) a unei mașini de calcul:

- Programe stocate sub formă de instrucțiuni
- ”General-purpose”
- Datele și instrucțiunile stocate în memorie
- Instrucțiunile executate în ordine

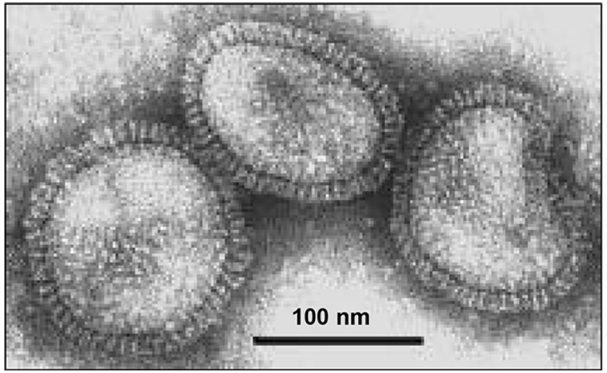
Arhitectura unui sistem este determinată atât de hardware cât și de software.

Putting things into perspective

10 µm – 1971
6 µm – 1974
3 µm – 1977
1 µm – 1985
600 nm – 1994
250 nm – 1997
130 nm – 2001
90 nm – 2004
65 nm – 2006
32 nm – 2010
22 nm – 2012
14 nm – 2014
10 nm – 2017
7 nm – 2018
5 nm – 2020

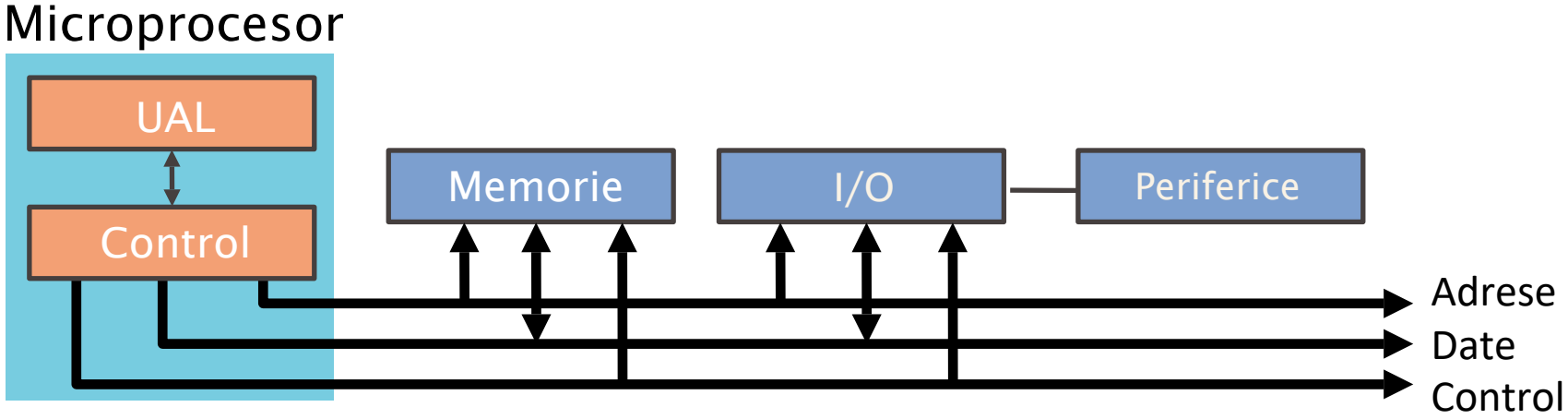


Tranzistor - 10nm



Influenza A virus – 100nm

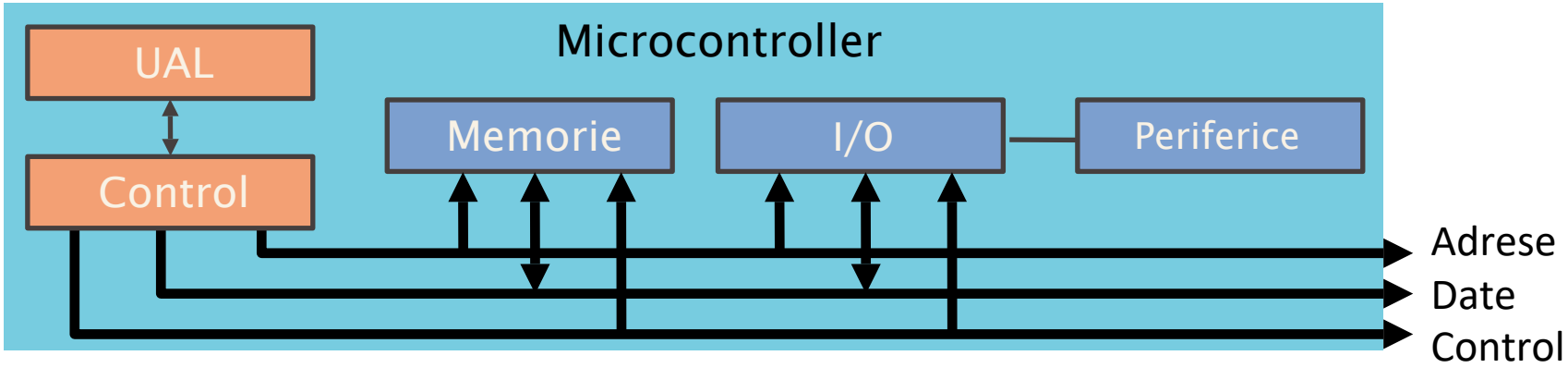
Microprocesoare



High performance, general purpose, pentru PC & workstations
Instruction decode and control, arithmetic/logic operations, registers, timing, external control
Cost tipic: $75 - $500

Cerere anuală: zeci de milioane

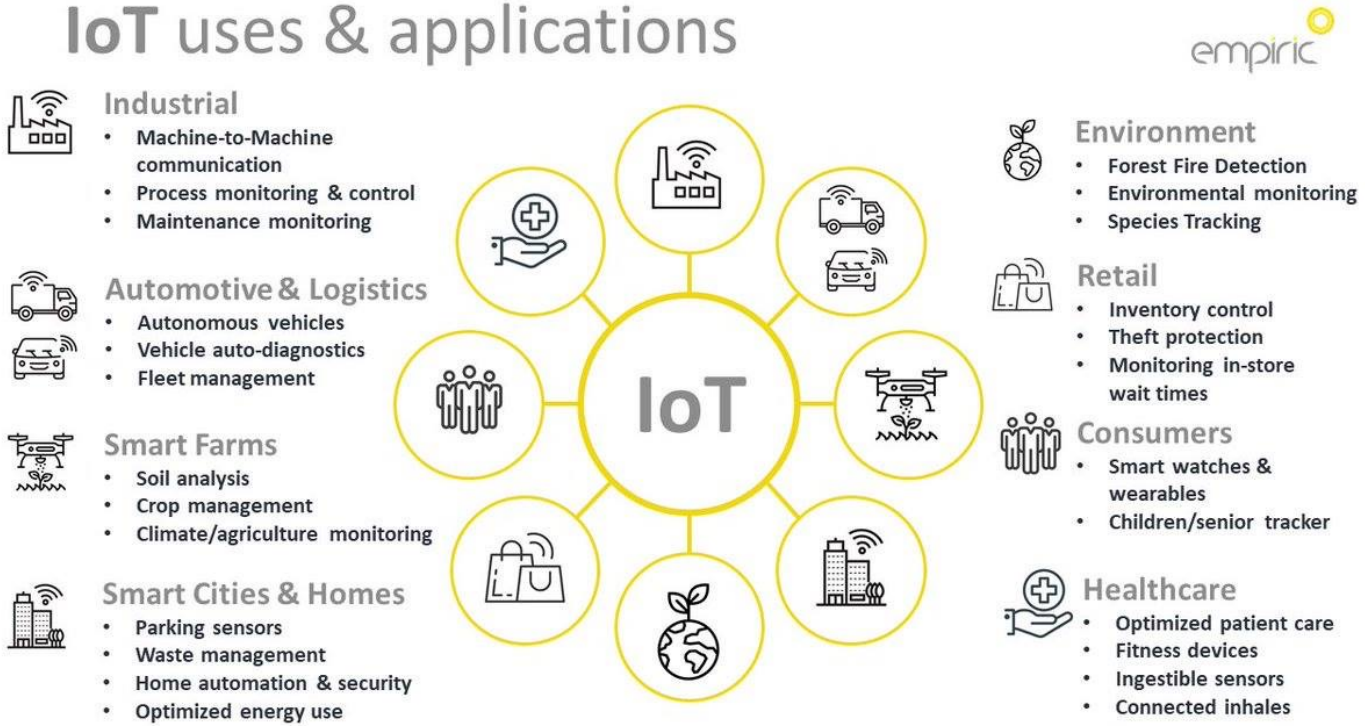
Microcontrollere



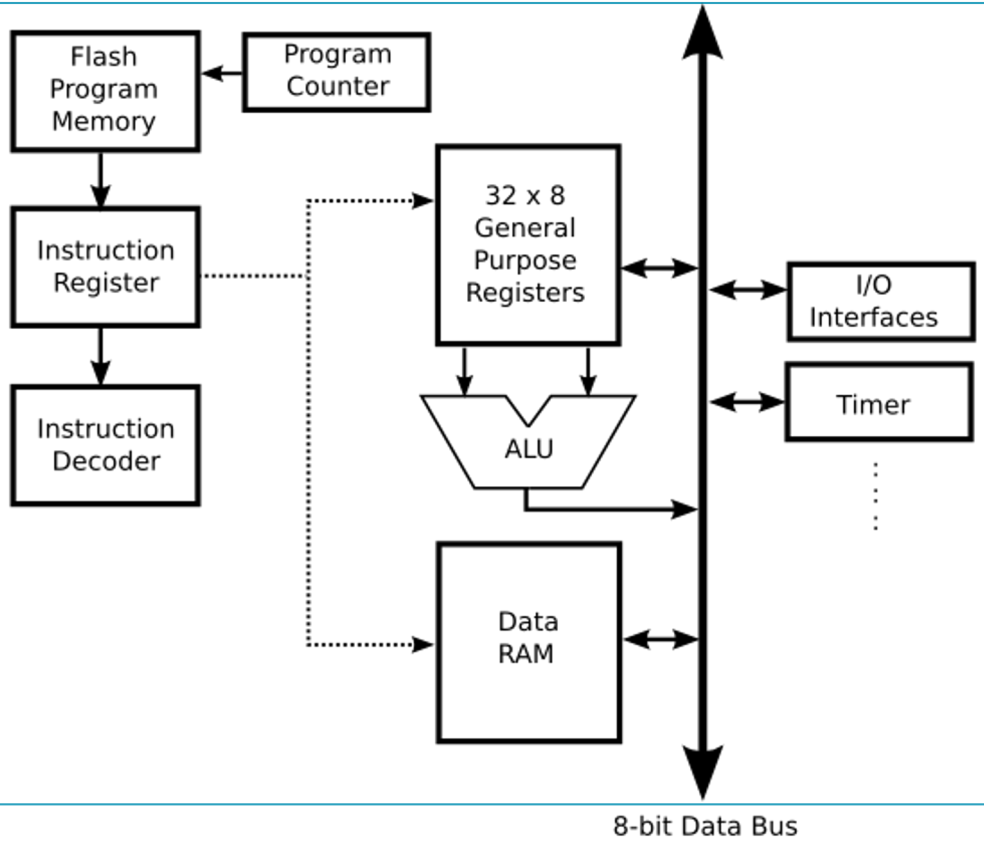
Nivel mult mai mare de integrare pentru controlul embedded
Funcții de microprocesor, plus memorie și periferice on-chip (ex. porturi, timere)
"Swiss army knife" al tehnologiei
Cost tipic: $0.1- $25

Cerere anuală: miliarde!

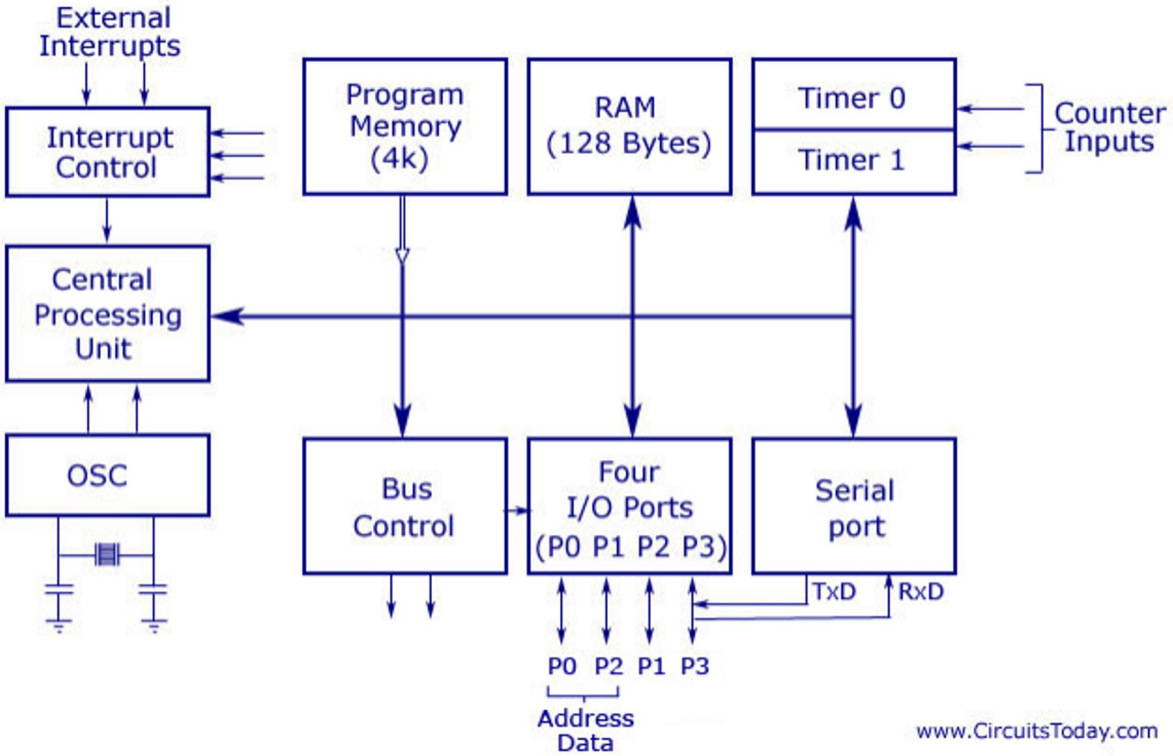
IoT

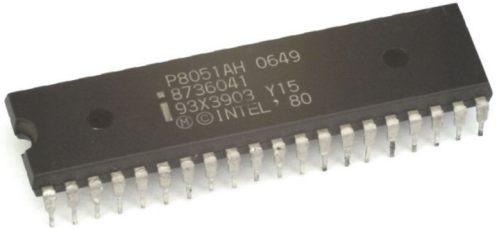


Baseline Microcontroller

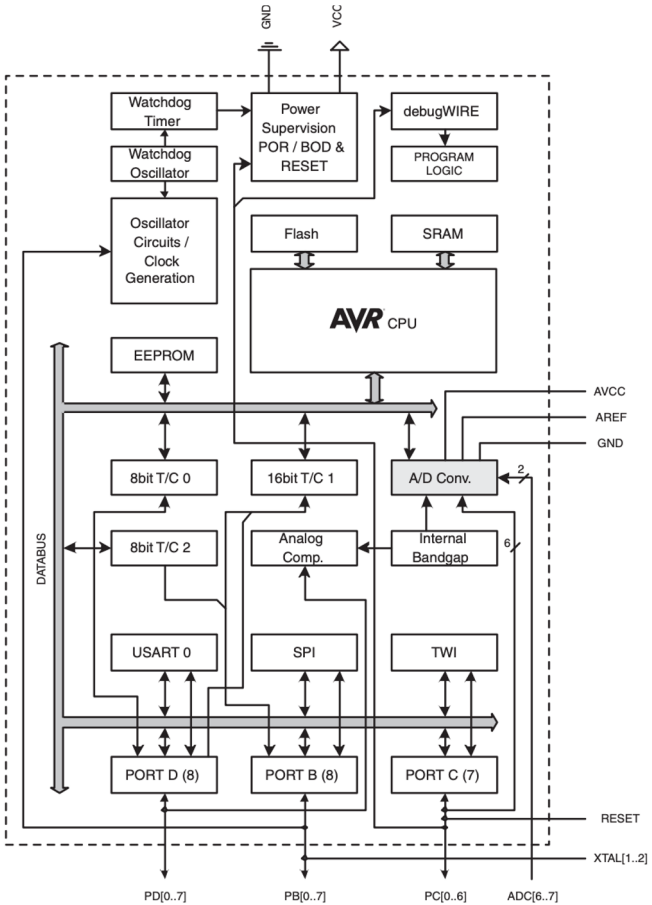


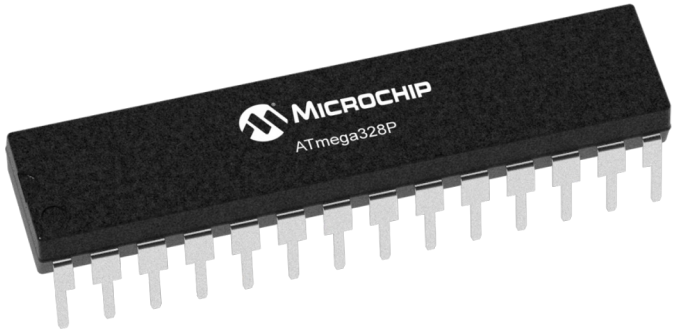
8051 - Intel


External Interrupts
Interrupt Control
Program Memory (4k)
RAM (128 Bytes)
Timer 0
Timer 1
Counter Inputs
Central Processing Unit
OSC
Bus Control
Four I/O Ports (P0 P1 P2 P3)
Serial port
TxD
RxD
P0 P2 P1 P3
Address Data
www.CircuitsToday.com

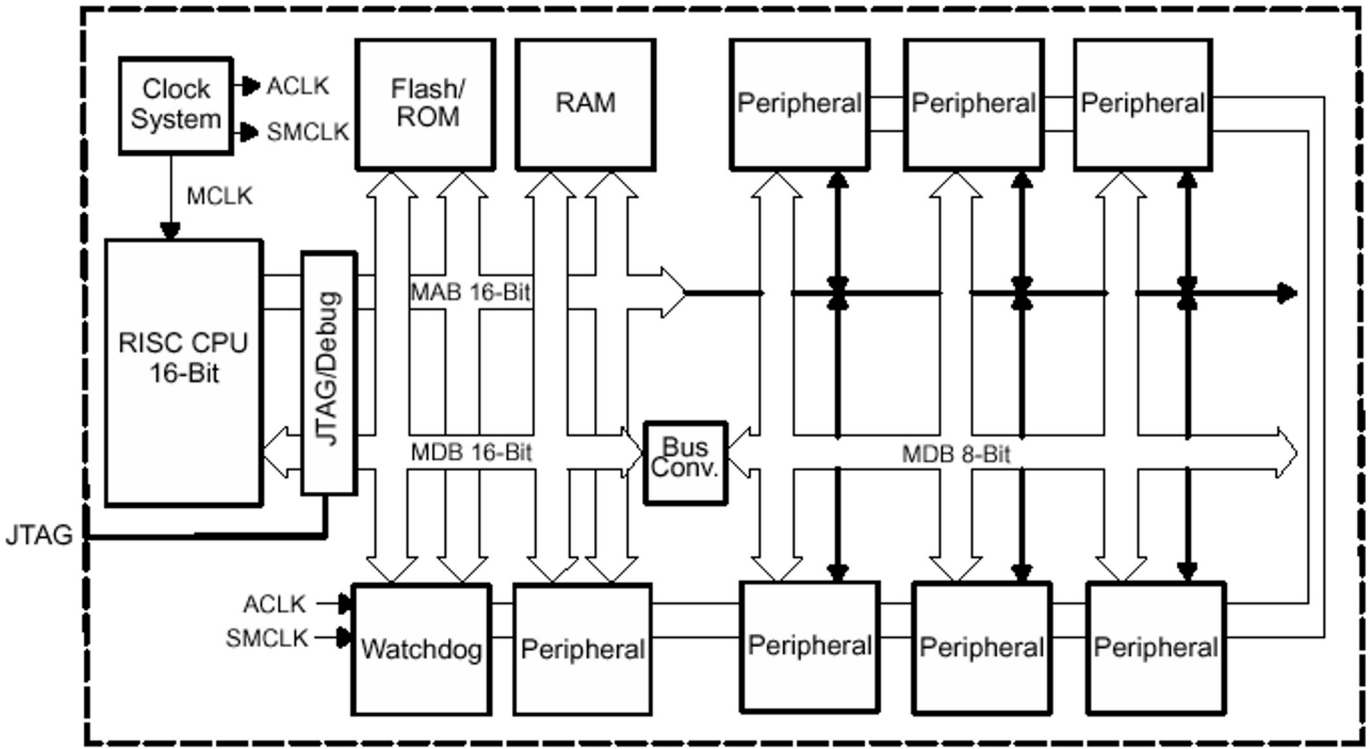

P8051AH 0649
8736041
93X3903 Y15
©INTEL '80

ATmega328p - Atmel





MSP430 – Texas Instruments



25 billion
transistors

37 billion
transistors

92 billion
transistors

3-nanometer technology

Next-generation GPU architecture

Advanced Media Engine

with AV1 decode

M3

M3 PRO

M3 MAX

Up to
2.5x
Faster GPU rendering

Faster 16-core Neural Engine

Up to
8-core CPU
10-core GPU
24GB
unified memory

Up to
12-core CPU
18-core GPU
36GB
unified memory

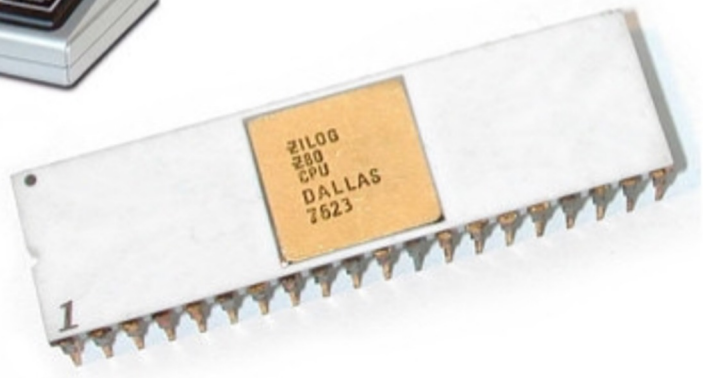
Up to
16-core CPU
40-core GPU
128GB
unified memory

World-Changing Microprocessors

Zilog Z80

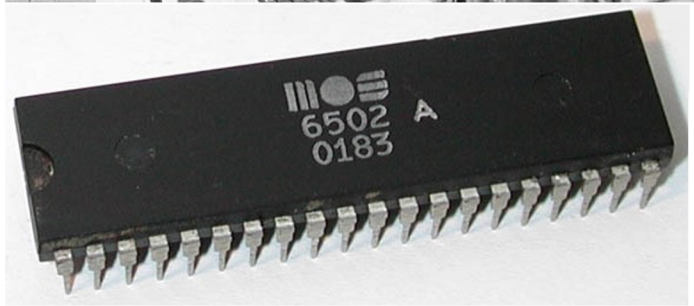
- Released 1976
- 8-bit architecture
- Enhanced clone of Intel 8080
- Nintendo Game Boy
- Sega Master System
- Texas Instruments graphing calculators
- Still sold for embedded applications

Zilog



MOS Technology 6502 (1975)

- 6502 - inexpensive and capable
- Intel 8080 sold for $149
- 6502 sold for only $25
- **Apple II (1977)**
- Atari 2600
- Nintendo Entertainment System (NES)



Motorola 68000

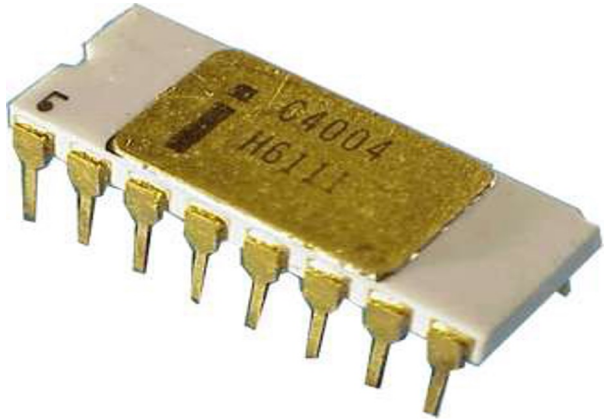
- Released 1980
- 16/32 bits
- UNIX workstations
- Apple Macintosh

MOTOROLA

AIM PowerPC 601

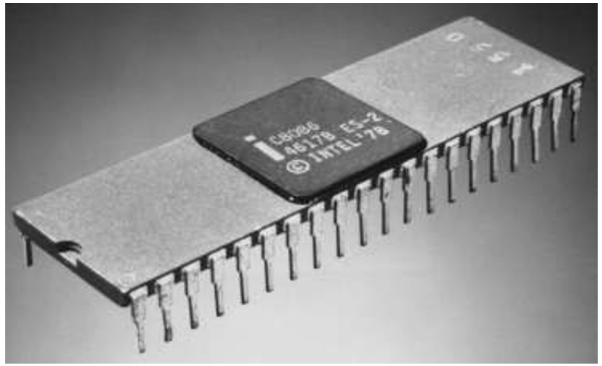
- 1992
- Apple, IBM & Motorola ”unholly alliance”
- Break the Intel + Microsoft monopoly
- Used in Apple Macintosh from 1994 to 2006
- Nintendo Wii
- Xbox 360
- Sony PlayStation 3 (part of Cell processor)

INTEL 4004



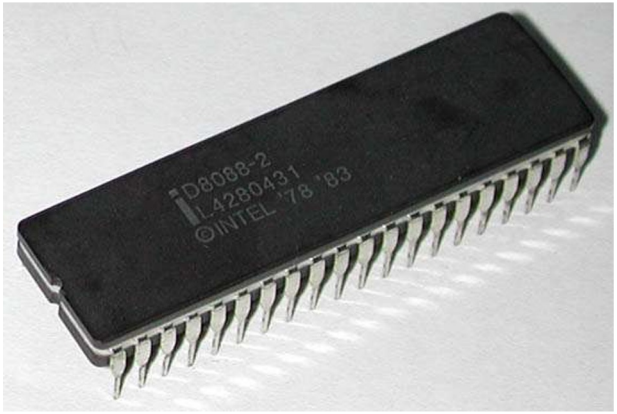
- Introduced in 1971
- First Intel uP
- Word width: 4-bit
- 2300 transistors
- Clock: 108KHz/500/740
- 46 instructions
- Registers: 16 x 4-bit
- Stack: 12 x 4-bit
- Address space
  - 1Kb of program, 4Kb of data

INTEL 8086



- Introduced in 1978
- First 16-bit µP
- 4.77 MHz, 8 MHz and 10 MHz
- 16-bit data bus and 20-bit address bus
- 29,000 transistors
- 2.5 million instructions per second
- Could access 1 MB of memory
- 22,000 instructions
- ***Multiply*** and ***Divide*** instructions

INTEL 8088



- Introduced in 1979.
- Created as a cheaper version of Intel's 8086
- 16-bit processor with an 8-bit external bus
- 2.5 million instructions per second
- This chip became the most popular in the computer industry when IBM used it for its first PC.

INTEL CORE I7

- Introduced in 2008
- 4 physical cores
- Clock speed from 2.66GHz to 3.33GHz
- 781 million transistors
- 64 KB of L1 cache per core, 256 KB of L2 cache and 8 MB of L3 cache

INTEL CORE I5

- Introduced in 2009
- 4 physical cores
- Clock speed is from 2.40GHz to 3.60GHz
- 781 million transistors
- 64 KB of L1 cache per core, 256KB of L2 cache and 8MB of L3 cache

INTEL CORE I3

- Introduced in 2010
- 2 physical cores
- Clock speed is from 2.93GHz to 3.33GHz
- 781 million transistors
- 64 KB of L1 cache per core, 512KB of L2 cache and 4MB of L3 cache

INTEL CORE I9

- Introduced in 2017
- 10-18 physical cores
- Clock speed is from 1.8GHz to 5.1GHz
- ~7 billion transistors (depending on version and core count)

https://en.wikipedia.org/wiki/List_of_Intel_Core_i9_processors

Ce vă trebuie pentru a reuși la acest curs?

- Cunoștințe de C și (ceva) electronică
- Dorința de a învăța multe despre ce se petrece în calculatorul vostru
- Tenacitate. Software is hard, Hardware is even harder!
  - Hard to find out how it works
  - Hard to write code for
  - Hard to debug
- Dorința de a crea un produs complet