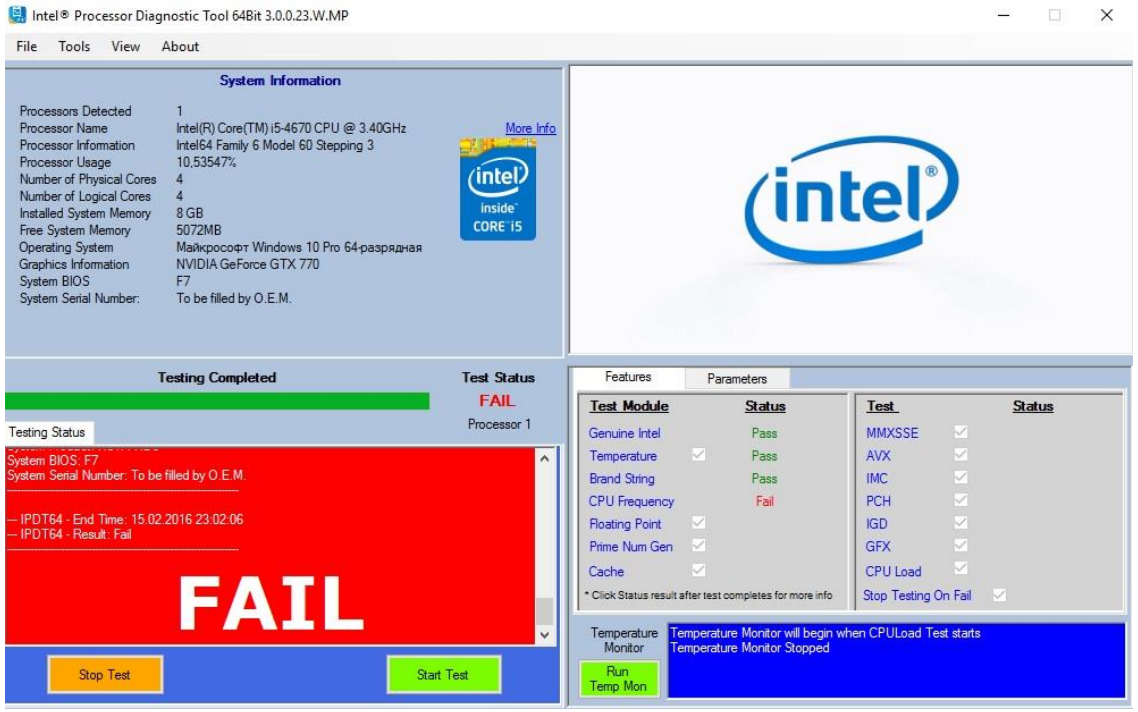
Computer Architecture -22966-

- Carlos J. Barrios H., PhD.
- cbarrios@uis.edu.co
- @carlosjaimebh

"Sure, it will be an eyesore, but after we build a lot of them, it'll fit right in!"

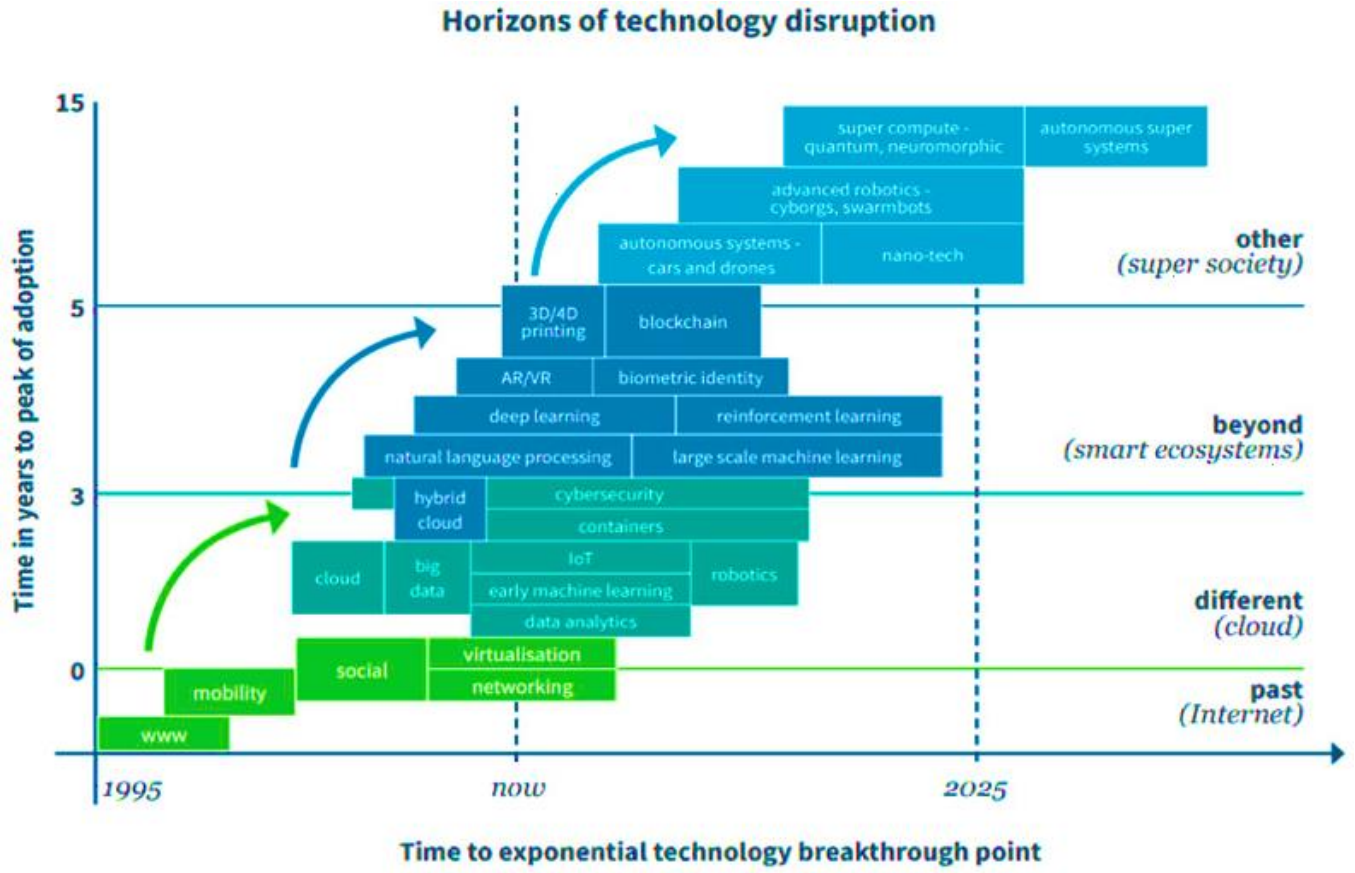
Business vs Engineering



« The problem seems to be that elevated operating voltages have led to instability and even processor failures, requiring a microcode update ».

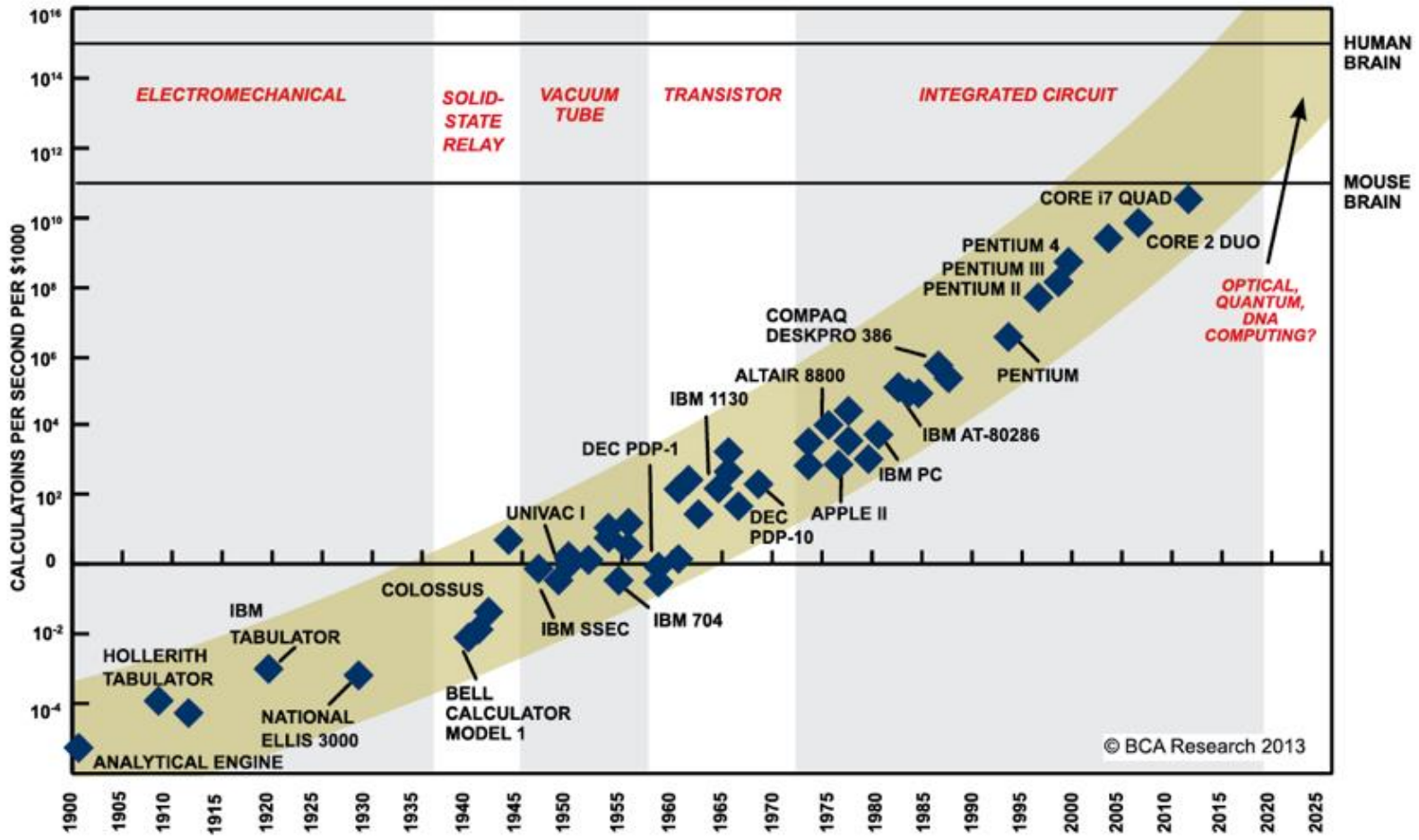
https://www.theregister.com/2024/08/09/opinion_column_intel/

New Computing – New Humans



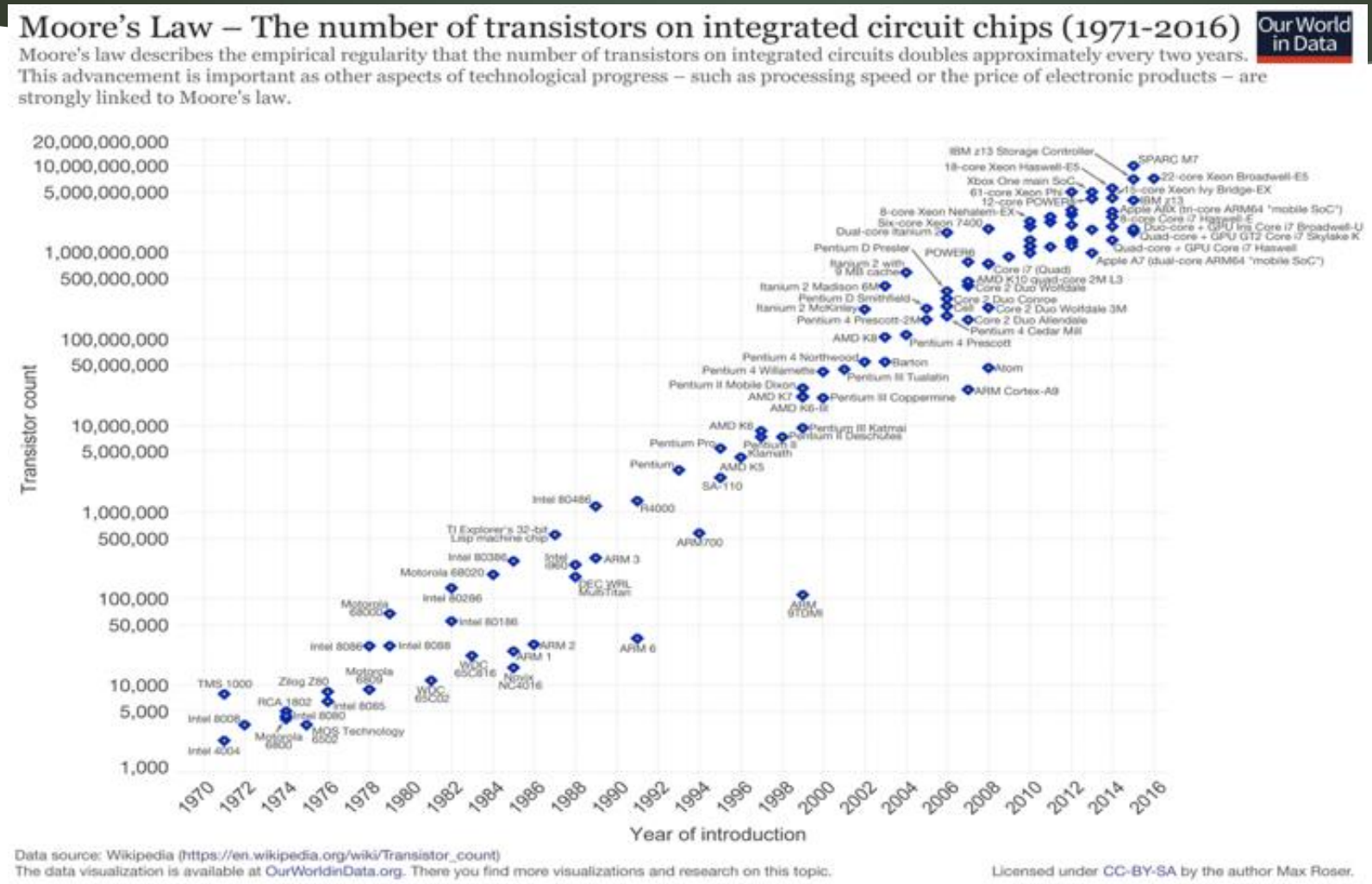
From: http://asiandatascience.com/horizons-of-technology-disruption/

Computer Disruption



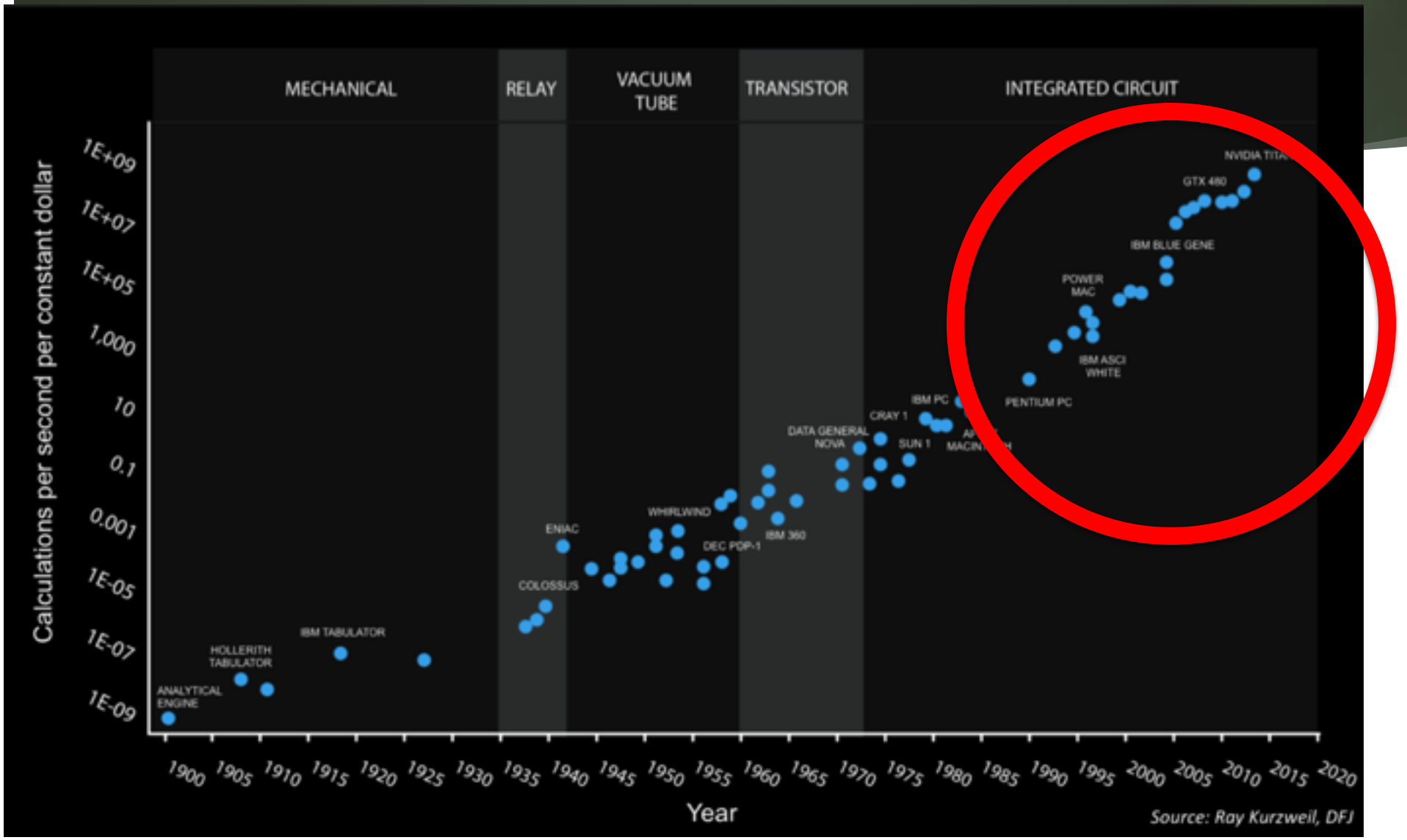
SOURCE: RAY KURZWEIL, "THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY", P.67, *THE VIKING PRESS*, 2006. DATAPOINTS BETWEEN 2000 AND 2012 REPRESENT BCA ESTIMATES.

The Moore Evolution



Gordon Moore (In the 60's)

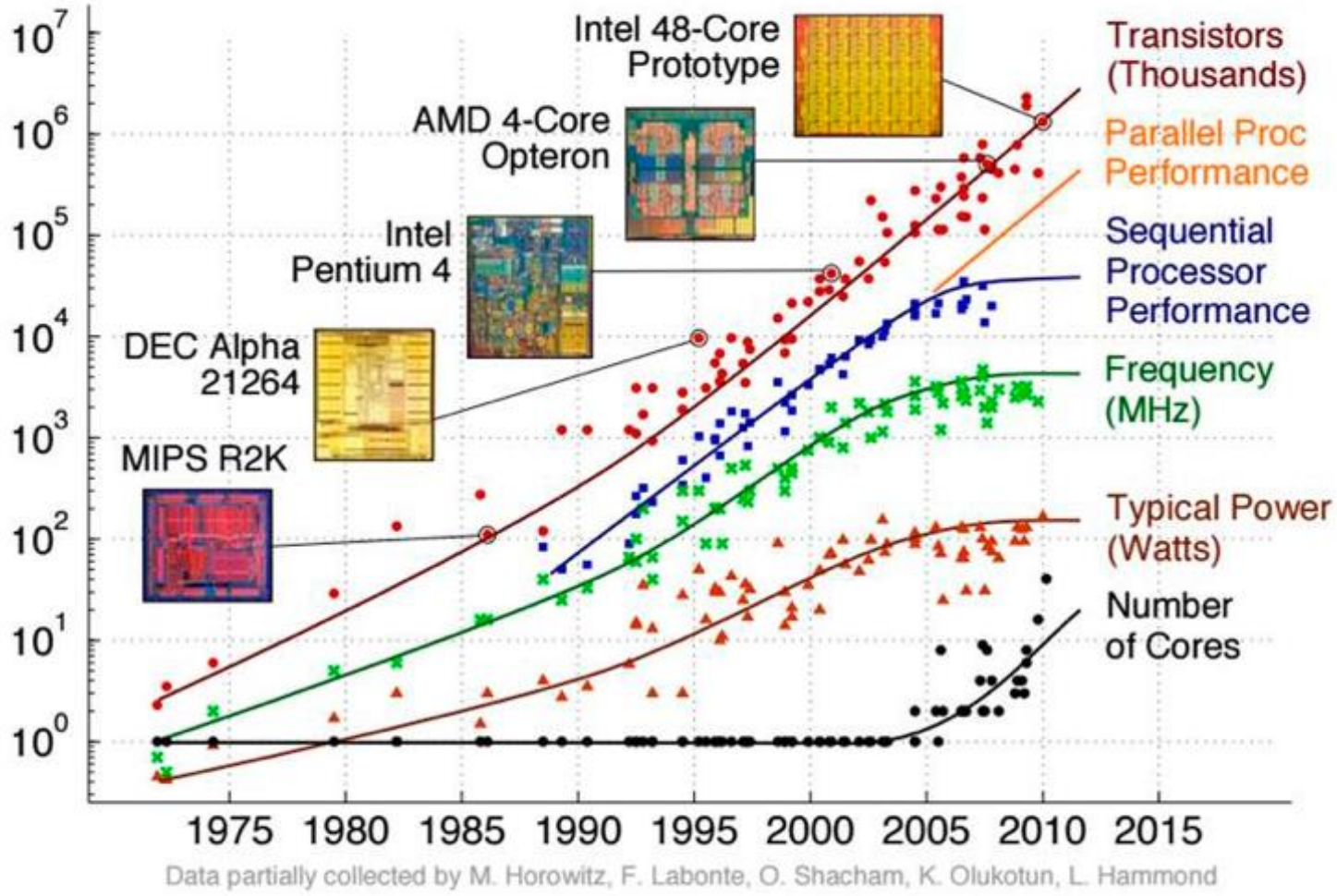
The (Post) Moore Era



After 120 years… The Moore's Law is Dead

Jack Dongarra

Computer (Moore?) Disruption



Gordon Moore pass away March 24/2023

The Cambrian Explosion in Architecture for AI

Satoshi Matsouka Vision

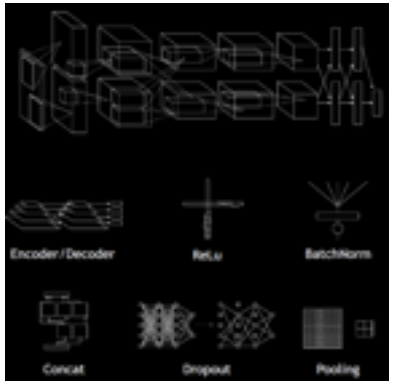

CPU


RAM

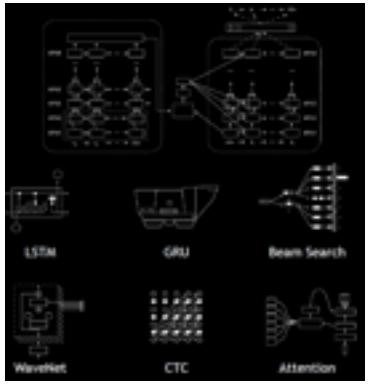

GPU


Storage

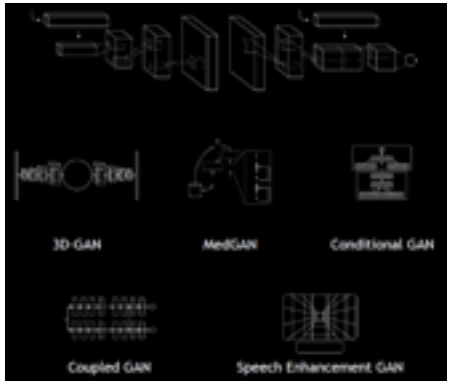
Convolution Networks



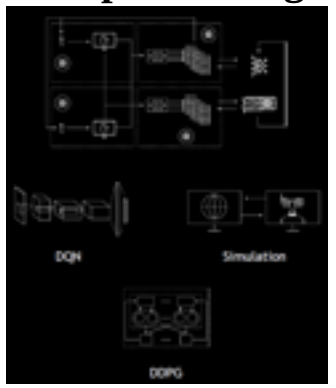
Recurrent Networks



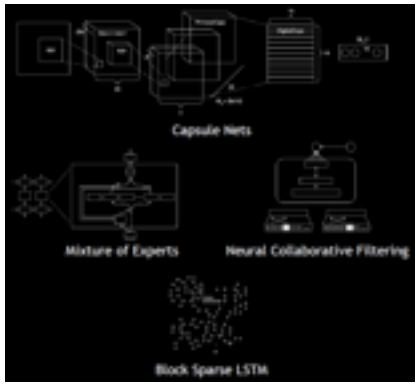
AR Netwroks



Deep Learning



New Networks



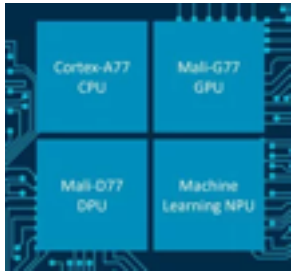

RPI


Nano


TX2


Xavier


FPGA



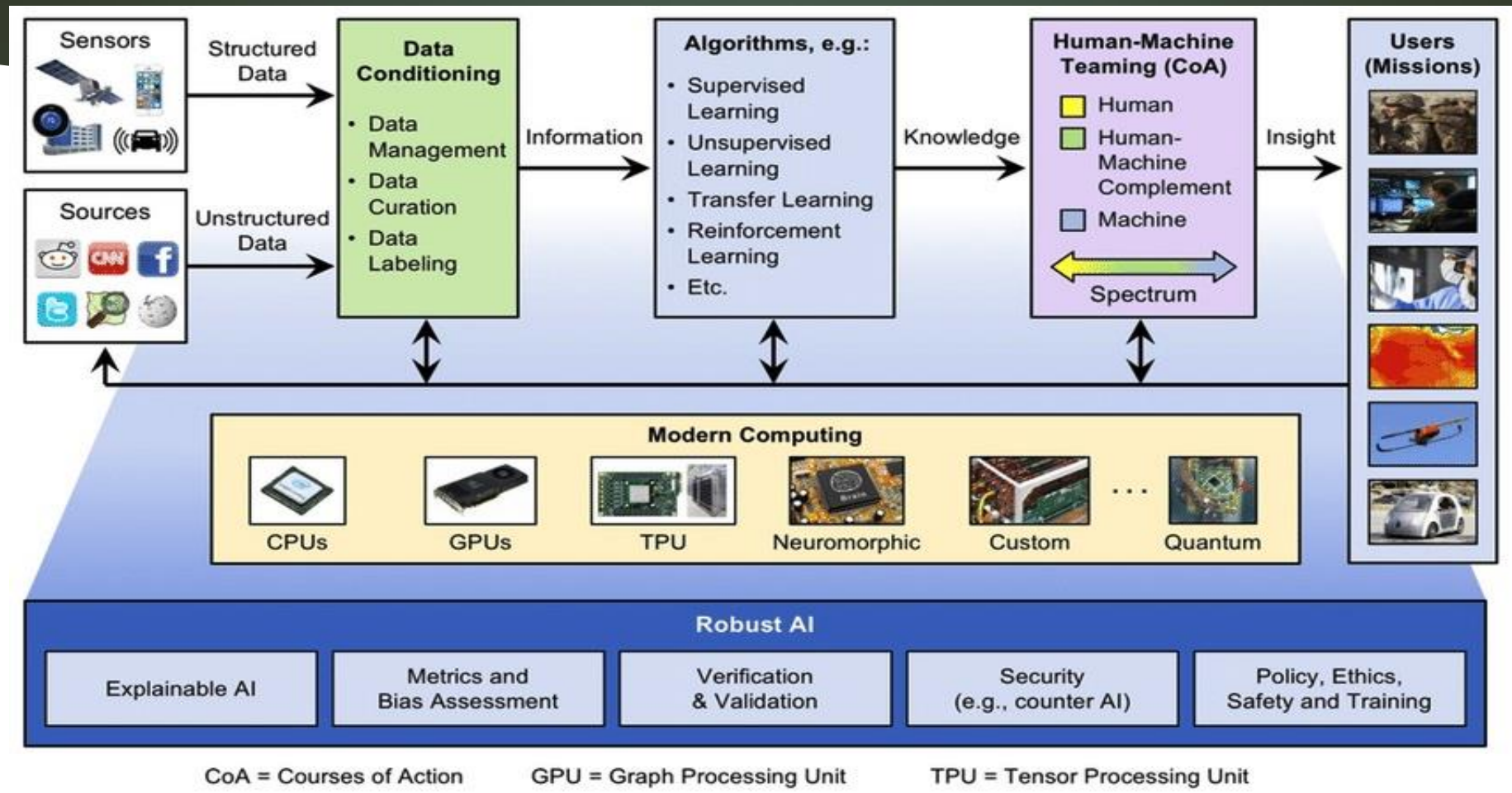
SiP


ASIC


TPU


V100

Canonichal Architecture for AI



Reuther, Albert & Michaleas, Peter & Jones, Michael & Gadepally, Vijay & Samsi, Siddharth & Kepner, Jeremy. (2020). Survey of Machine Learning Accelerators. 10.1109/HPEC43674.2020.9286149.

Computer Architecture Representation (1/2)

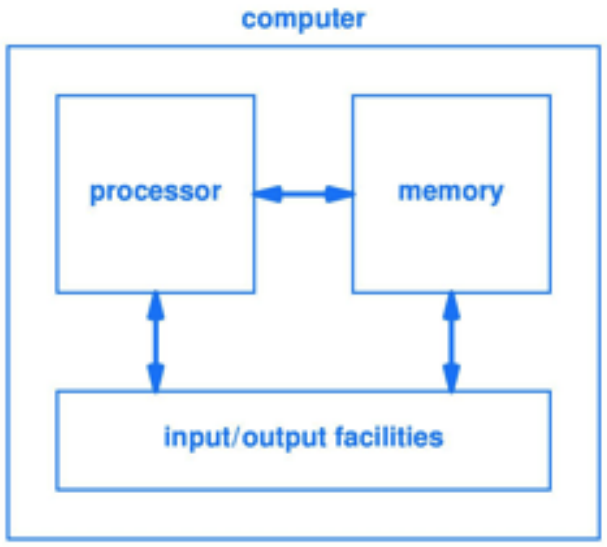


Illustration of the Von Neumann Architecture. Both programs and data can be stored in the same memory.

- Von Neumann Representation
  - Von Neumann Computer Machines
  - Classical Computers
- Input
- Processor
- Memory
- Output

From https://eca.cs.purdue.edu/index.html

Computer Architecture Representation (2/2)

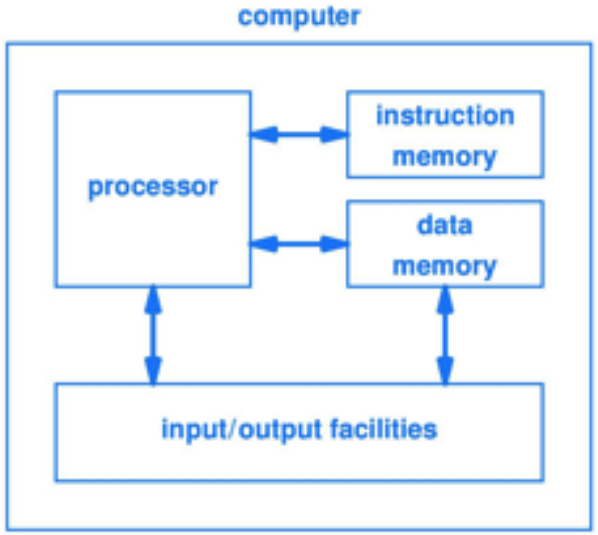
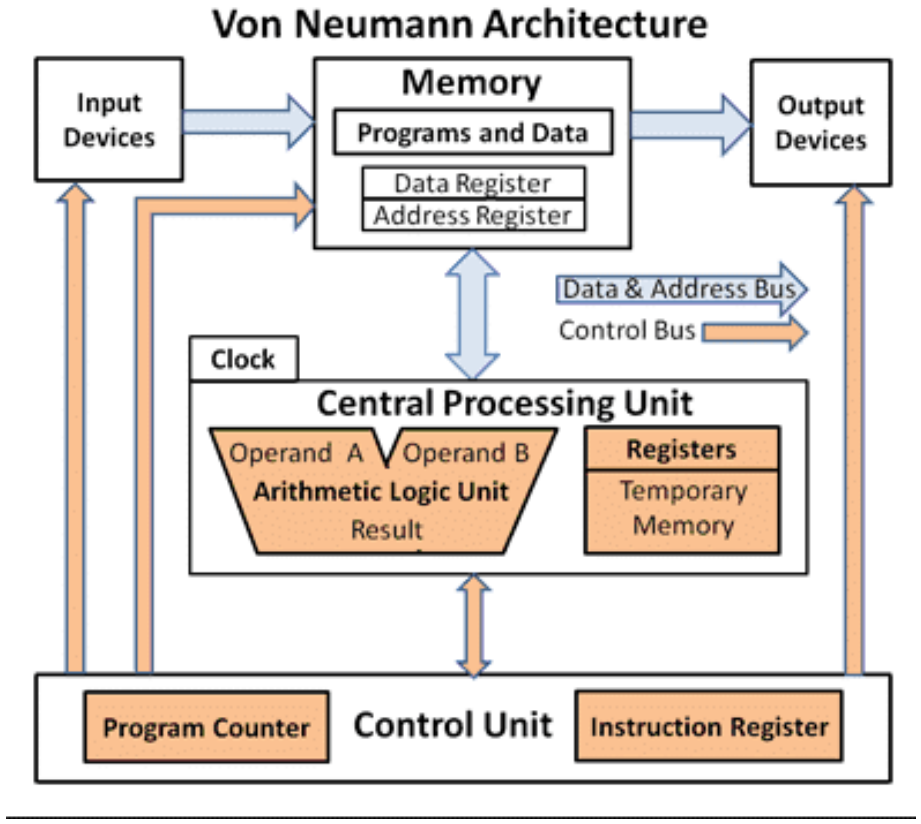


Illustration of the Harvard Architecture that uses two memories, one to hold programs and another to store data.

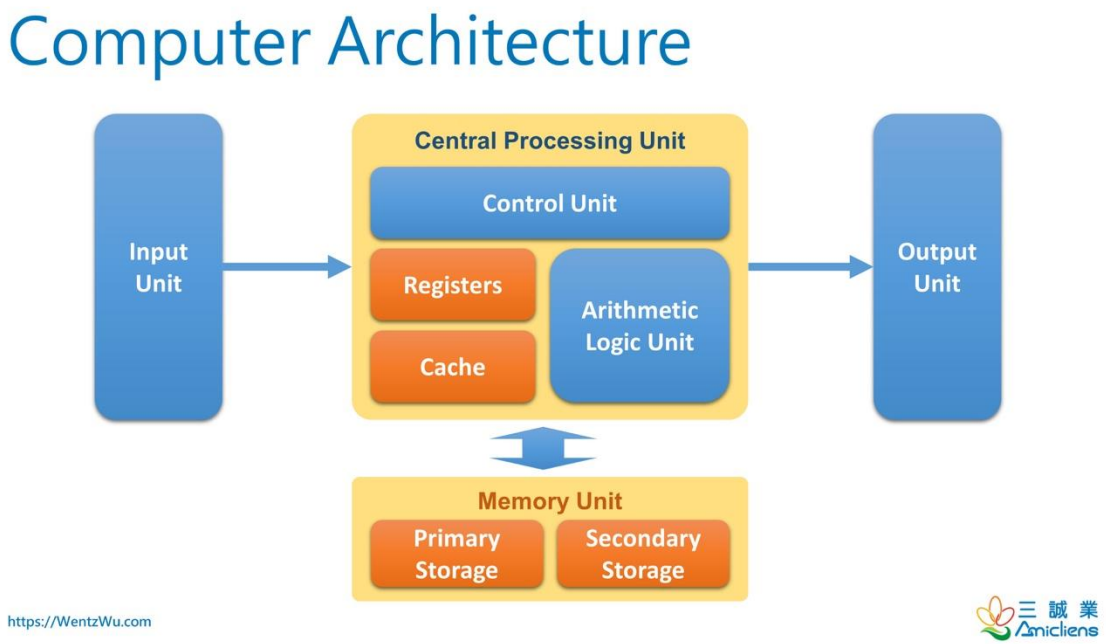
- Non- Von Newmann Representation
  - Non Von Newmann Computer Machines
    - Quantum Computers
    - Harvard Architectures
    - Hybrid Computers (or Post Moore Architectures)
- Processor
- Data Memory
- Instruction Memory
- Output

From https://eca.cs.purdue.edu/index.html

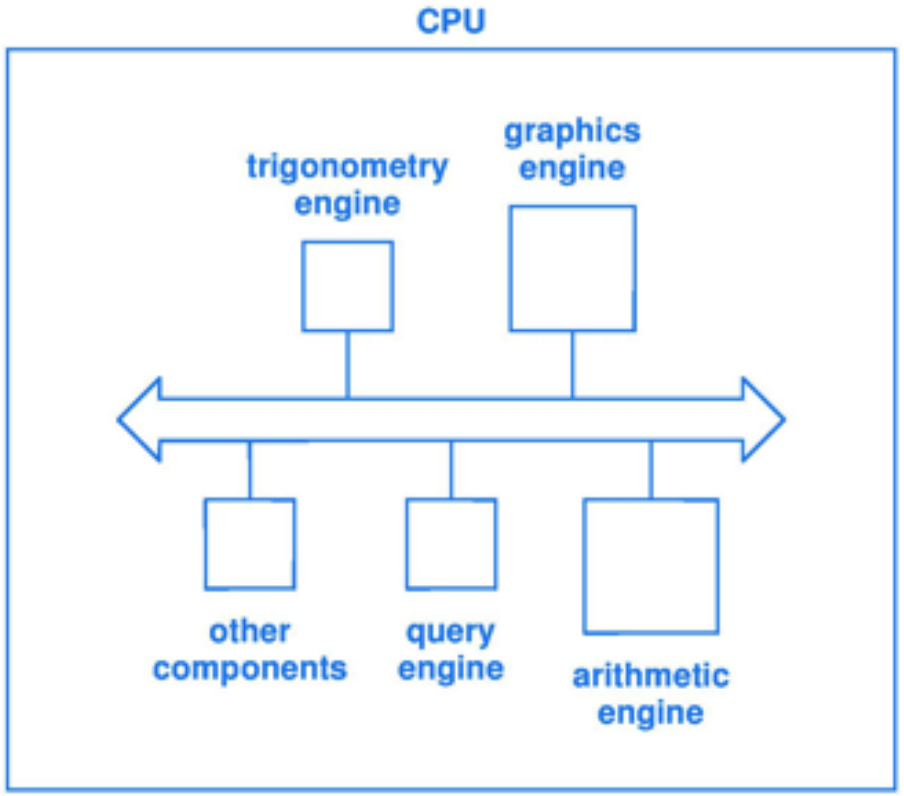
Von Neumann Architecture Representation in Detail



The CPU: Central Processing Unit



Processors Representation

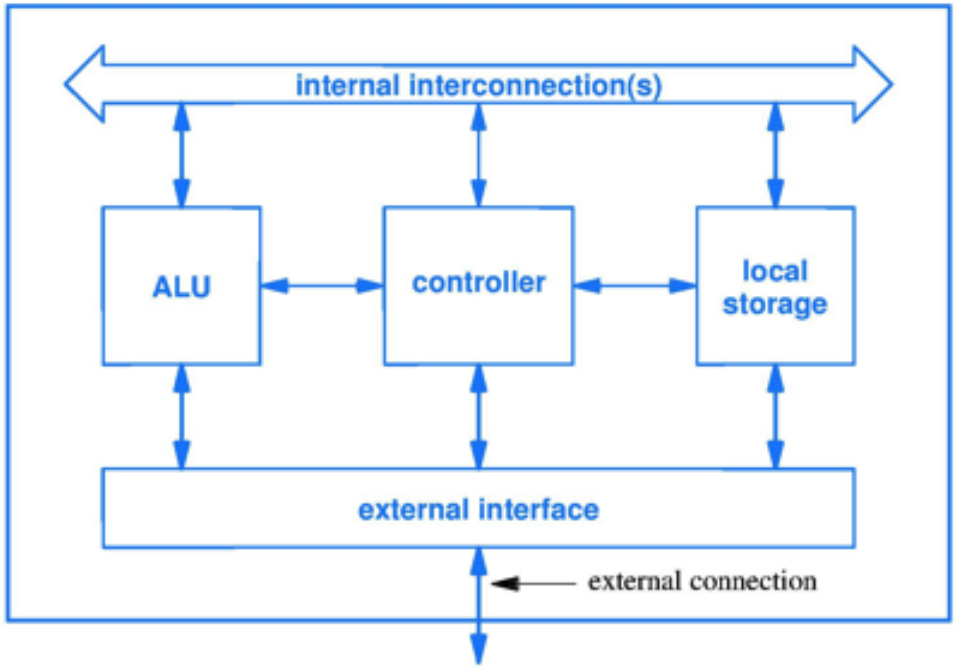


From https://eca.cs.purdue.edu/index.htm I

Processor Structure Representation

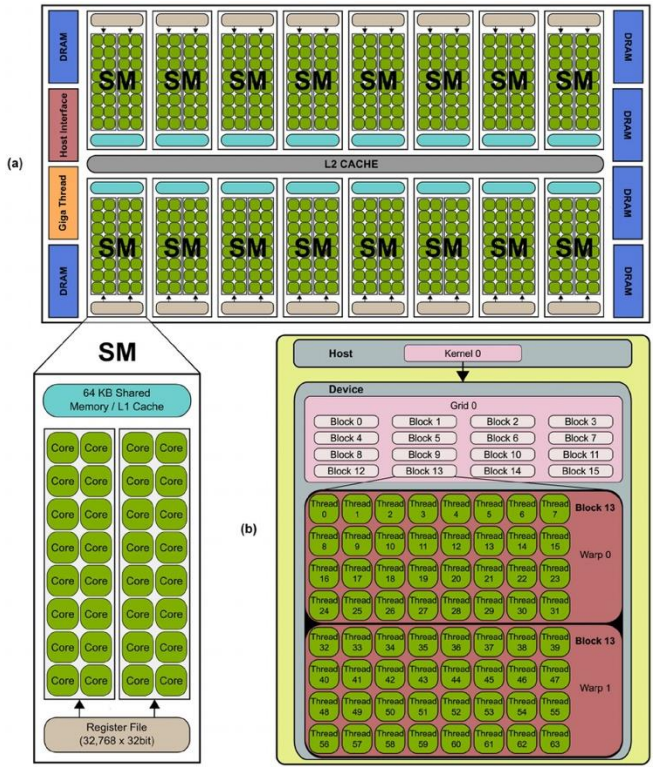
Conceptual Units:

- Controller
- Arithmetic Logic Unit (ALU)
- Local Data Storage (Registers)
- Internal Interconections
- External Interfaces (I/Os)



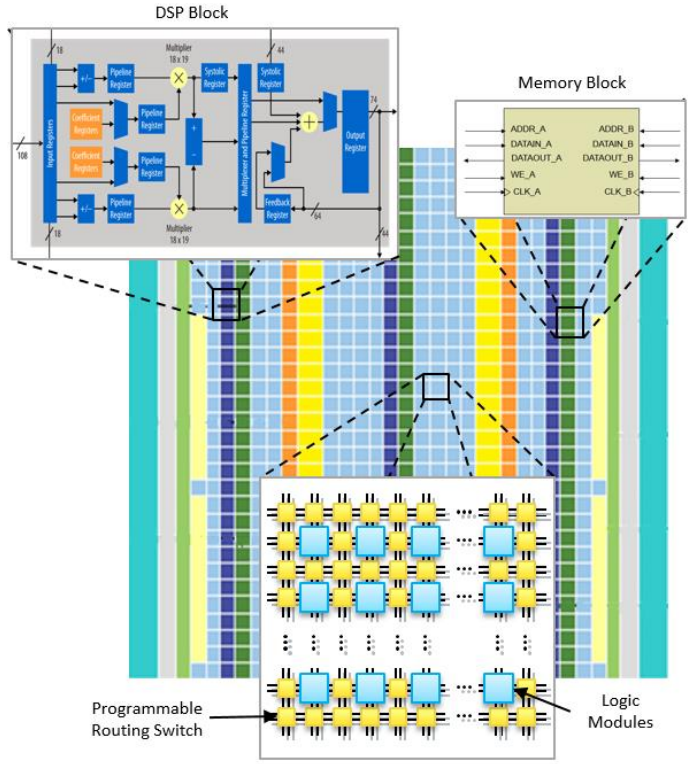
From https://eca.cs.purdue.edu/index.html

More than CPUs: GPUs, FPGAs, TPUs, QPUs…



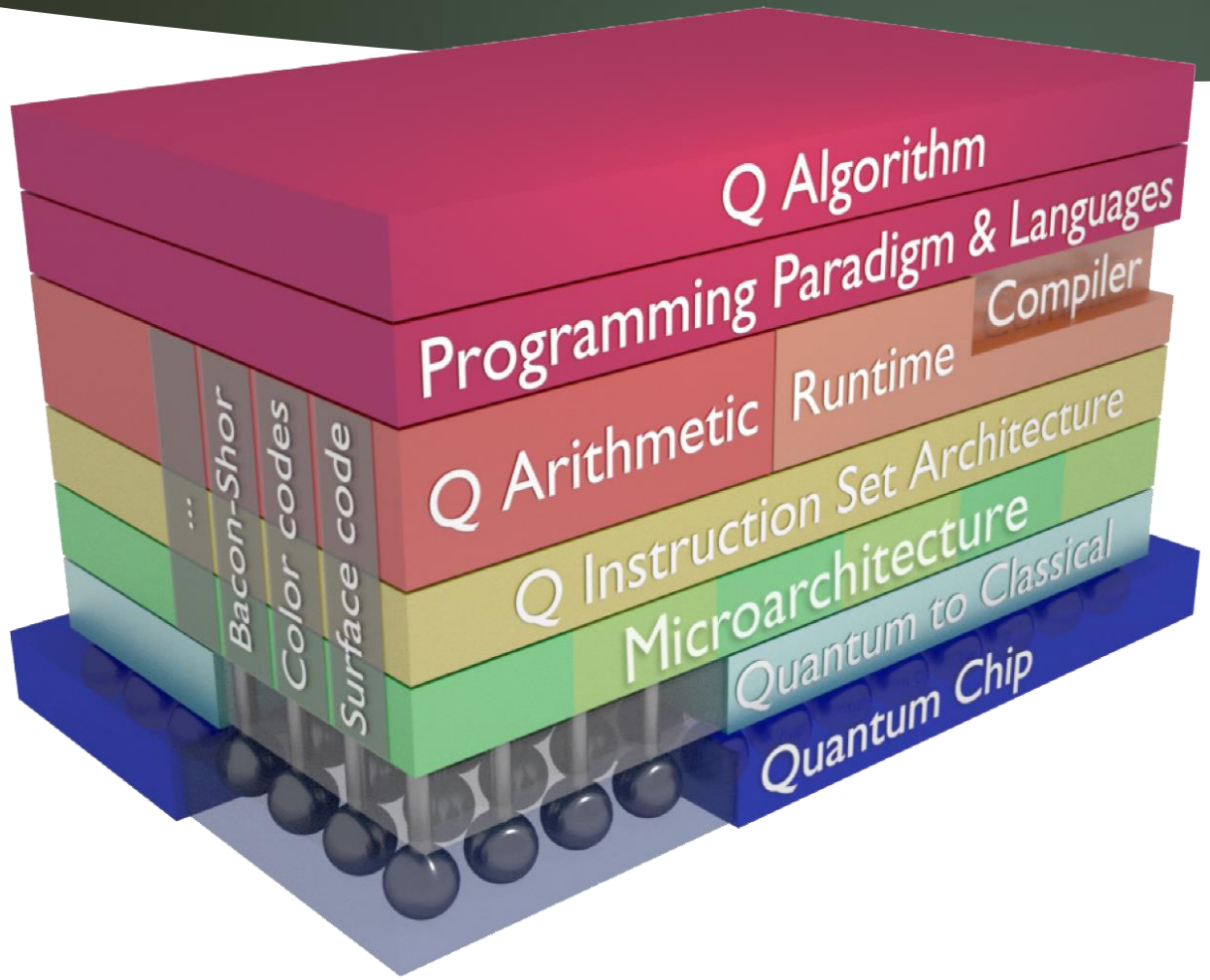
GPU

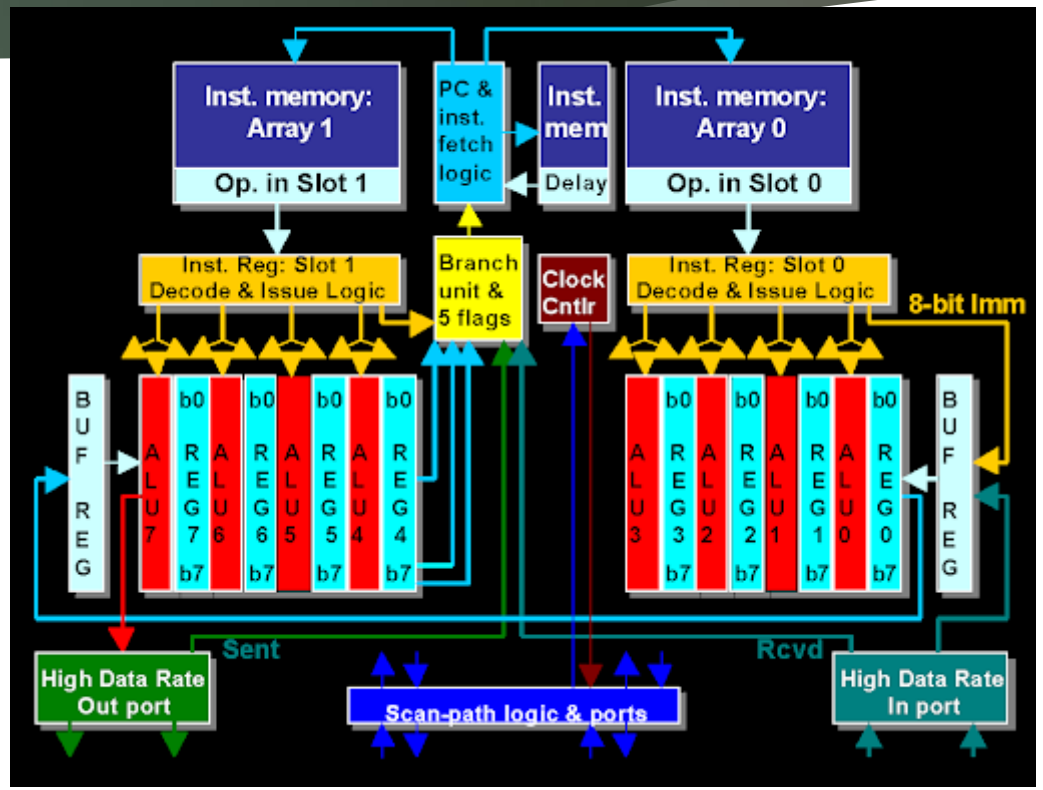
TPU



FPGA

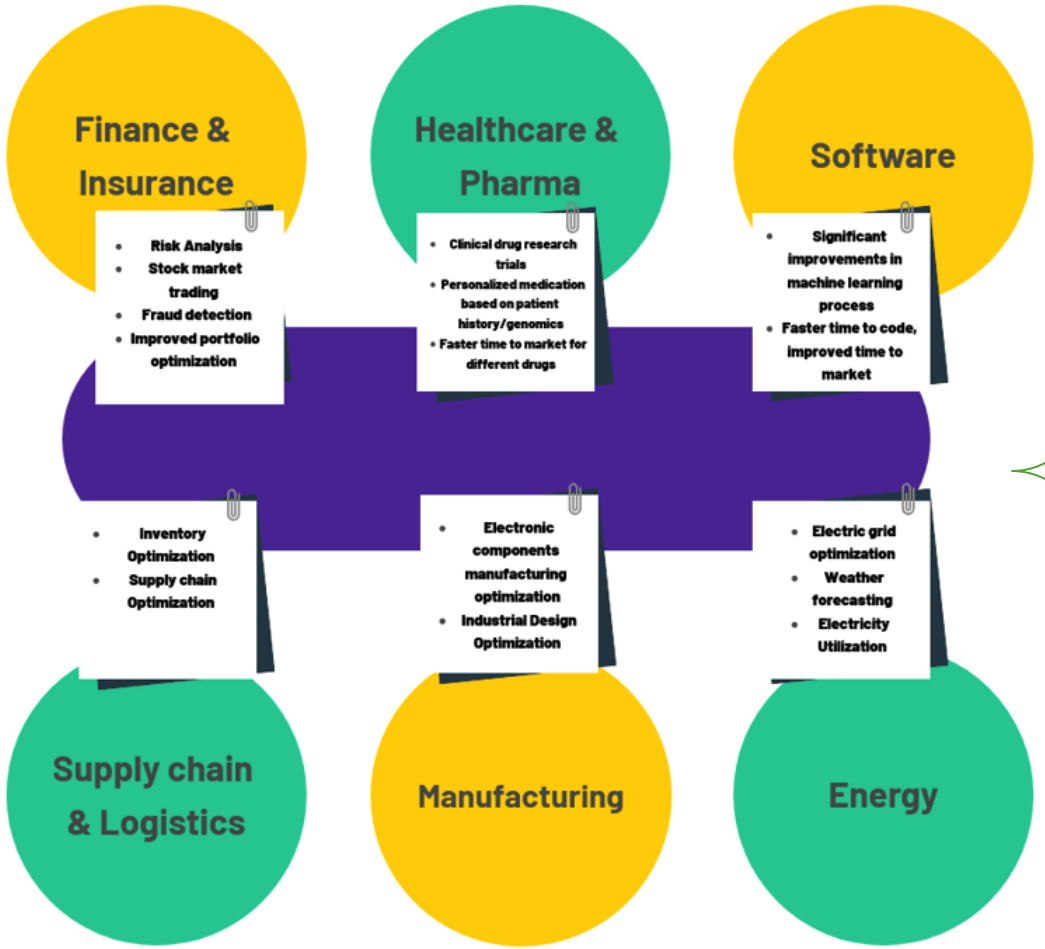
Quantum Processor Unit Architecture*

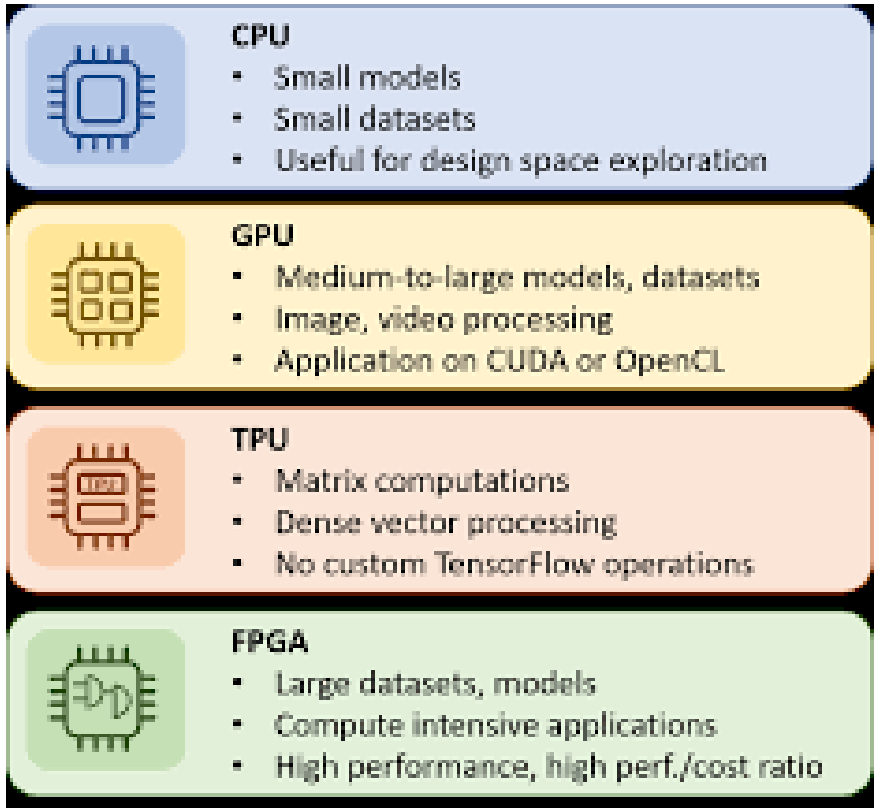




*Simplest Approach

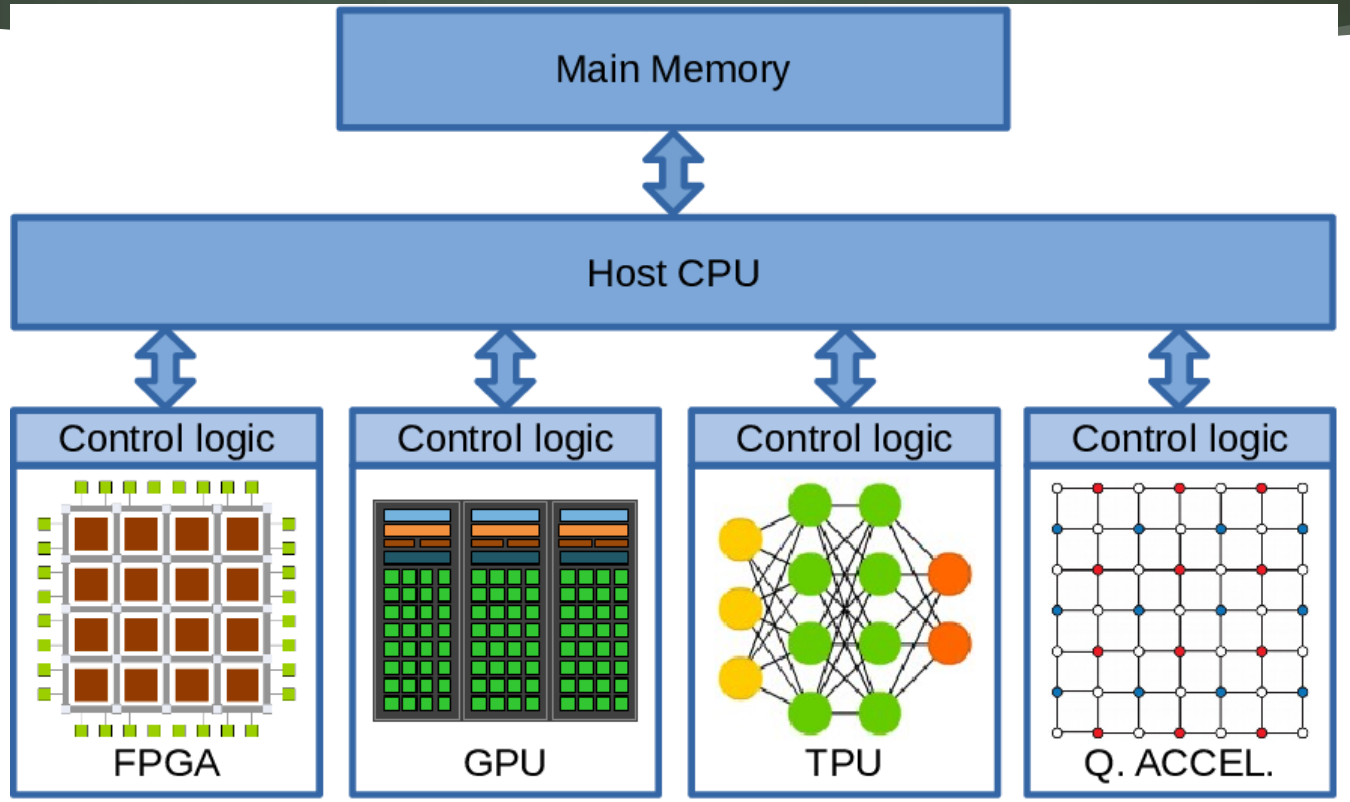
Each PU for Specific Requirements





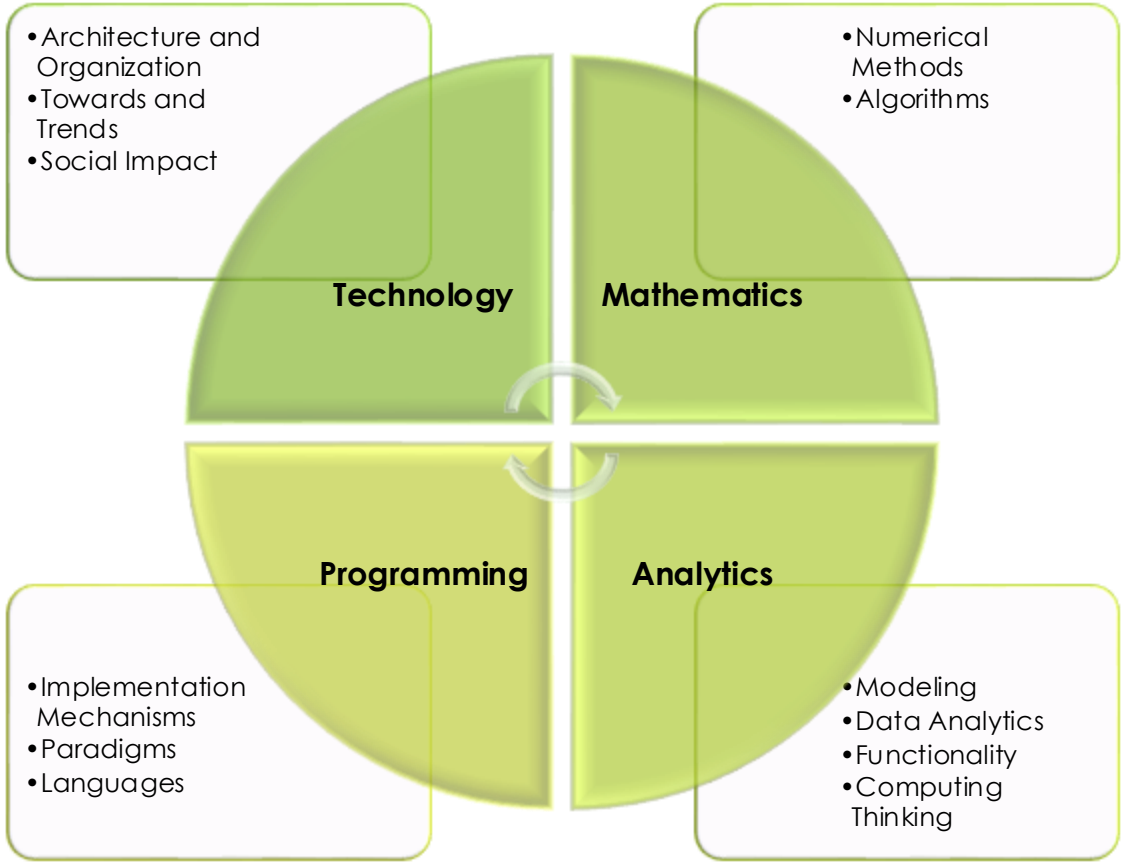
And QPUs

(New) Computer Architectures



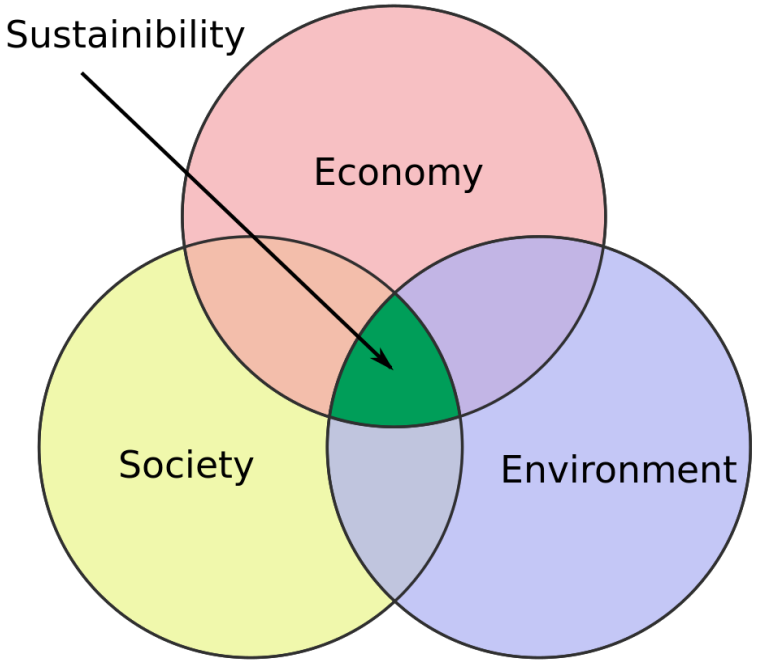
From : Bertels, K., Sarkar, A., Hubregtsen, T., Serrao, M., Mouedenne, A.A., Yadav, A., Krol, A.M., Ashraf, I., & Almudever, C.G. (2020). Quantum Computer Architecture Toward Full-Stack Quantum Accelerators. IEEE Transactions on Quantum Engineering, 1, 1-17.

Computer Knowledge



Sustainability and Durable Computing Technology

Long-term viability involving low energy consumption and affordable costs of production, maintenance, and use.



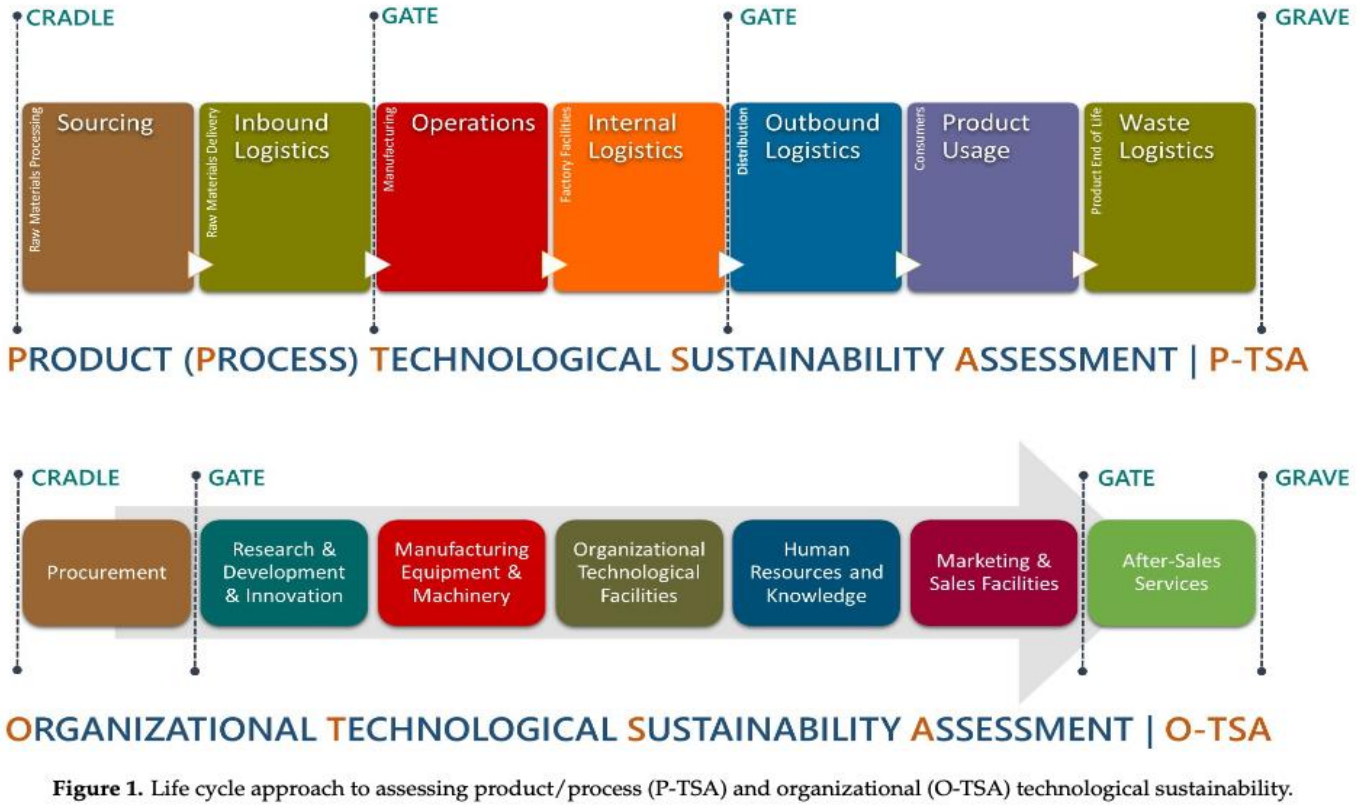
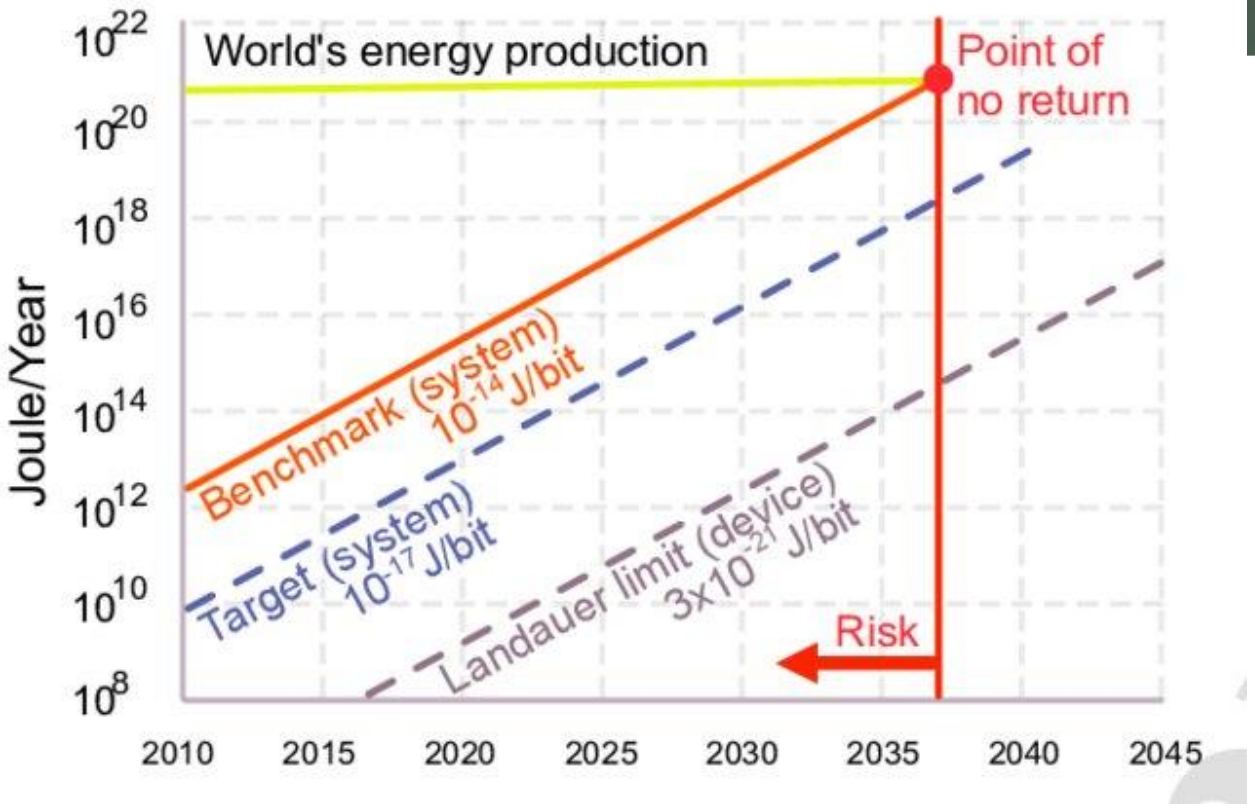
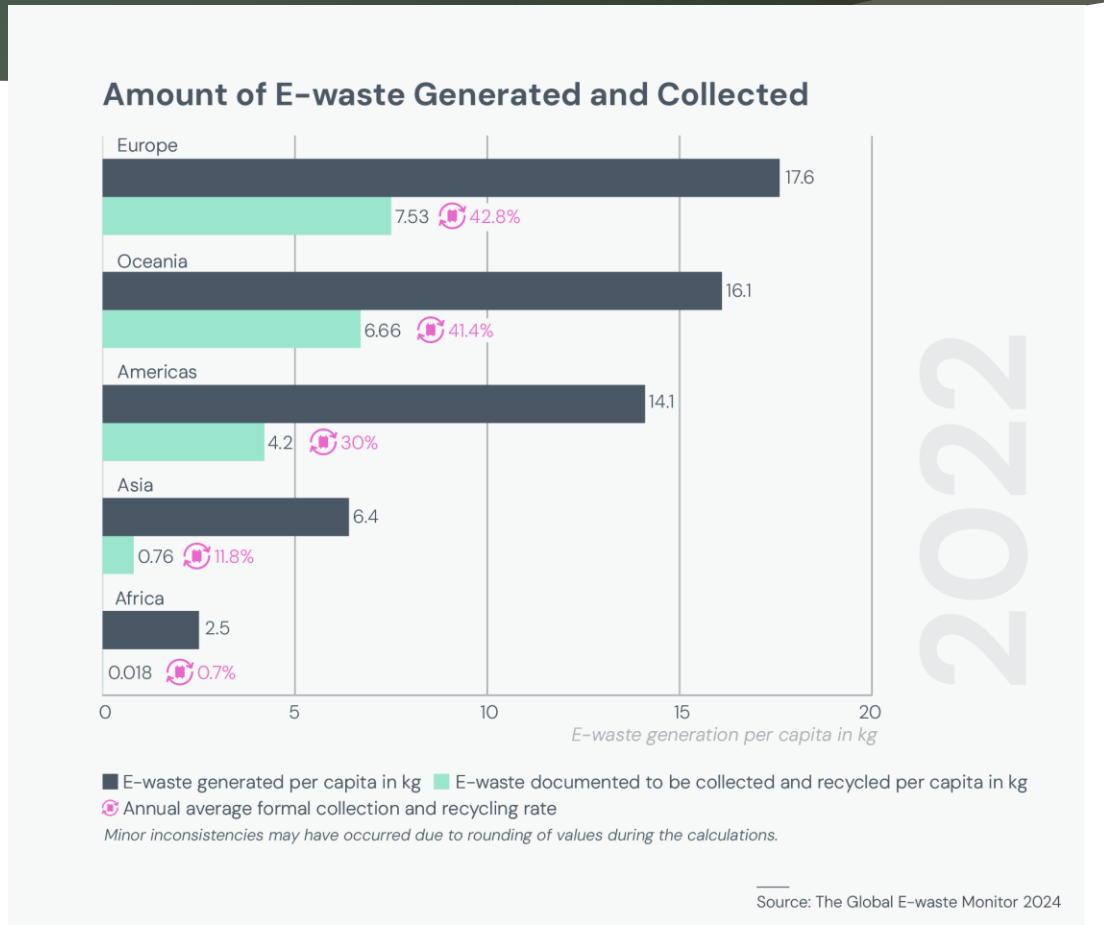


Figure 1. Life cycle approach to assessing product/process (P-TSA) and organizational (O-TSA) technological sustainability.

Vacchi,M.;Siligardi,C.; Demaria, F.; Cedillo-González, E.I.; González-Sánchez, R.; Settembre-Blundo, D. Technological Sustainability or Sustainable Technology? A Multidimensional Vision of Sustainability in Manufacturing. *Sustainability* **2021**, *13*, 9942. https://doi.org/10.3390/ su13179942

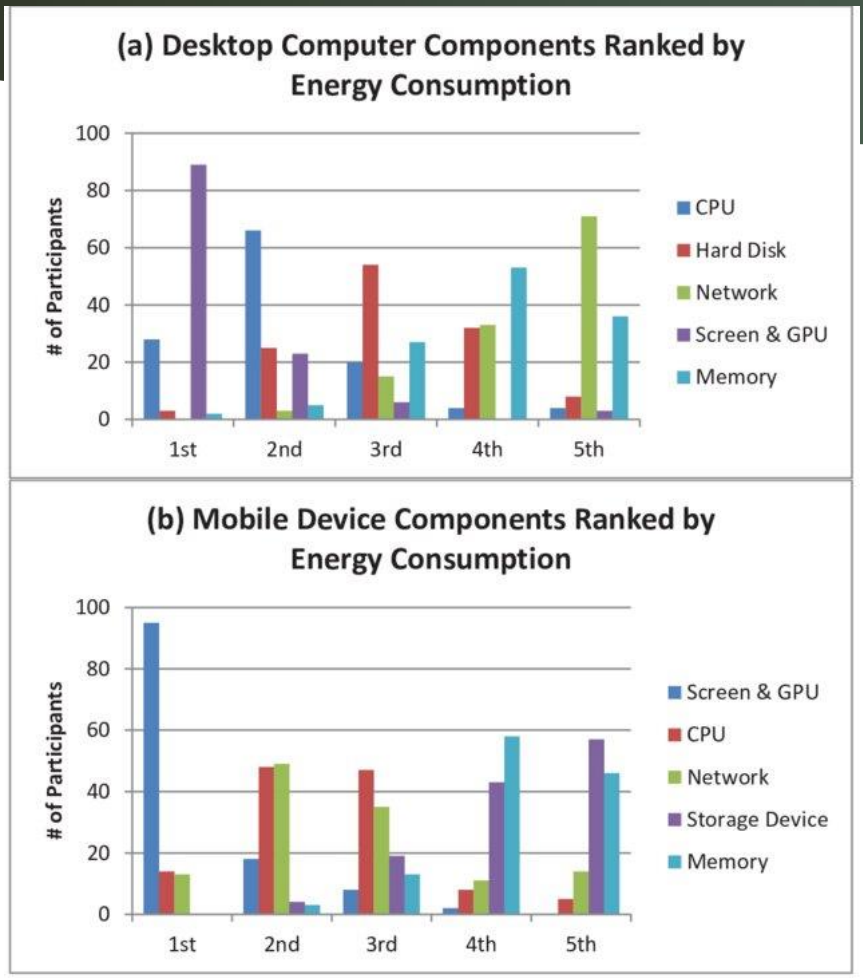
Energy and E-Waste





Damsgaard, Hans & Ometov, Aleksandr & Mowla, Md. Munjure & Flizikowski, Adam & Nurmi, Jari. (2023). Approximate computing in B5G and 6G wireless systems: A survey and future outlook. Computer Networks. 10.1016/j.comnet.2023.109872.

Digital World and Energy Consumption Growth



From Pang, Candy & Hindle, Abram & Adams, Bram & Hassan, Ahmed E.. (2015). What do programmers know about the energy consumption of software?. 10.7287/PEERJ.PREPRINTS.886.

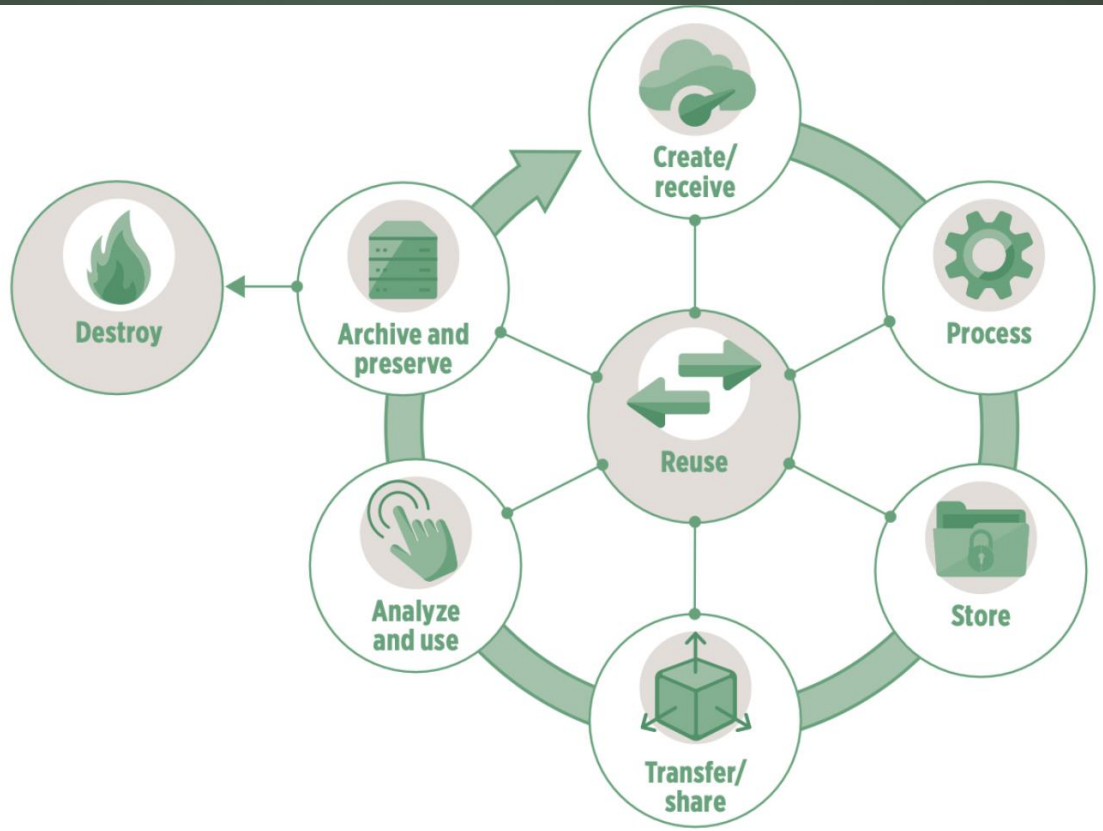
Evolution	2010	2015	2020	2025
Users (million)	2 023	3 185	4 700	5 500
Devices (million)	13 531	18 405	19 041	20 278
Equipment level	7	6	4	4
IoT (million)	1 000	9 605	20 315	48 272
Devices incl. IoT (million)	14 531	28 010	39 356	68 550
Mass (million tonnes)	128	164	236	317

The digital world from 2010 to 2025

F. Bordage. Study available in: https://www.greenit.fr/wp-content/uploads/2019/11/GREENIT_EENM_etude_EN_accessible.pdf

The number of devices sold (computer, gaming console, etc.) stabilises from 2015 (+ 10% only between 2015 and 2025), with the notable exception of the number of connected objects which is multiplied by 48 in 15 years (48 billion in 2025)

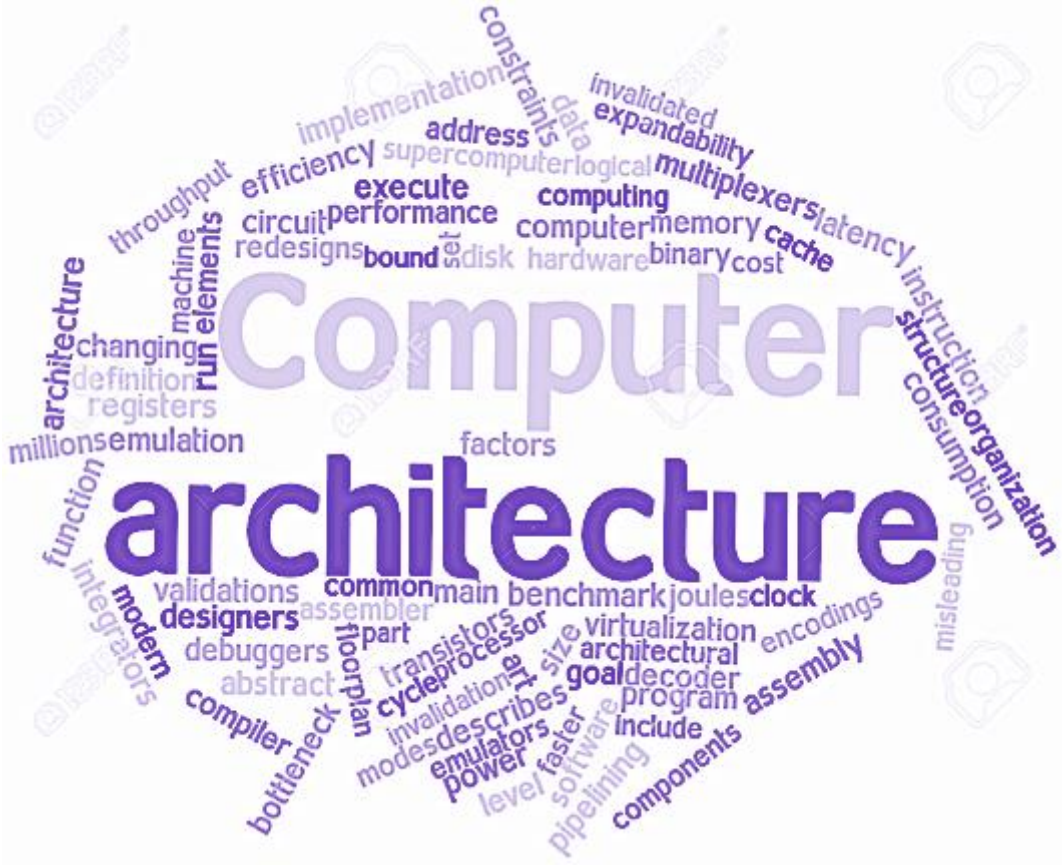
Data Cycle of Life



Source: WDR 2021 team.

[WBR2021] World Bank. 2021. *World Development Report 2021: Data for Better Lives.* Washington, DC: World Bank. doi:10.1596/978-1-4648-1600-0.

Computer Architecture



Rules and Methods that describe the functionality, organization and implementation of computer systems (Observing capabilities, performance, linking with programming models, trends and environmental aspects).
Abstraction, Design, Organization and Implementation.

About the Course

- Theoretical Magisterial Sessions
  - Conducted by C. J. Barrios Hernández, PhD.
- Theoretical - Practical Sessions
  - Conduced by SC3UIS and CAGE Team
    - Special Guest: Postgraduate Students
    - Special Seminars
  - Invited People of Research Centers or Industries
- Webminars and Video Talks
  - TED or others…

Goals

This is a course of Computer Architecture addressed to Systems Engineering, Informatics and Computer Science Students.

- Being able to locate oneself in the State of Art of Computer Architecture (from our point of view)
  - Handle terminology and technical specs.
  - **Promote Self-Learning.**
  - Understand the link between knowledge, technology and performance.
- **Understand (without fear) computer technology.**

About Teaching and Instruction

- **Carlos Jaime Barrios Hernández, PhD. cbarrios@uis.edu.co @carlosjaimebh**
  - Director of High Performance and Scientific Computing Centre SC3UIS (www.sc3.uis.edu.co) and CAGE Research Group Director
  - Associate Professor EISI/UIS (http://cormoran.uis.edu.co)
    - Systems Engineering UIS, Bucaramanga, Colombia (2002), Master in Mat. Applied, Systems and Informatics UJF-Grenoble I, Grenoble, France (2005), Computer Science and Informatics Doctor, UNSA, Nice-Sophia Antipolis, France (2009), PostDoctoral Research, I3S/CNRS, Sophia Antipolis,Francia (2010).
    - Researcher in Advanced, High Performance and Scientific Computing (LIG, I3S/CNRS, INRIA (France), GPPD/UFRGS (Brazil), SC3UIS (Colombia)) and International Instructor in HPC and SC (ICTP/UNESCO (Italy), SCCAMP).
    - Chair of the Advanced Computing System for Latin America and Caribbean (SCALAC)
    - NVIDIA Deep Learning Institute Instructor

- **SC3 and CAGE Team (More Information in www.sc3.uis.edu.co)**

Contact: EISI Block: LP 226 and SC3 Space 4to Floor CENTIC

Please, Send an email for Rendez-vous

Course Highlights

- **58 Hours Program**
- **Theoretical – Practical Course**
- Theoretical Sessions (Starts at 0XX:10)
- Theoretical – Practical Sessions (Starts at XX:00)
  - **Please Punctuality!**
- About deliveries and evaluations
  - **Observe format, rules, time, and deadline (date and hour)**
  - **Please read the recommendations carefully**
- All course information is in:
  http://wiki.sc3.uis.edu.co/index.php/Arquitectura_de_computadores
- AutoLearning !!

Content

1. Historic Development and Perspectives
2. Arithmetic of Computers
3. Computer Abstractions and Technology
4. Machine Programming and Linking
5. Processors and Memory
6. Storage and I/O
7. Multicores and Multiprocessing
8. Graphics and Visualization
9. Hot Topics and Trends

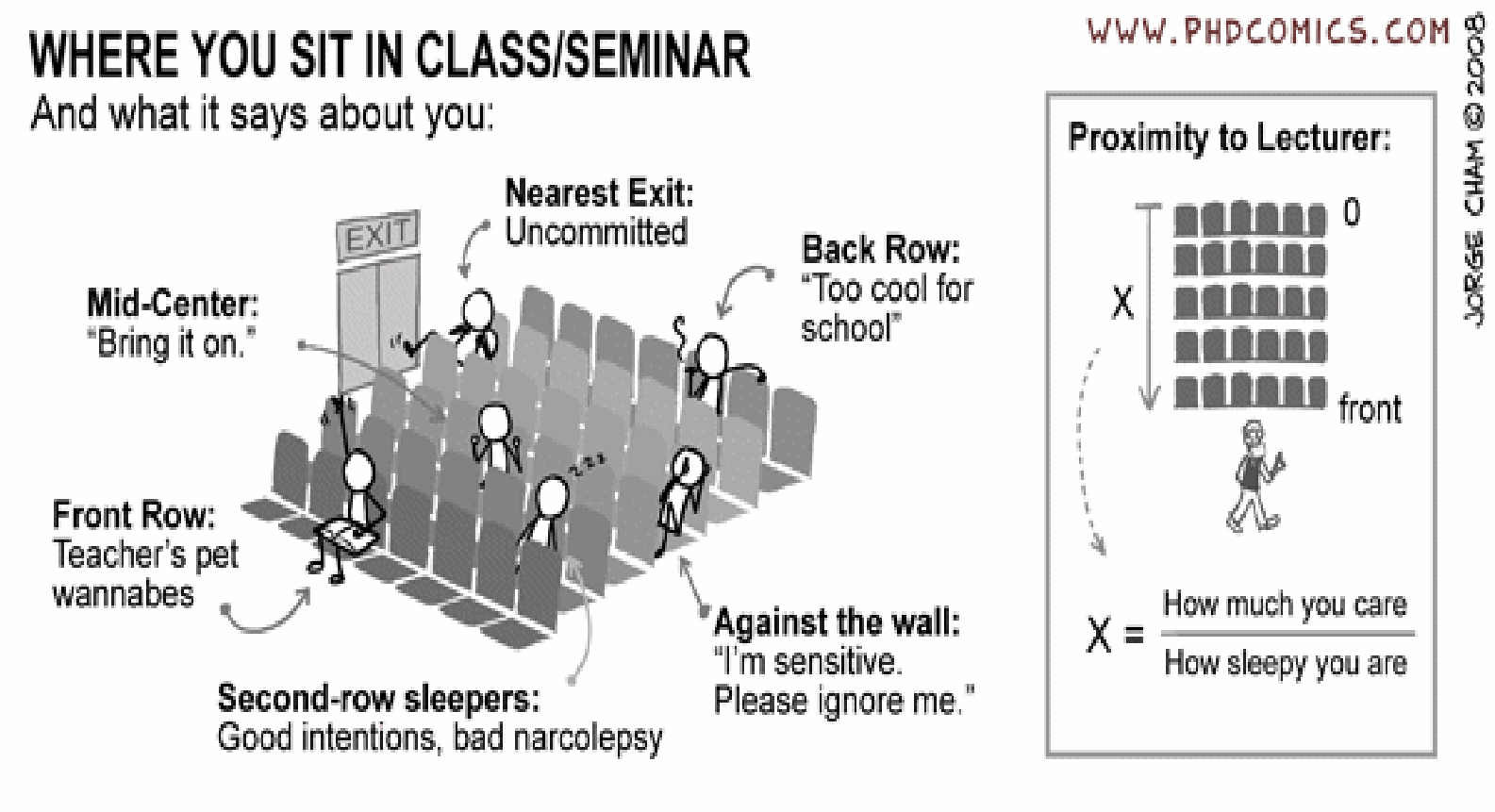
Evaluation

- **All Updates are in the course site**
  http://wiki.sc3.uis.edu.co/index.php/Arquitectura_de_computadores
- **Individual Work-First Note**
- **`Theoretical Practical Sessions** (In groups)
- **Project Class** (In groups)
  - Advance Report
  - White Paper
  - Digital Poster
- **Individual Formal Evaluation – Final**
- **BONUS (+0,3 max. in each evaluation:** (Quiz, group performance, attendance, Questions in the Course)

Important Notes

- All Available materials in English (International Technical/Scientific English)
- Bibliography and other resources are available in the site of the course. **This material is used for evaluations**.
- Attention to Students : (**Please, Send an email before for Rendez-vous)**
- **By default, the communication is via email from cormoran-web utility or email direct (cbarrios@uis.edu.co).**

Questions?


WHERE YOU SIT IN CLASS/SEMINAR
And what it says about you:
EXIT
Nearest Exit:
Uncommitted
Back Row:
"Too cool for school"
Mid-Center:
"Bring it on."
Front Row:
Teacher's pet wannabes
Against the wall:
"I'm sensitive. Please ignore me."
Second-row sleepers:
Good intentions, bad narcolepsy
WWW.PHDCOMICS.COM
JORGE CHAM © 2008
Proximity to Lecturer:
0
X
front
X = How much you care / How sleepy you are