

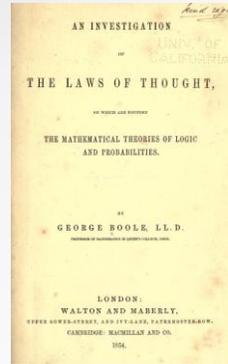
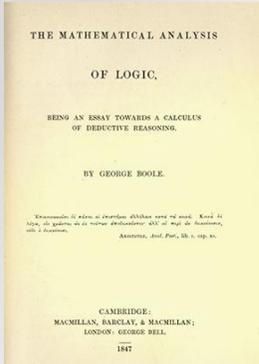
Εισαγωγή στον Προγραμματισμό

Εισαγωγική ενότητα (25%) :
Βασικές έννοιες και τομείς
της Επιστήμης Υπολογιστών
2^η ομιλία

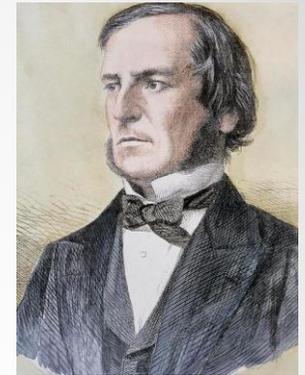
Παναγιώτης Τζουνάκης

Άνοιξη 2026





Άλγεβρα Boole



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

Βασικές πράξεις:

ΚΑΙ – σύζευξη (AND – conjunction) : $x \wedge y$ (x AND y)

Η – διάζευξη (OR – disjunction) : $x \vee y$ (x OR y)

ΟΧΙ - άρνηση (NOT – negation) : $\neg x$ (NOT x, Nx ή !x)

Πίνακες αληθείας

x	y	$x \wedge y$	$x \vee y$	x	$\neg x$
0	0	0	0	0	1
1	0	0	1	1	0
0	1	0	1		
1	1	1	1		



Άλγεβρα Boole

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

δευτερεύουσες πράξεις: Υλική συνεπαγωγή, Αποκλειστικό Η (Exclusive OR – XOR), Ισοδυναμία (equivalence)

$$x \rightarrow y = \neg x \vee y$$

$$x \oplus y = \neg(x \equiv y) = (x \vee y) \wedge (\neg x \vee \neg y) = (x \wedge \neg y) \vee (\neg x \wedge y)$$

$$x \equiv y = \neg(x \oplus y) = (x \wedge y) \vee (\neg x \wedge \neg y)$$

Πίνακες αληθείας

x	y	$x \rightarrow y$	$x \oplus y$	$x \equiv y$
0	0	1	0	1
1	0	0	1	0
0	1	1	1	0
1	1	1	0	1



Άλγεβρα Boole

Νόμοι (κατ' αναλογία με συνήθη άλγεβρα με + αντί \vee και * αντί \wedge)

Associativity of \vee :

$$x \vee (y \vee z) = (x \vee y) \vee z$$

Associativity of \wedge :

$$x \wedge (y \wedge z) = (x \wedge y) \wedge z$$

Commutativity of \vee :

$$x \vee y = y \vee x$$

Commutativity of \wedge :

$$x \wedge y = y \wedge x$$

Distributivity of \wedge over \vee :

$$x \wedge (y \vee z) = (x \wedge y) \vee (x \wedge z)$$

Identity for \vee :

$$x \vee 0 = x$$

Identity for \wedge :

$$x \wedge 1 = x$$

Annihilator for \wedge :

$$x \wedge 0 = 0$$



Άλγεβρα Boole

Νόμοι (δεν ισχύουν στη συνήθη άλγεβρα με + , *)

Annihilator for \vee : $x \vee 1 = 1$

Idempotence of \vee : $x \vee x = x$

Idempotence of \wedge : $x \wedge x = x$

Absorption 1: $x \wedge (x \vee y) = x$

Absorption 2: $x \vee (x \wedge y) = x$

Distributivity of \vee over \wedge : $x \vee (y \wedge z) = (x \vee y) \wedge (x \vee z)$



Άλγεβρα Boole

Κι άλλοι νόμοι!

Για το συμπλήρωμα :

Complementation 1

$$x \wedge \neg x = 0$$

Complementation 2

$$x \vee \neg x = 1$$

Διπλή άρνηση:

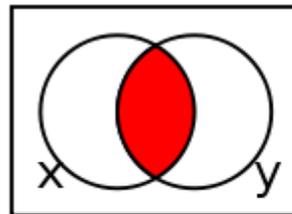
$$\neg(\neg x) = x$$

Νόμοι De Morgan:

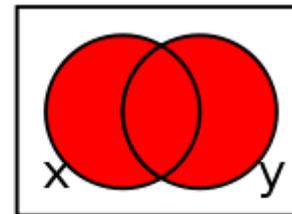
$$\neg x \wedge \neg y = \neg(x \vee y)$$

$$\neg x \vee \neg y = \neg(x \wedge y)$$

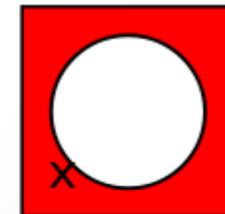
Διαγράμματα Venn για πράξεις στην άλγεβρα Boole :



$$x \wedge y$$



$$x \vee y$$



$$\neg x$$



Άλγεβρα Boole και ψηφιακές λογικές πύλες

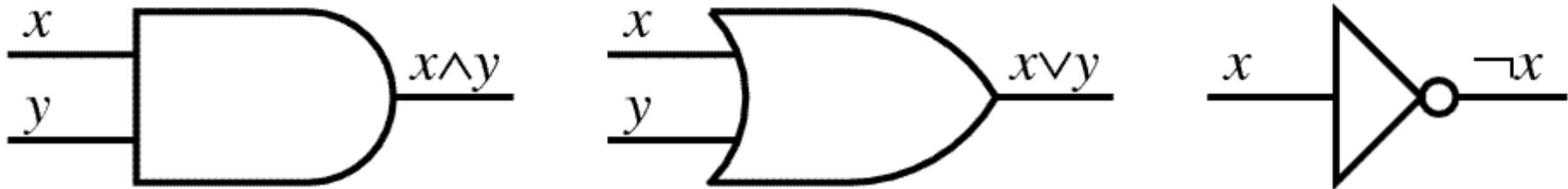


Figure 3. Logic gates

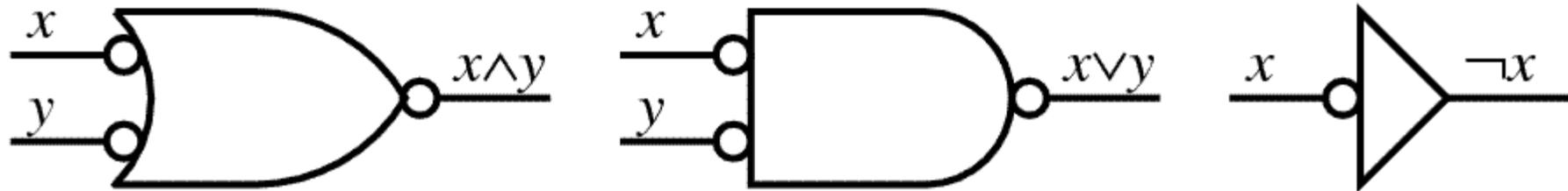


Figure 4. De Morgan equivalents

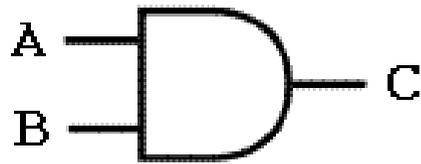


Αντιστρεψιμότητα (reversibility) υπολογισμών

- Φυσική και λογική αντιστρεψιμότητα

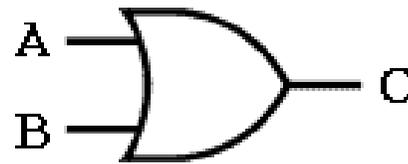
https://en.wikipedia.org/wiki/Reversible_computing

AND



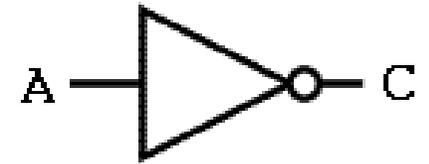
Inputs		Output
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1 ✓

OR



Inputs		Output
A	B	C
0	0	0 ✓
0	1	1
1	0	1
1	1	1

NOT



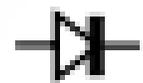
Input	Output
A	C
0	1 ✓
1	0 ✓



Δείτε την αρχή και το όριο του Landauer https://en.wikipedia.org/wiki/Landauer's_principle



Ψηφιακά κυκλώματα



Diode



Capacitor



Inductor



Resistor



DC voltage source



AC voltage source



And gate



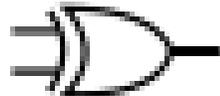
Nand gate



Or gate



Nor gate



Xor gate

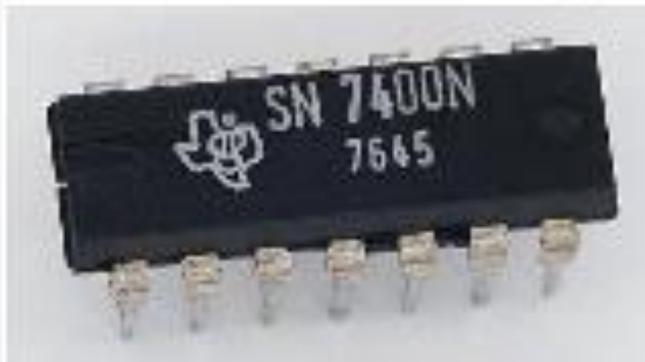
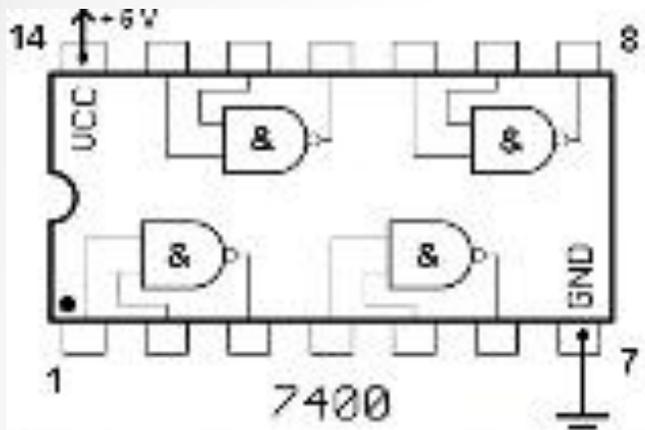


Inverter
(Not gate)

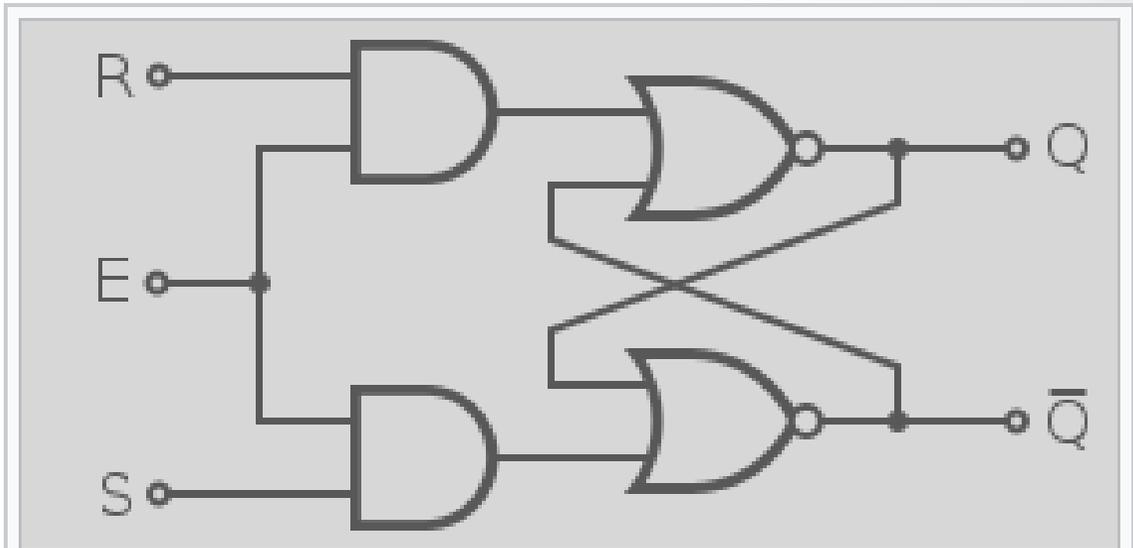
Συνήθη σύμβολα σε σχηματικά διαγράμματα κυκλωμάτων



Ψηφιακά κυκλώματα



Ακολουθιακό κύκλωμα



A gated SR latch circuit diagram constructed from AND gates (on left) and NOR gates (on right).

«τσιπάκι» (αριστερά) και μανταλωτής (δεξιά)

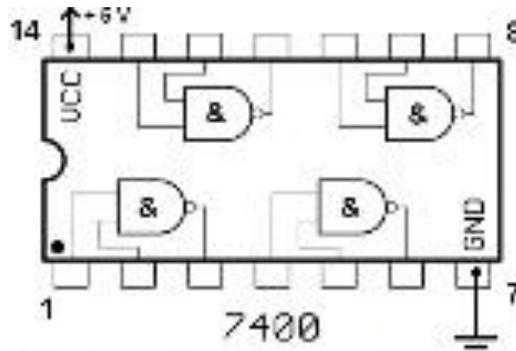
βλ. https://en.wikipedia.org/wiki/Logic_gate#Symbols και

[https://en.wikipedia.org/wiki/Flip-flop_\(electronics\)](https://en.wikipedia.org/wiki/Flip-flop_(electronics)) αντίστοιχα



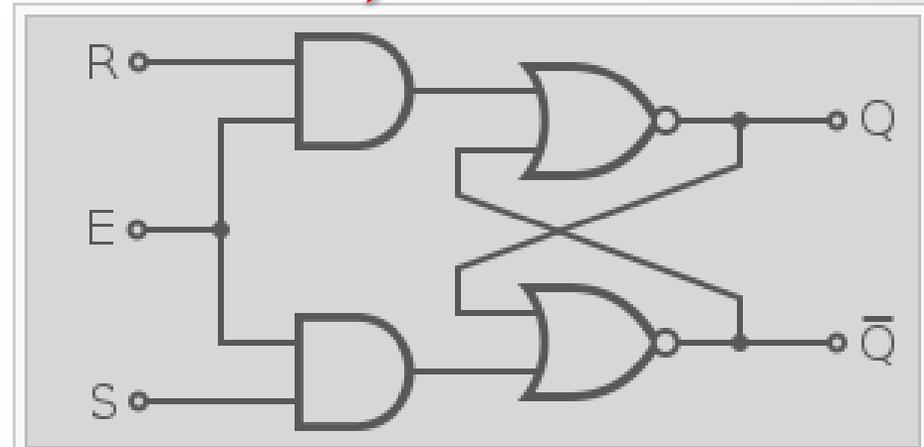
Ψηφιακά κυκλώματα

1959: (κάτω) Ο εφευρέτης του πρώτου μονολιθικού ολοκληρωμένου κυκλώματος Robert Noyce.



https://en.wikipedia.org/wiki/7400-series_integrated_circuits

Ακολουθιακό κύκλωμα

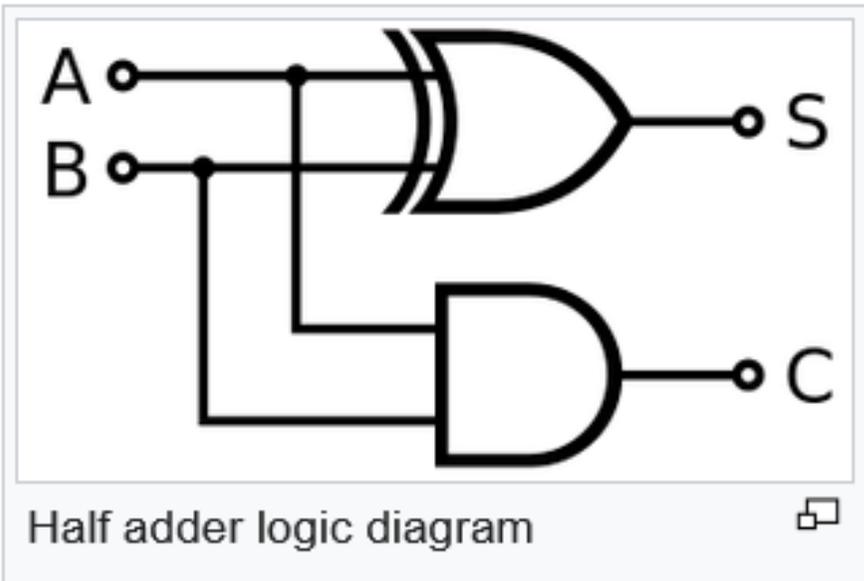


A gated SR latch circuit diagram constructed from AND gates (on left) and NOR gates (on right).

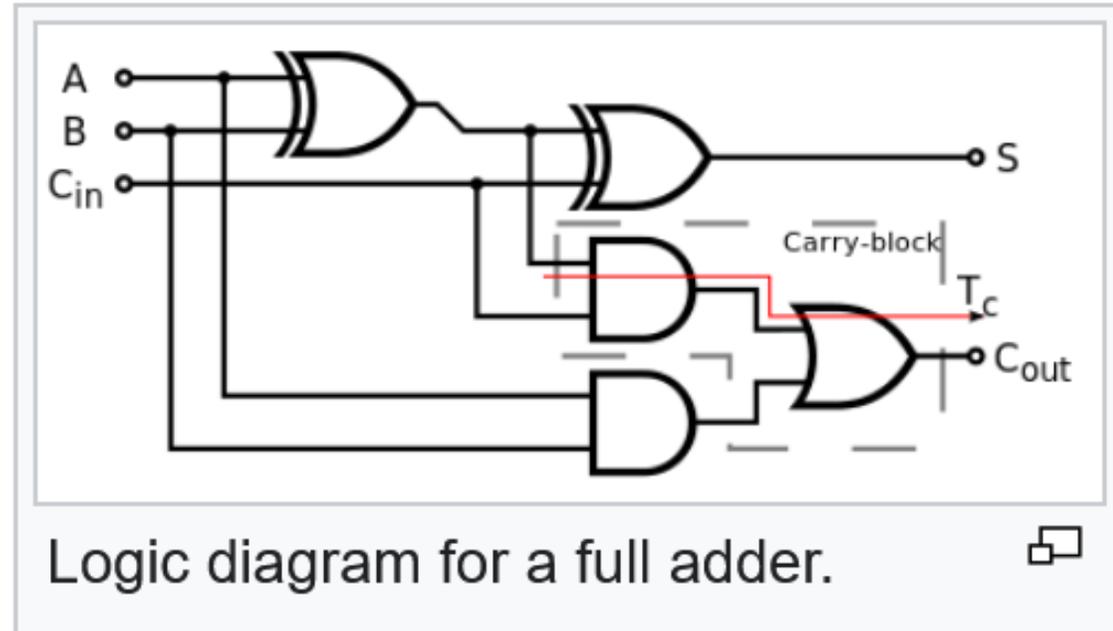
«τσιπάκι» της δεκαετίας 1980 (αριστερά) και μανταλωτής (διάγραμμα δεξιά) βλ. https://en.wikipedia.org/wiki/Logic_gate#Symbols και [https://en.wikipedia.org/wiki/Flip-flop_\(electronics\)](https://en.wikipedia.org/wiki/Flip-flop_(electronics)) αντίστοιχα



Αριθμητικές πράξεις με άλγεβρα Boole



Συνδυαστικό κύκλωμα



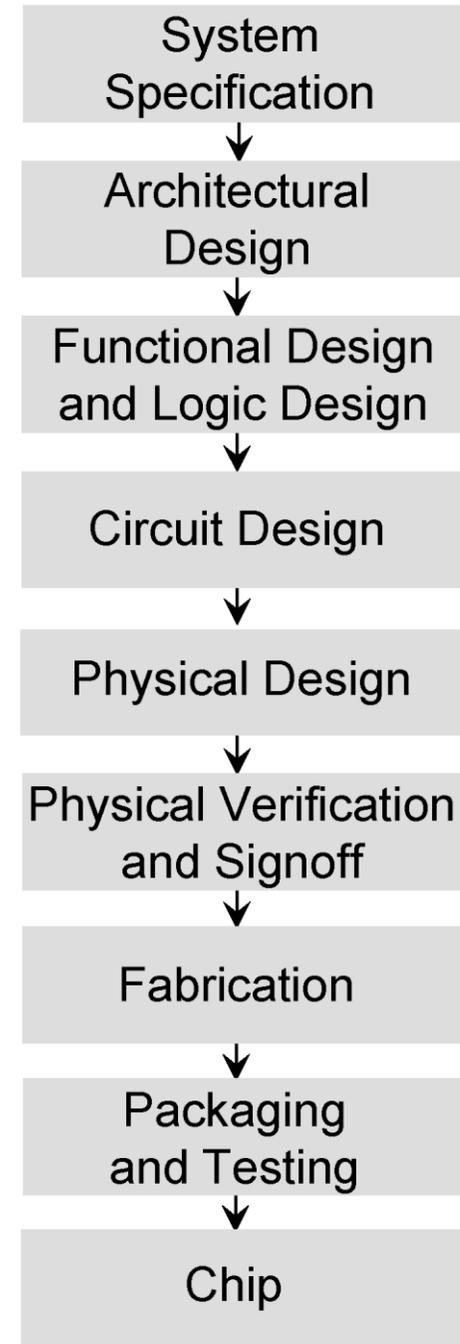
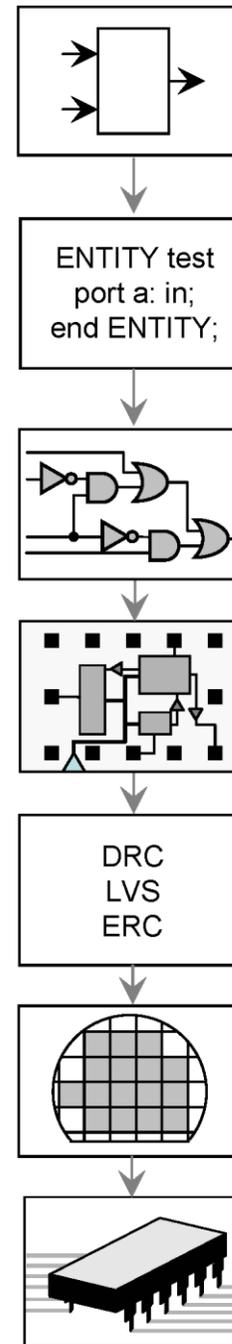
[https://en.wikipedia.org/wiki/Adder_\(electronics\)](https://en.wikipedia.org/wiki/Adder_(electronics))



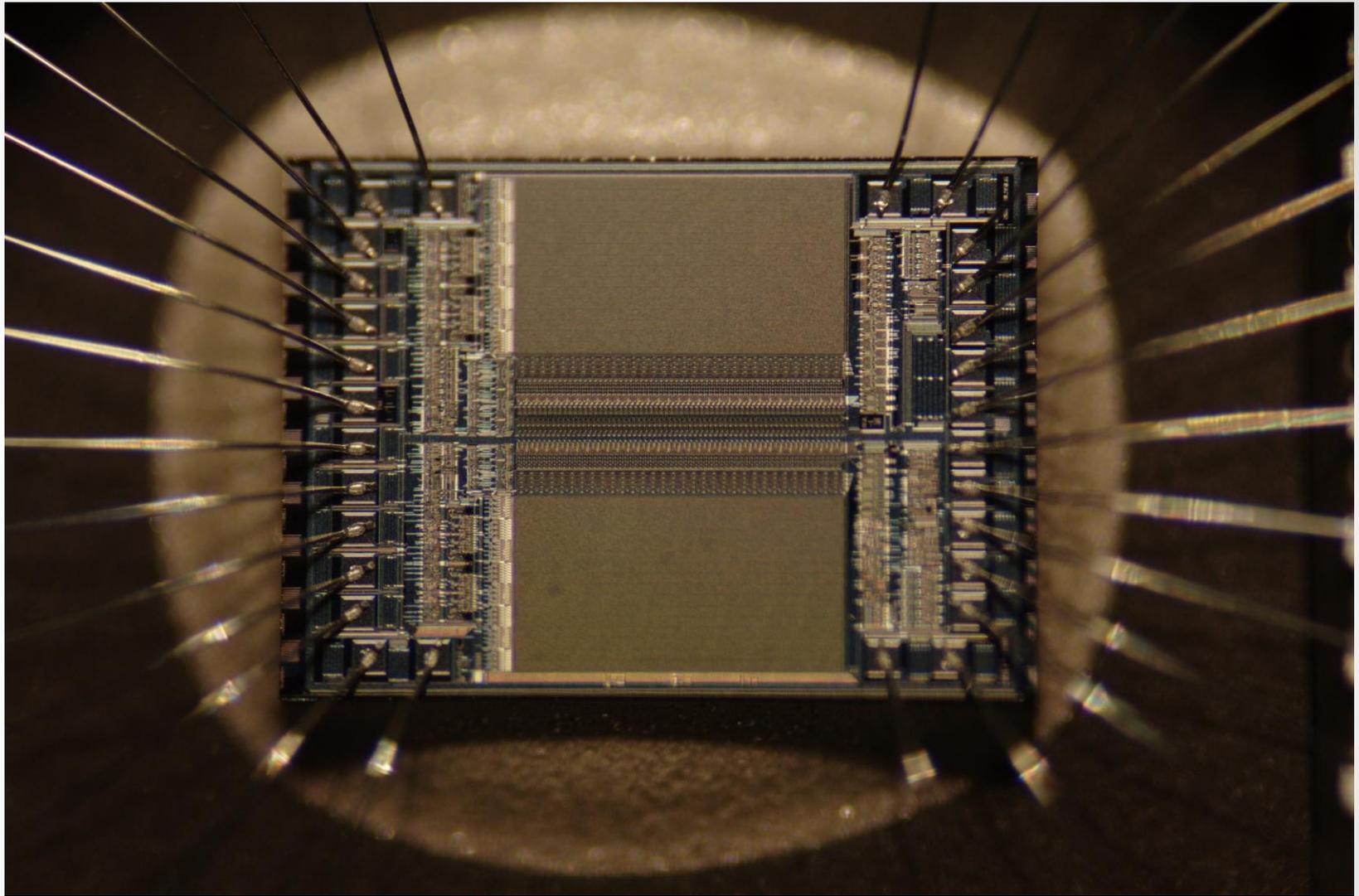
Ψηφιακή Σχεδίαση

Στάδια κατασκευής
ολοκληρωμένου κυκλώματος
(chip)

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



Ψηφιακή σχεδίαση

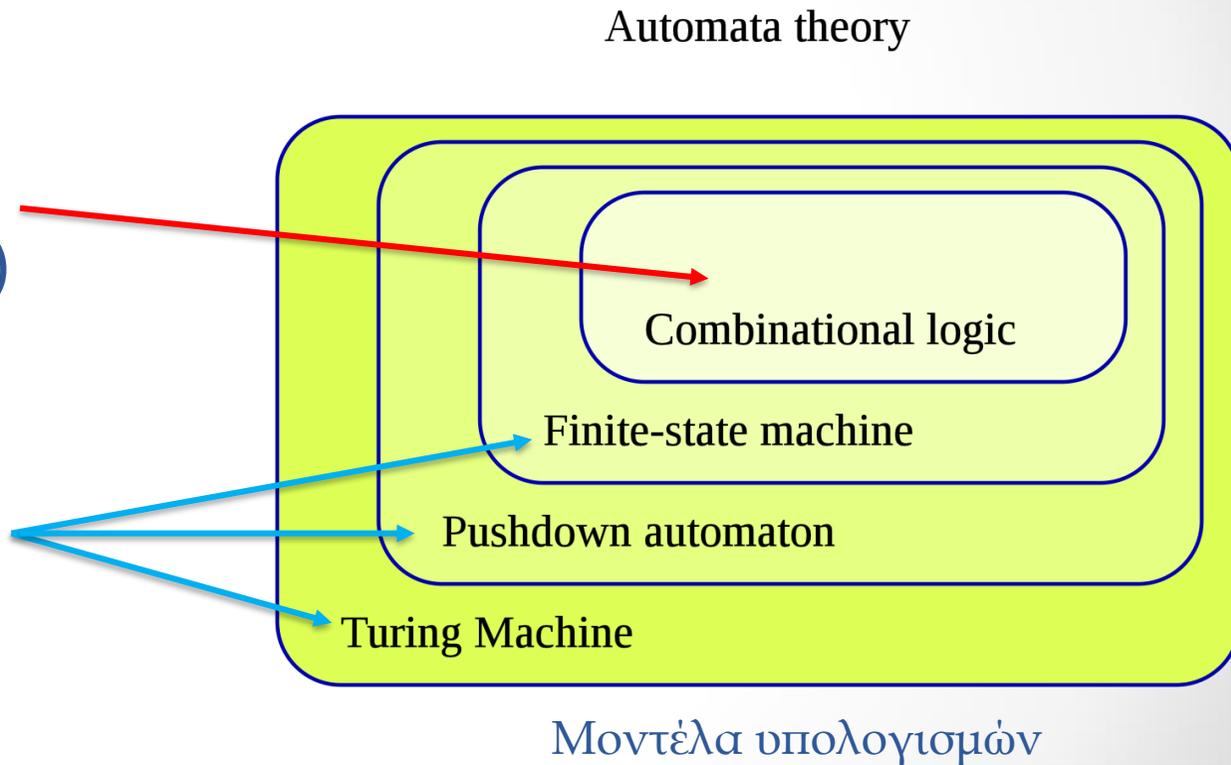


Integrated circuit from an EPROM memory microchip showing the memory blocks, the supporting circuitry and the fine silver wires which connect the integrated circuit die to the legs of the packaging

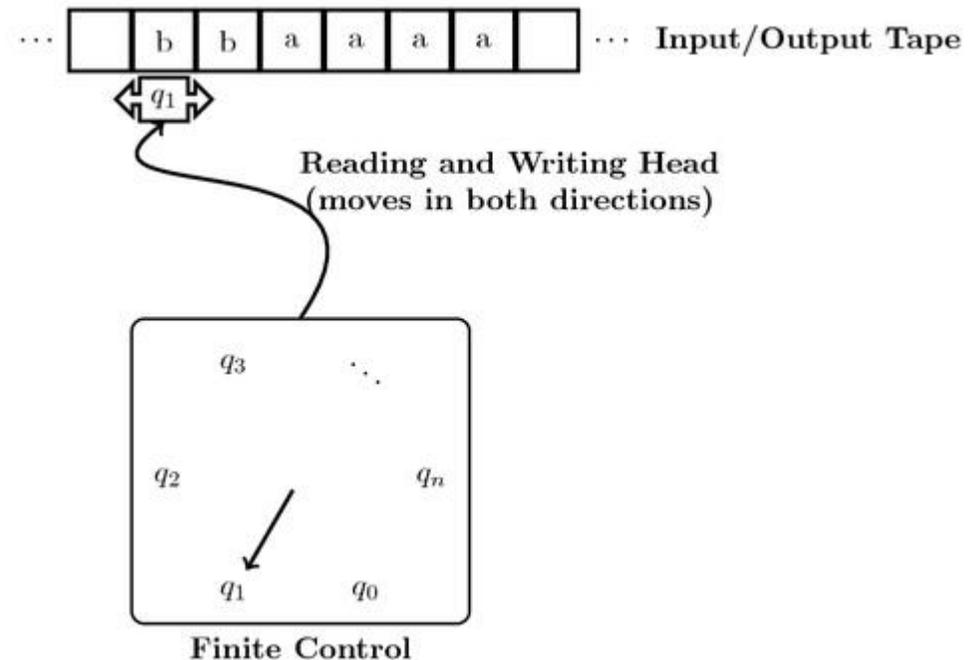
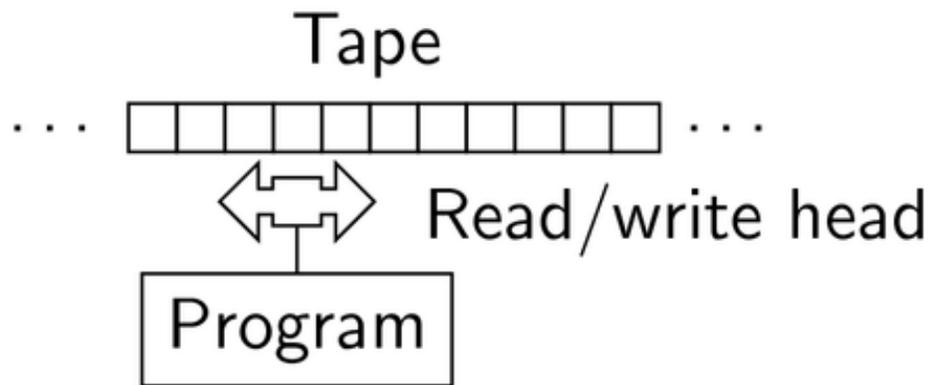
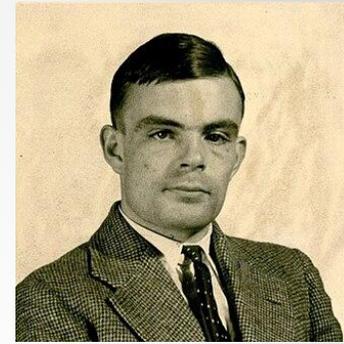


Από την ψηφιακή σχεδίαση στην αρχιτεκτονική Η/Υ

- Συνδυαστικά κυκλώματα (συνδυαστική λογική – combinational logic)
- Ακολουθιακά κυκλώματα (ακολουθιακή λογική – sequential logic) υλοποιεί μνήμη!



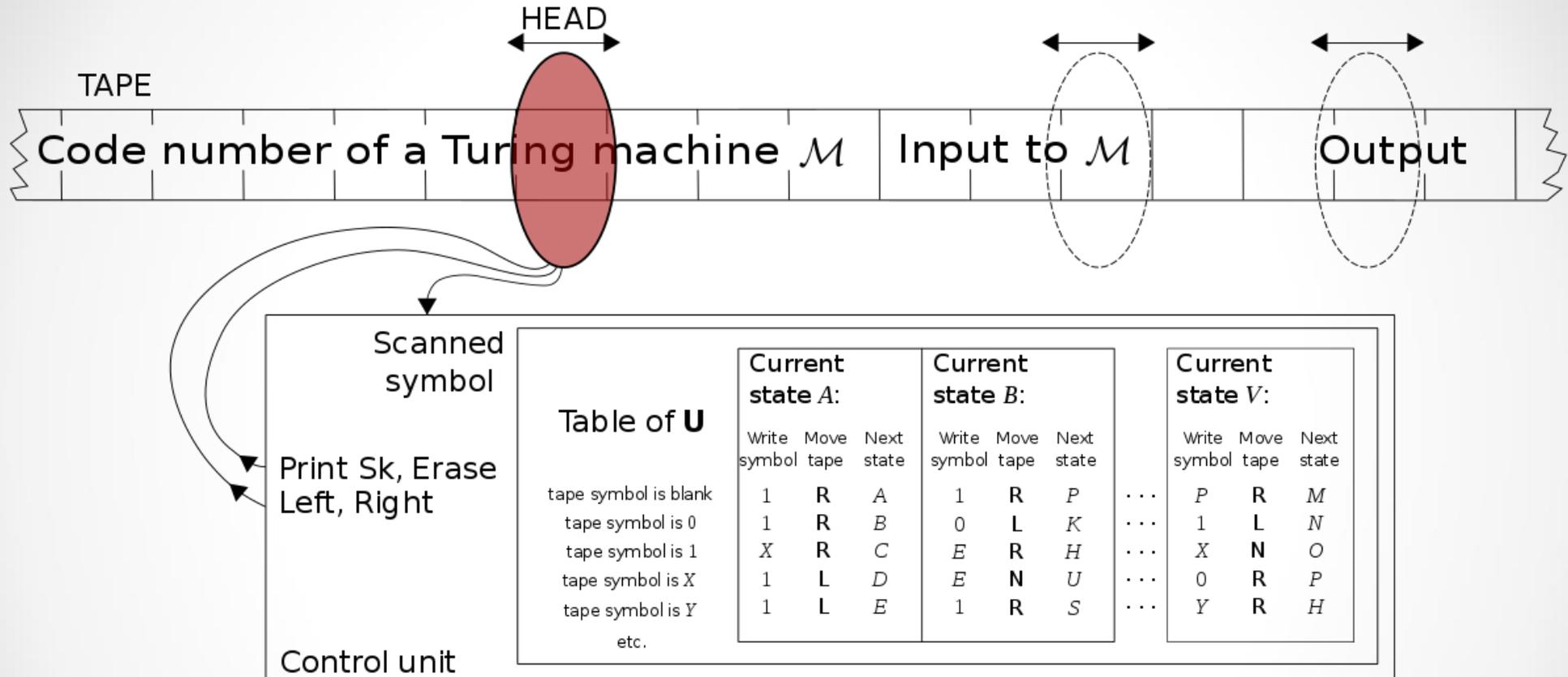
Η μηχανή του Turing



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



Universal Turing Machine

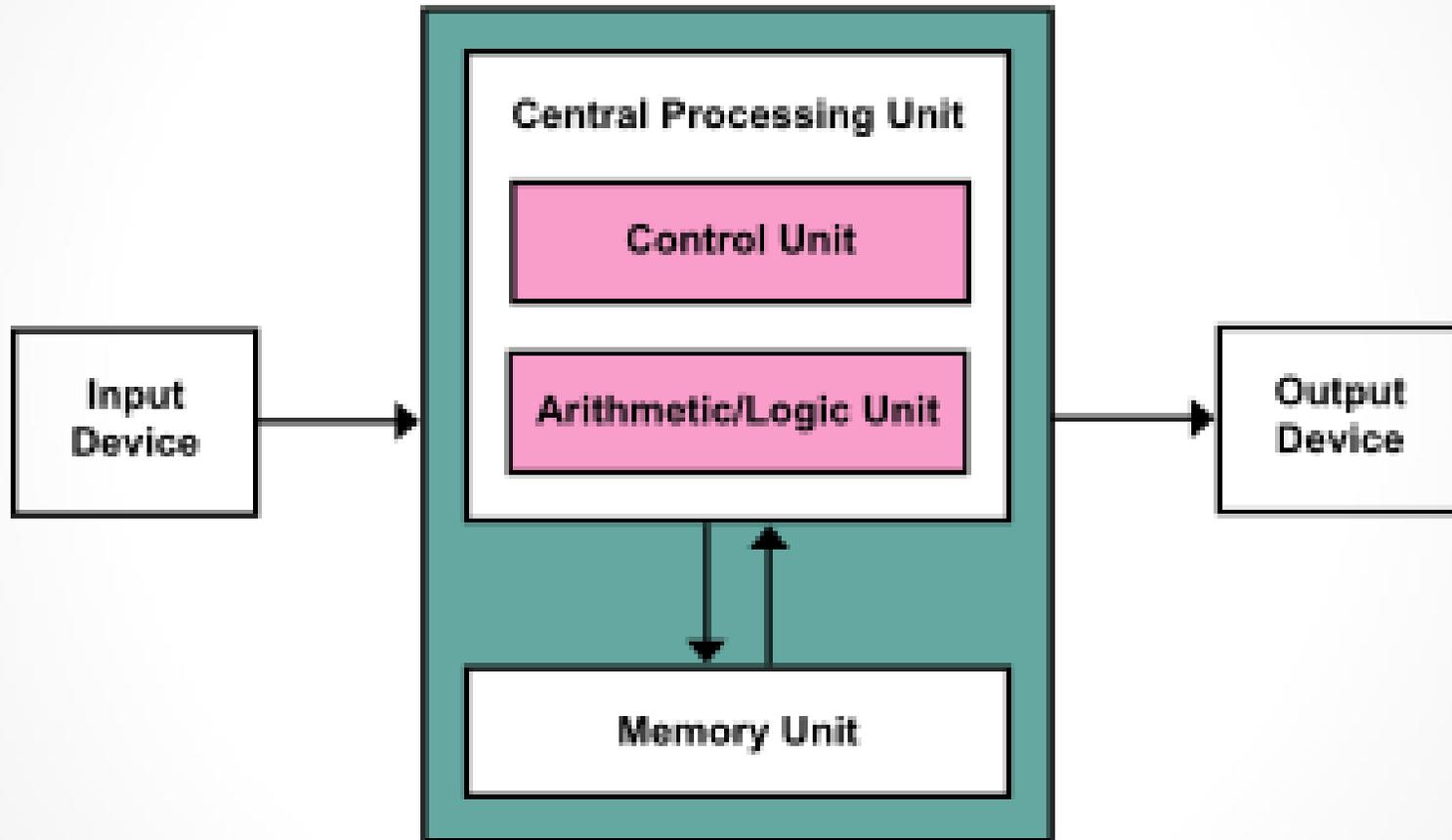


https://en.wikipedia.org/wiki/Universal_Turing_machine

“...the origin of the idea of a stored-program computer used by John von Neumann in 1946 for the "Electronic Computing Instrument" that now bears von Neumann's name: the von Neumann architecture.^[1]”



Αρχιτεκτονική Η/Υ



Αρχιτεκτονική **von Neumann**



ΟΔΗΓΟΣ ΣΠΟΥΔΩΝ
2021 - 2022



Αρχιτεκτονική von Neumann

Οδηγός σπουδών 2021-22
<https://drive.google.com/file/d/1MDznpDkSSWurOSABAUtrrUB8csyNgvEh/view>

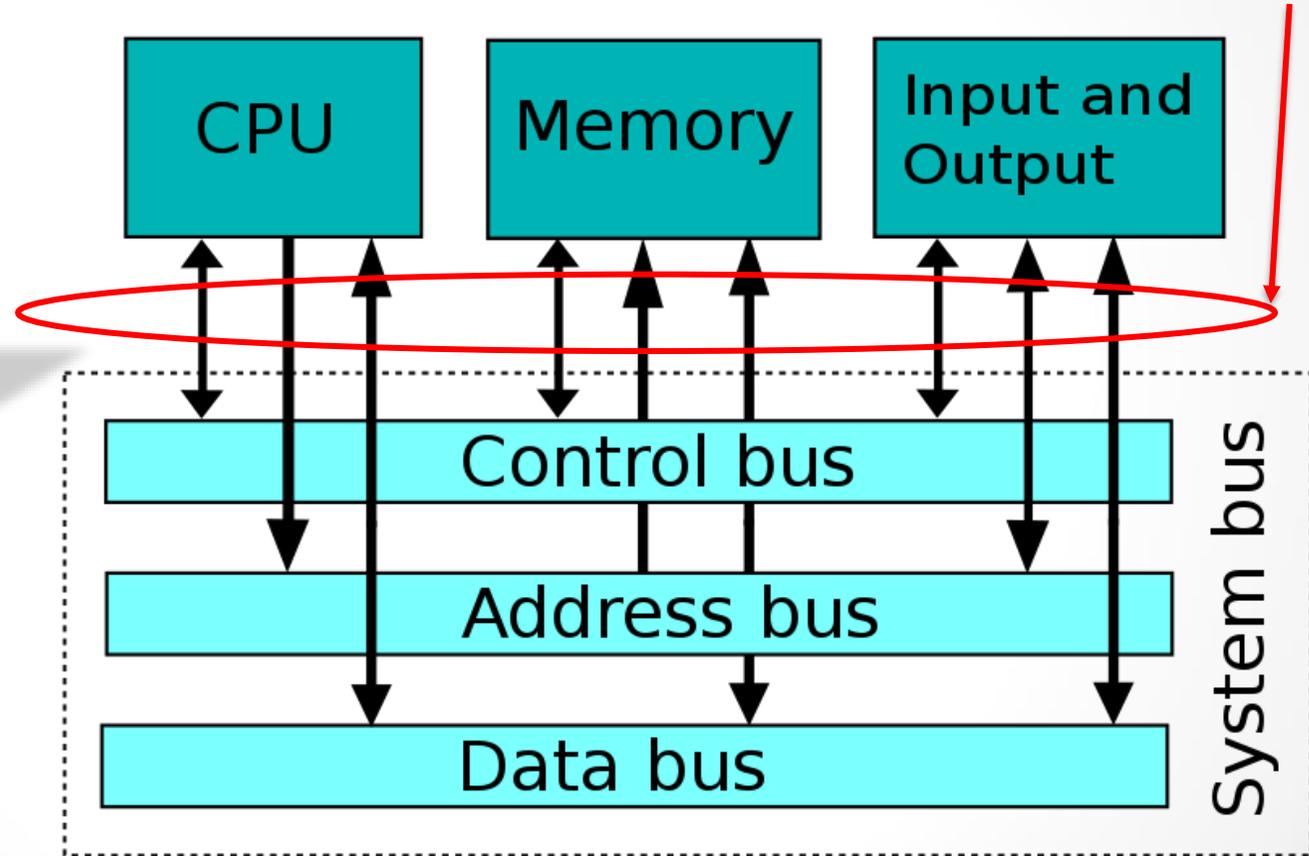


Αρχιτεκτονική Η/Υ

Μεταφορά bits
=>
von Neumann
bottleneck

- προσκόμιση (fetch)
- αποκωδικοποίηση (decode)
- εκτέλεση (execution)
- αποθήκευση (store)

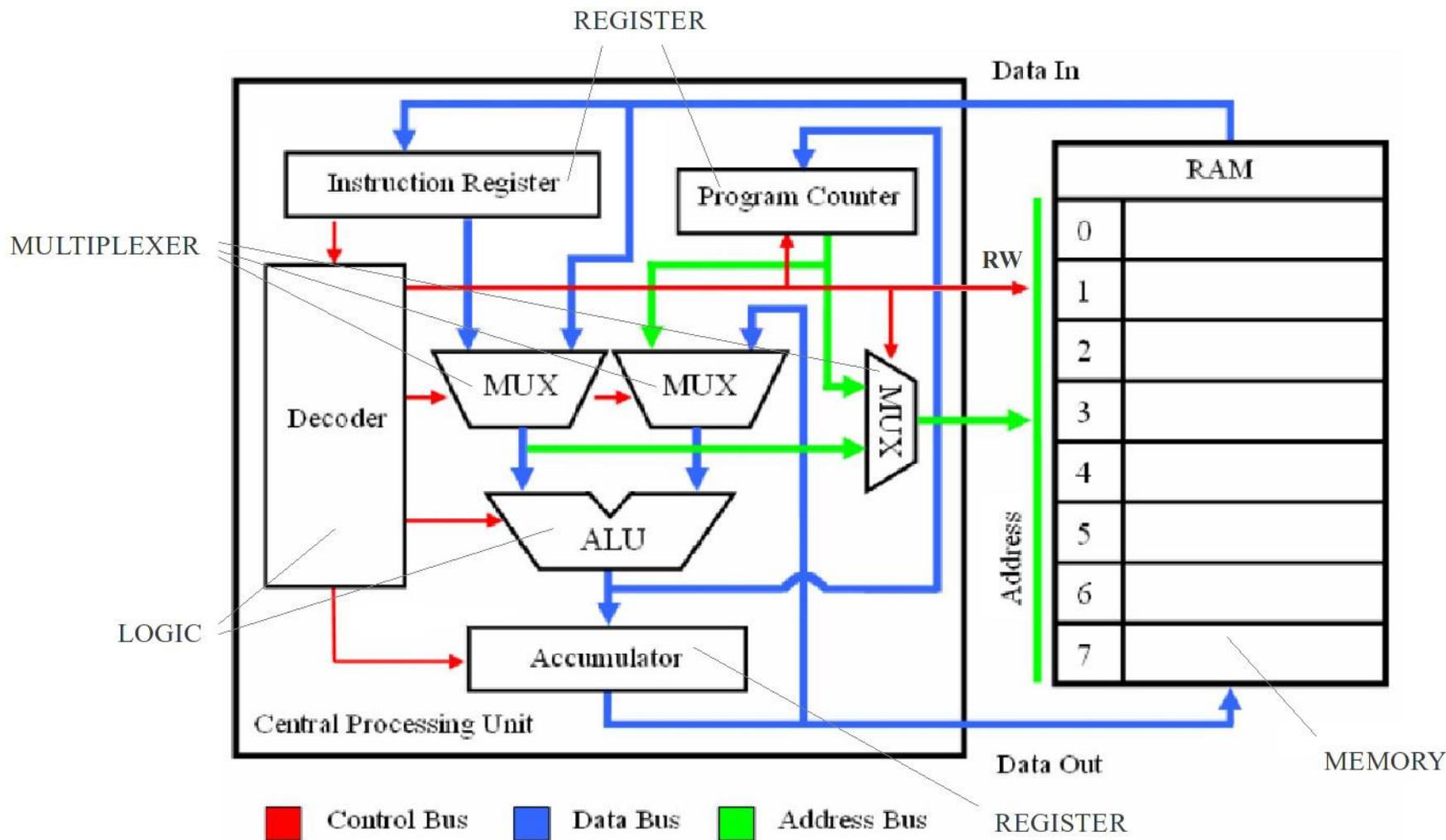
Απλουστευμένη παρουσίαση σταδίων εκτέλεσης εντολής μηχανής στη CPU



Αρχιτεκτονική von Neumann



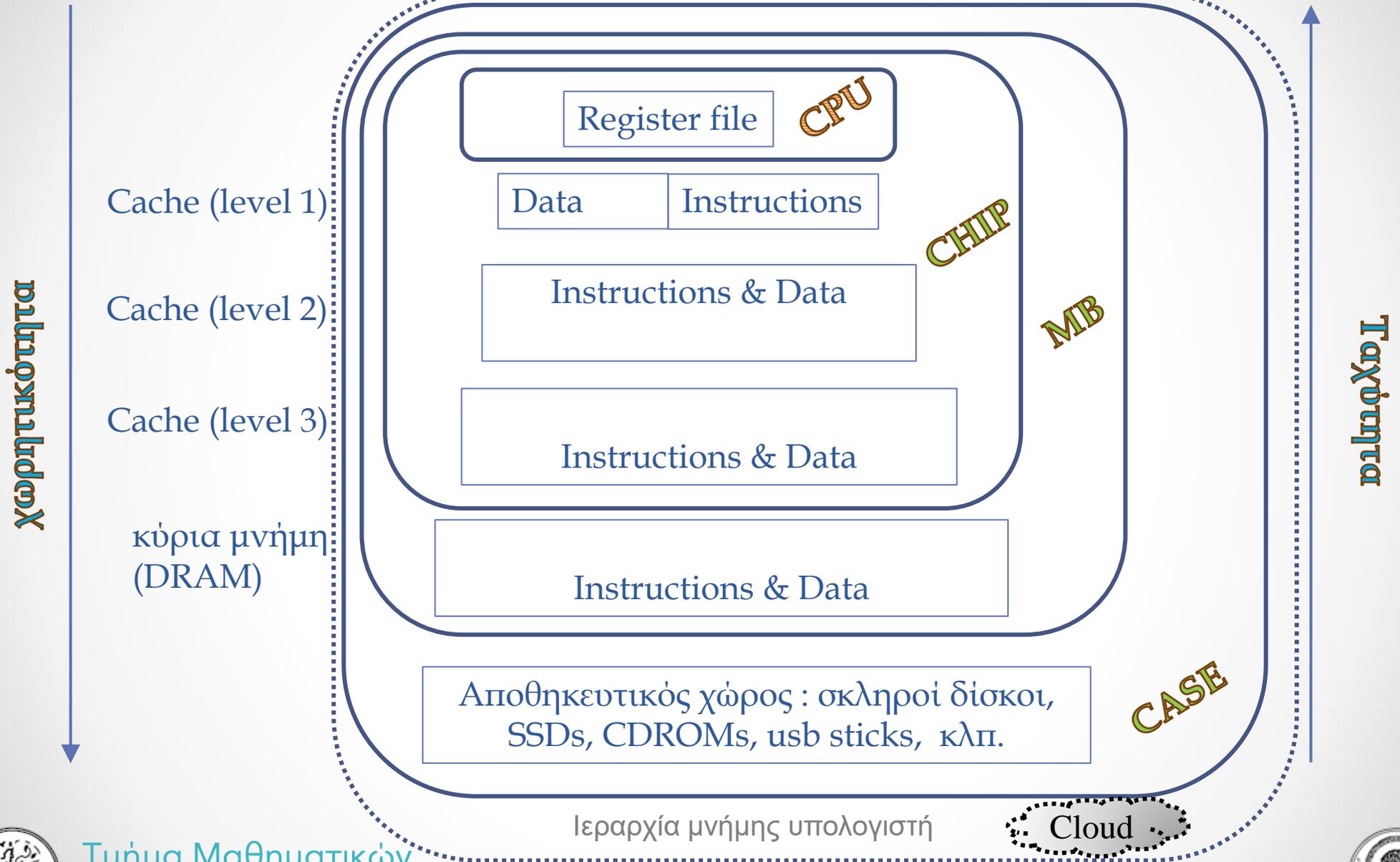
Αρχιτεκτονική Η/Υ



Πηγή : http://www.simplecpudesign.com/simple_cpu_v1/index.html



Αρχιτεκτονική Η/Υ



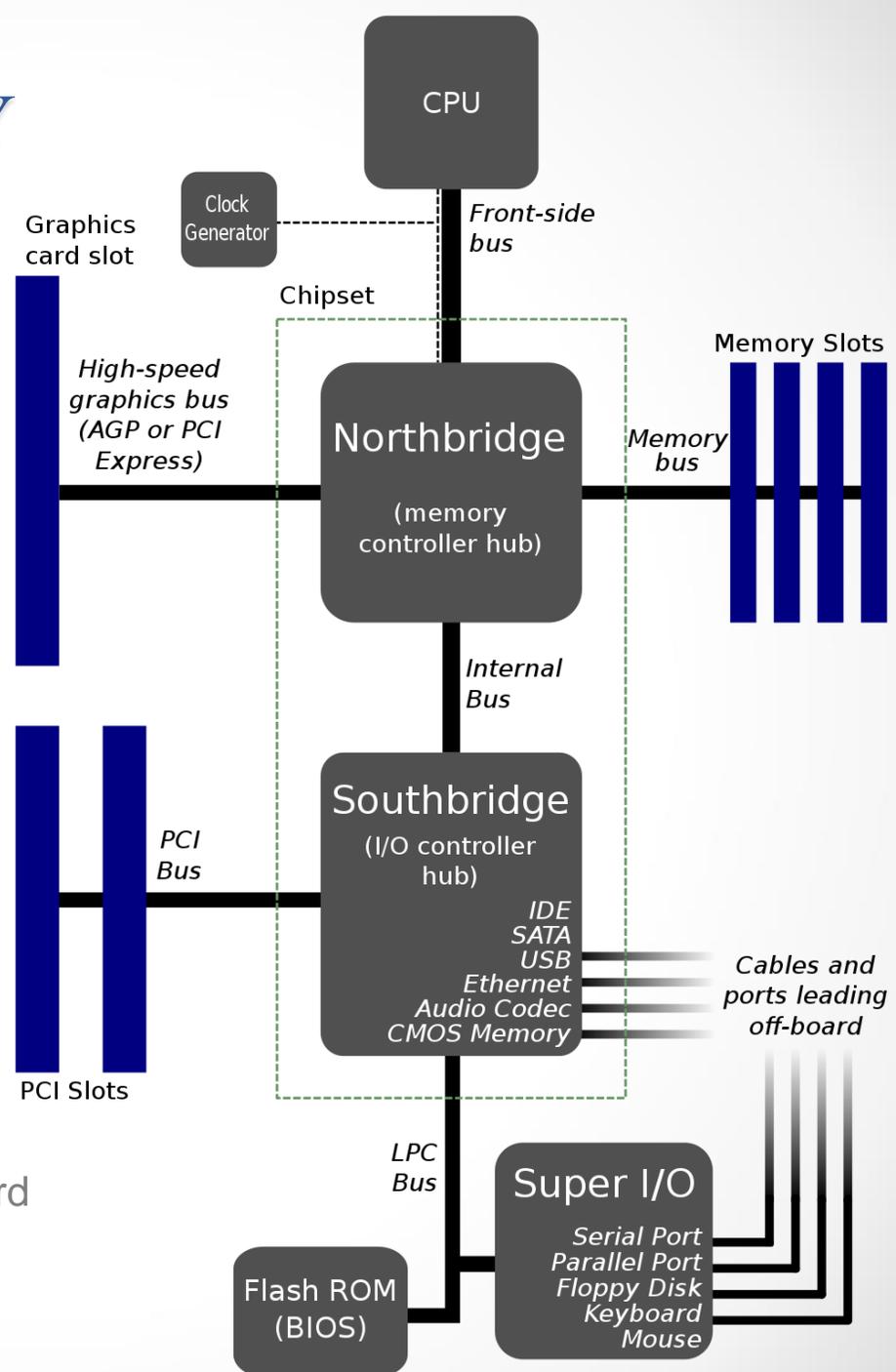
Ιεραρχία μνήμης υπολογιστή

Cloud



Αρχιτεκτονική Η/Υ

Σχηματικό διάγραμμα μητρικής κάρτας PC



Πηγή : <https://en.wikipedia.org/wiki/Motherboard>



Τμήμα Μαθηματικών

Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης

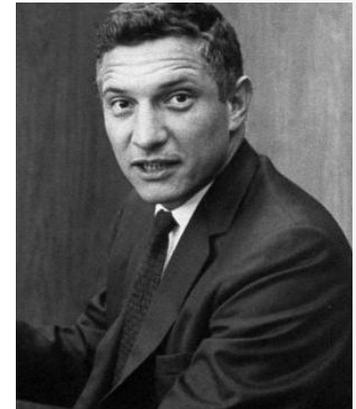


Αρχιτεκτονική Η/Υ

Intel founders



Gordon Moore in 1978



Robert Noyce in 1959



Arthur Rock in 2003



Εμπορικά διαθέσιμη (2023) CPU της εταιρίας Intel για PC



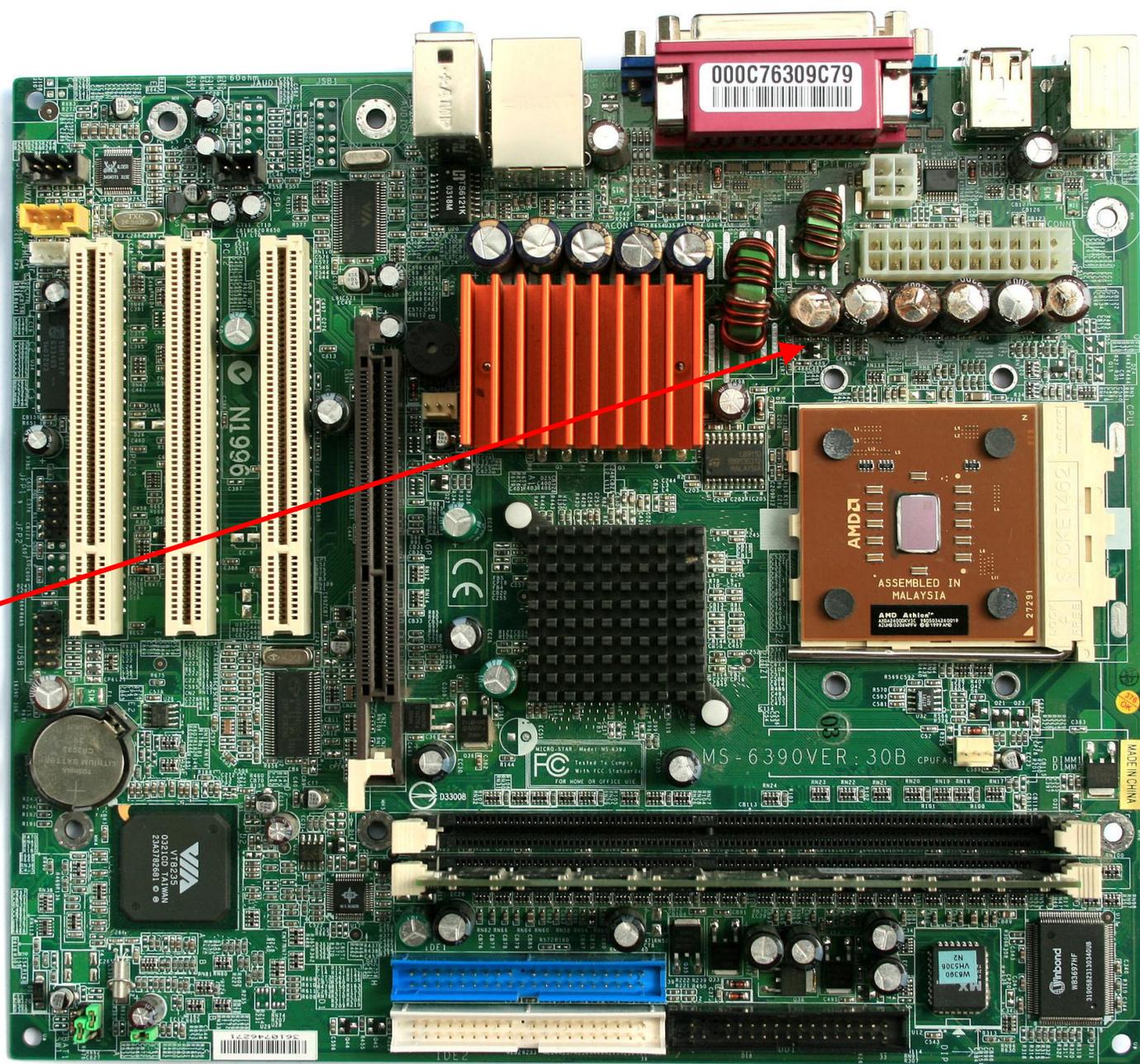
Τμήμα Μαθηματικών

Αριστοτέλειο Πανεπιστήμιο Θεσσαλονίκης



Αρχιτεκτονική Η/Υ

μητρική κάρτα τύπου
microATX για PC
(παρατηρήστε τους
σκασμένους
πυκνωτές)



Πέρα από την αρχιτεκτονική von Neumann: Αντισυμβατική – πρωτότυπη υπολογιστική (Unconventional computing)

PT explain unconventional computing with images



I'm sorry, I am a text-based AI language model and do not have the ability to display images. However, I can describe unconventional computing and its different branches in detail.

Unconventional computing encompasses a wide range of computing paradigms and technologies that depart from the conventional Von Neumann architecture, which is based on a stored program and a central processing unit (CPU) executing instructions in a sequential manner. Some of the branches of unconventional computing include:

1. DNA computing - This branch of computing uses DNA molecules to store and manipulate data and perform computations. In this approach, chemical reactions are used to perform operations on the DNA.
2. Quantum computing - This branch of computing leverages the unique properties of quantum systems, such as superposition and entanglement, to perform computations. Quantum computers use qubits instead of classical bits to perform computations.
3. Optical computing - In this approach, information is processed using light instead of electricity. Optical computing has the potential to be faster and more energy-efficient than electronic computing.
4. Memristor computing - This type of computing uses memristors, which are circuit elements that can change their resistance based on the flow of current, to perform computations.
5. Molecular computing - This branch of computing uses molecular systems, such as molecular electronics and molecular biology, to perform computations.

These are just a few examples of unconventional computing. Each of these branches of unconventional computing offers unique benefits and challenges, and the field is rapidly evolving, with new technologies and approaches being developed all the time.

PT explain unconventional computing with public domain sources



Unconventional computing refers to computing paradigms and technologies that depart from the conventional Von Neumann architecture, which is based on a stored program and a central processing unit (CPU) executing instructions in a sequential manner.

Unconventional computing encompasses a wide range of computing approaches, including quantum computing, DNA computing, molecular computing, optical computing, memristor computing, chaos computing, and more.

One example of unconventional computing is DNA computing. DNA computing is a branch of computing that uses DNA, biochemistry, and molecular biology to solve computational problems. DNA molecules can store and manipulate data and perform computations by performing chemical reactions. In 1994, researchers demonstrated the use of DNA to solve a simple mathematical problem, and since then, DNA computing has been used to solve increasingly complex problems.

Another example of unconventional computing is quantum computing. Quantum computing leverages the unique properties of quantum systems, such as superposition and entanglement, to perform computations. Quantum computers use qubits (quantum bits) instead of classical bits, which enables them to perform certain types of computations much faster than classical computers. For example, quantum computers can efficiently solve problems that are intractable for classical computers, such as breaking cryptographic codes.

Optical computing is another example of unconventional computing, in which information is processed using light instead of electricity. Optical computing has the potential to be faster and more energy-efficient than electronic computing because light can travel faster and carry more information than electrical signals.

These are just a few examples of unconventional computing, and the field is rapidly evolving, with new technologies and approaches being developed all the time. If you want to learn more about unconventional computing, I recommend starting with the Wikipedia articles on the various types of unconventional computing and the general concept of unconventional computing.

Απαντήσεις του [ChatGPT](https://chat.openai.com/chat) Jan 30, 23 Version.
<https://chat.openai.com/chat>



Πέρα από την αρχιτεκτονική von Neumann:

Αντισυμβατική – πρωτότυπη υπολογιστική (Unconventional computing)

PT explain unconventional computing with images



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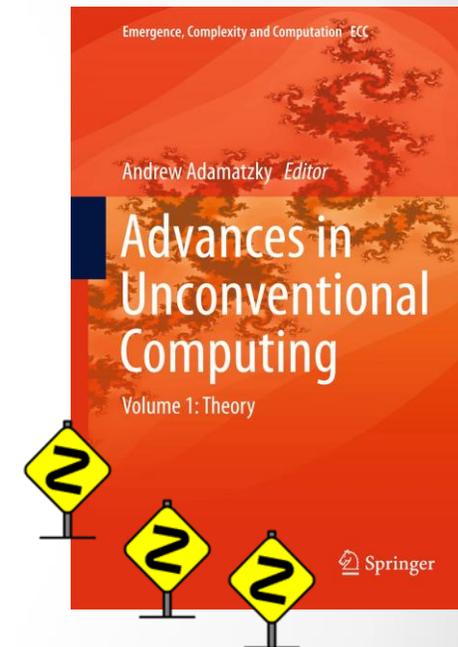
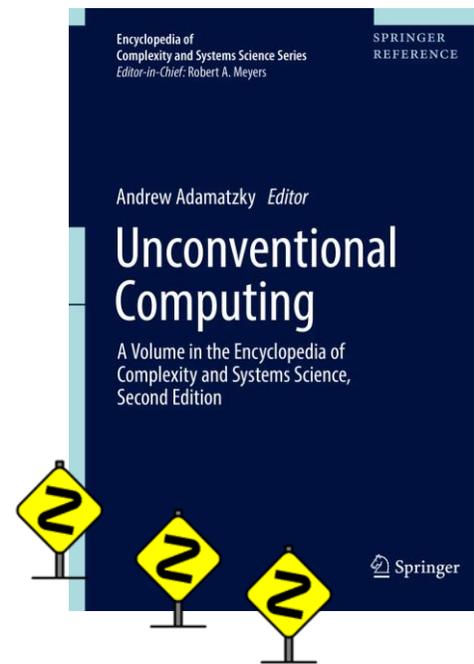
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These are just a few examples of unconventional computing. Each of these branches of unconventional computing offers unique benefits and challenges, and the field is rapidly evolving, with new technologies and approaches being developed all the time.

Πιο ...συμβατική αναζήτηση:

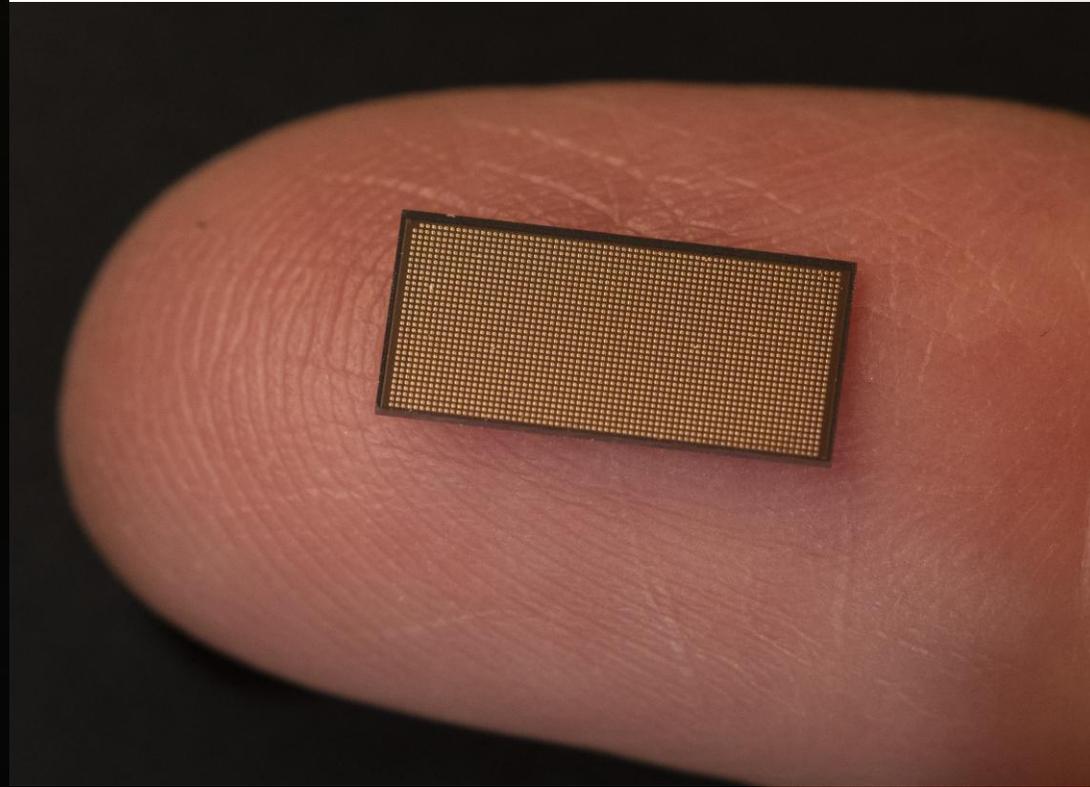
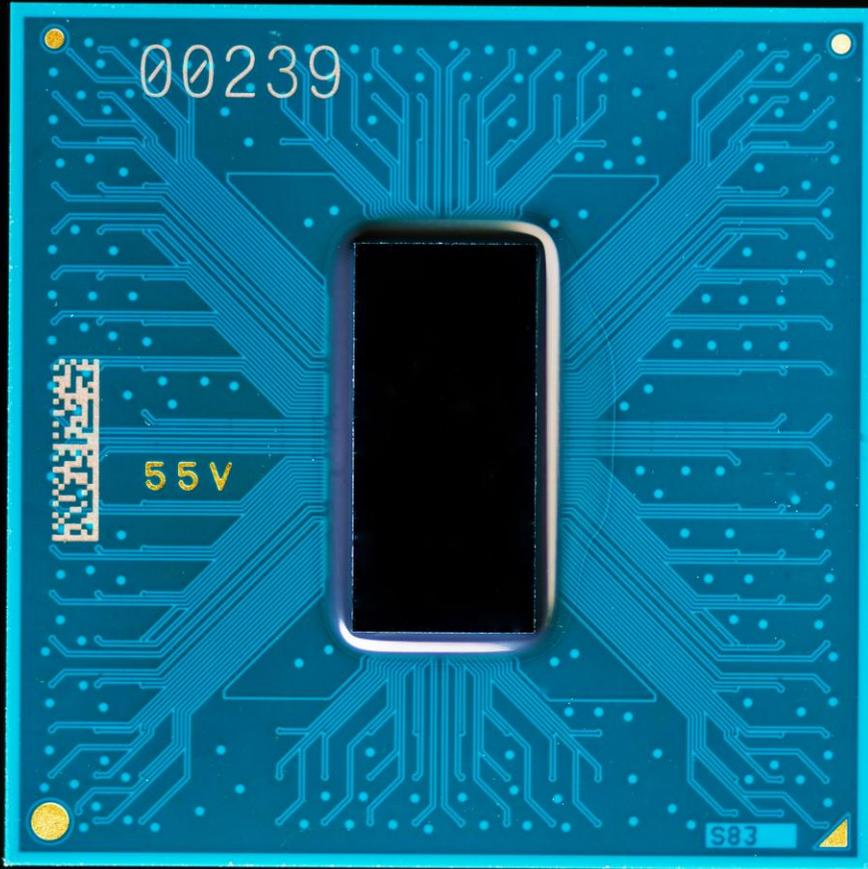
1. https://en.wikipedia.org/wiki/Unconventional_computing
2. <https://link.springer.com/referencework/10.1007/978-1-4939-6883-1>
3. <https://link.springer.com/book/10.1007/978-3-319-33924-5>



- Σε κάθε περίπτωση:
1. Έλεγχος πηγών, είναι αξιόπιστες;
 2. Διασταύρωση στοιχείων
 3. Ανάγνωση με κριτική σκέψη



Παράδειγμα: Intel's neuromorphic computing architecture



Παράδειγμα: Intel's neuromorphic computing architecture

<https://download.intel.com/newsroom/2021/new-technologies/neuromorphic-computing-loihi-2-brief.pdf>

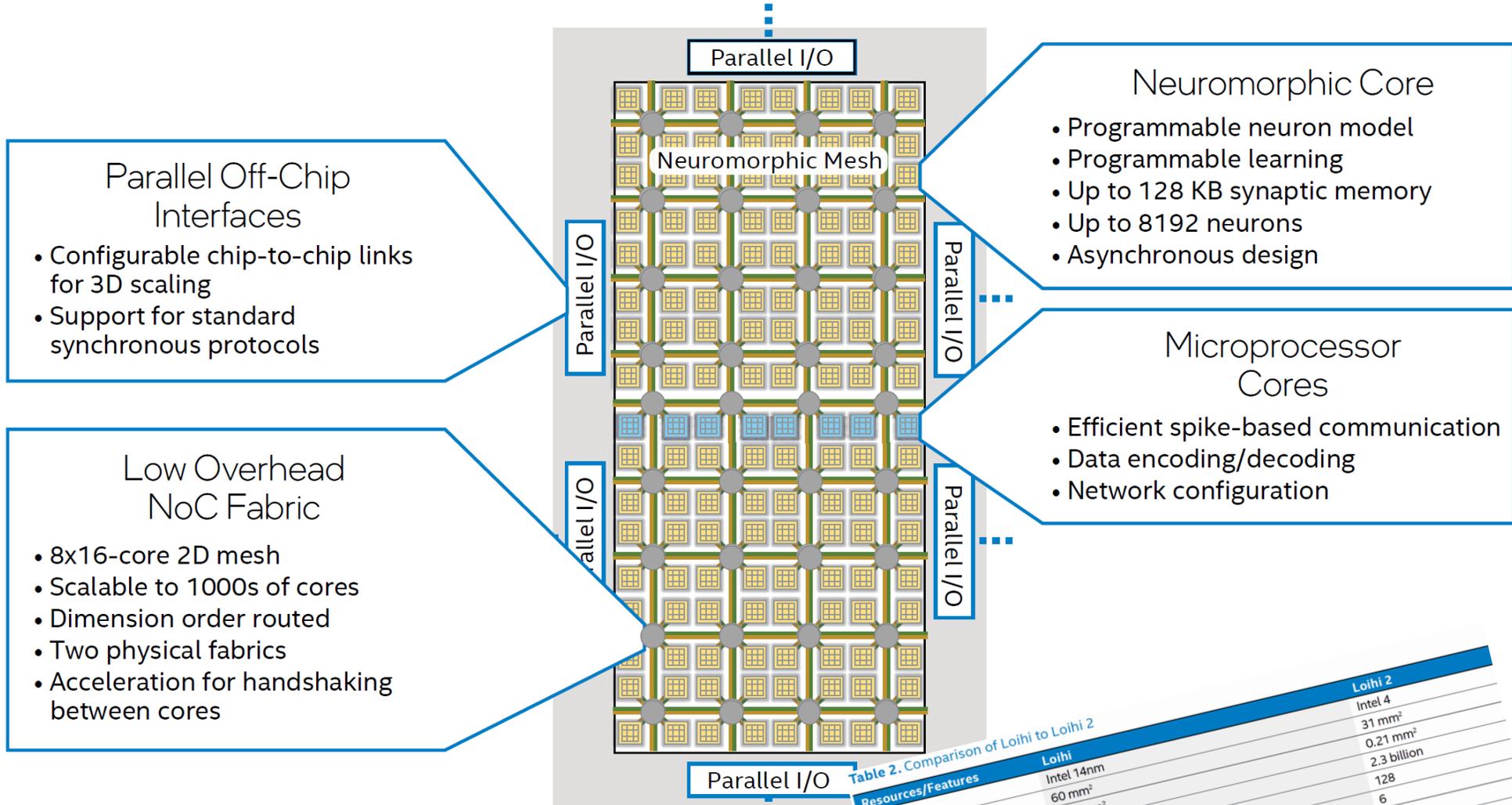


Figure 1. Loihi 2 chip architecture.



Ερωτήσεις & Απαντήσεις

