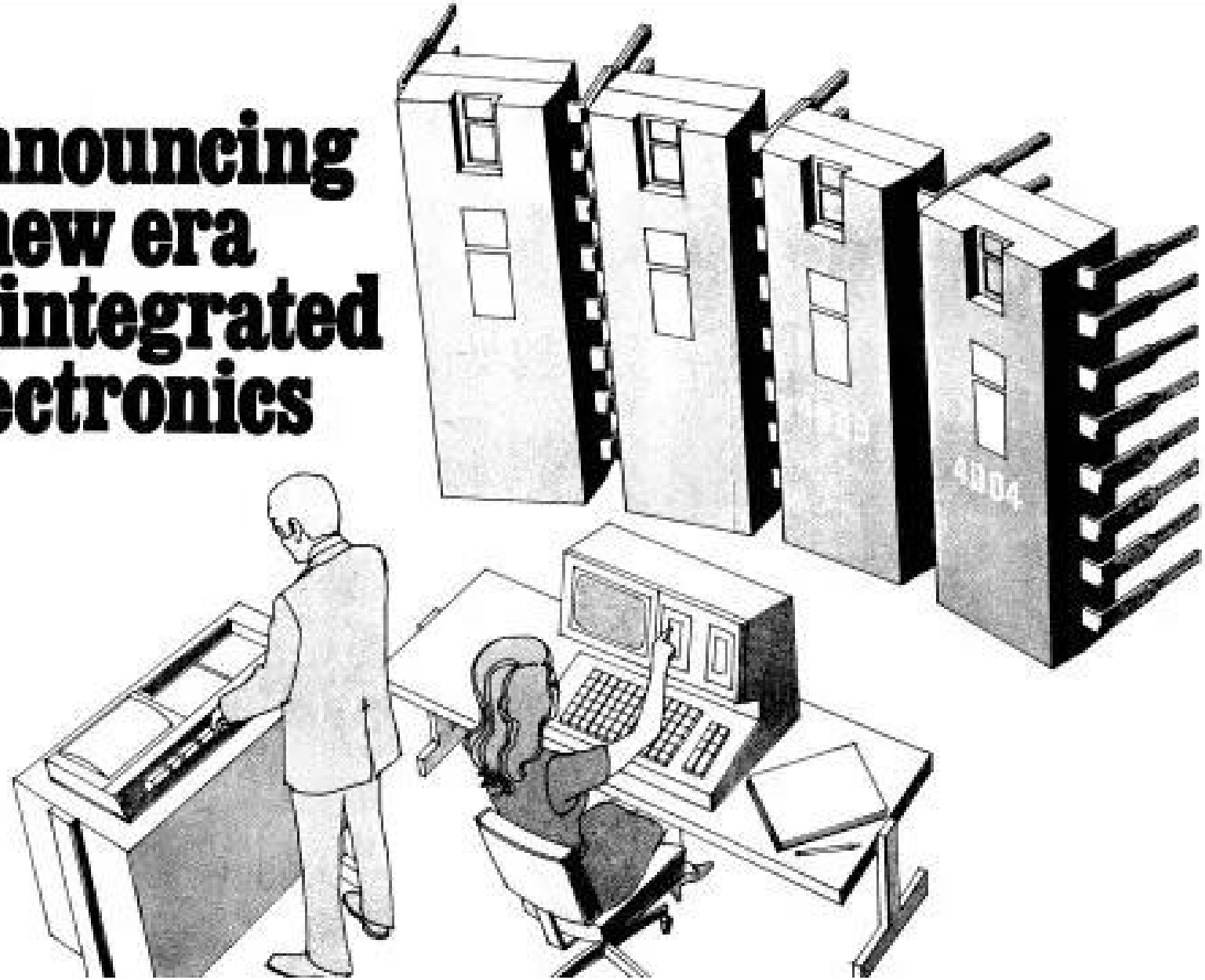
2 TEINE

Üliõpilane küsib professorilt:
– “Kas on tõsi, et arvuti saab mõelda?”
Professor vastab:
– “Jah, aga ainult siis, kui keegi on talle juba ette mõelnud, kuidas seda teha.”

“system on a chip” (SoC)

Announcing a new era of integrated electronics



A micro-programmable computer on a chip!

Intel introduces an integrated CPU complete with a 4-bit parallel adder, sixteen 4-bit registers, an accumulator and a push-down stack on one chip. It's one of a family of four new ICs which comprise the MCS-4 micro computer system— the first system to bring you the power and flexibility of a dedicated general-purpose computer at low cost in as few as two dual in-line packages.

MCS-4 systems provide complete computing and control functions for test systems, data terminals, billing machines, measuring systems, numeric control systems and process control systems.

The heart of any MCS-4 system is a Type 4004 CPU, which includes a powerful set of 45 instructions. Adding one or more Type 4001 ROMs for program storage and data tables gives you a fully functioning micro-programmed computer. To this you may add Type 4002 RAMs for read-write memory and Type 4003 registers to expand the output ports.

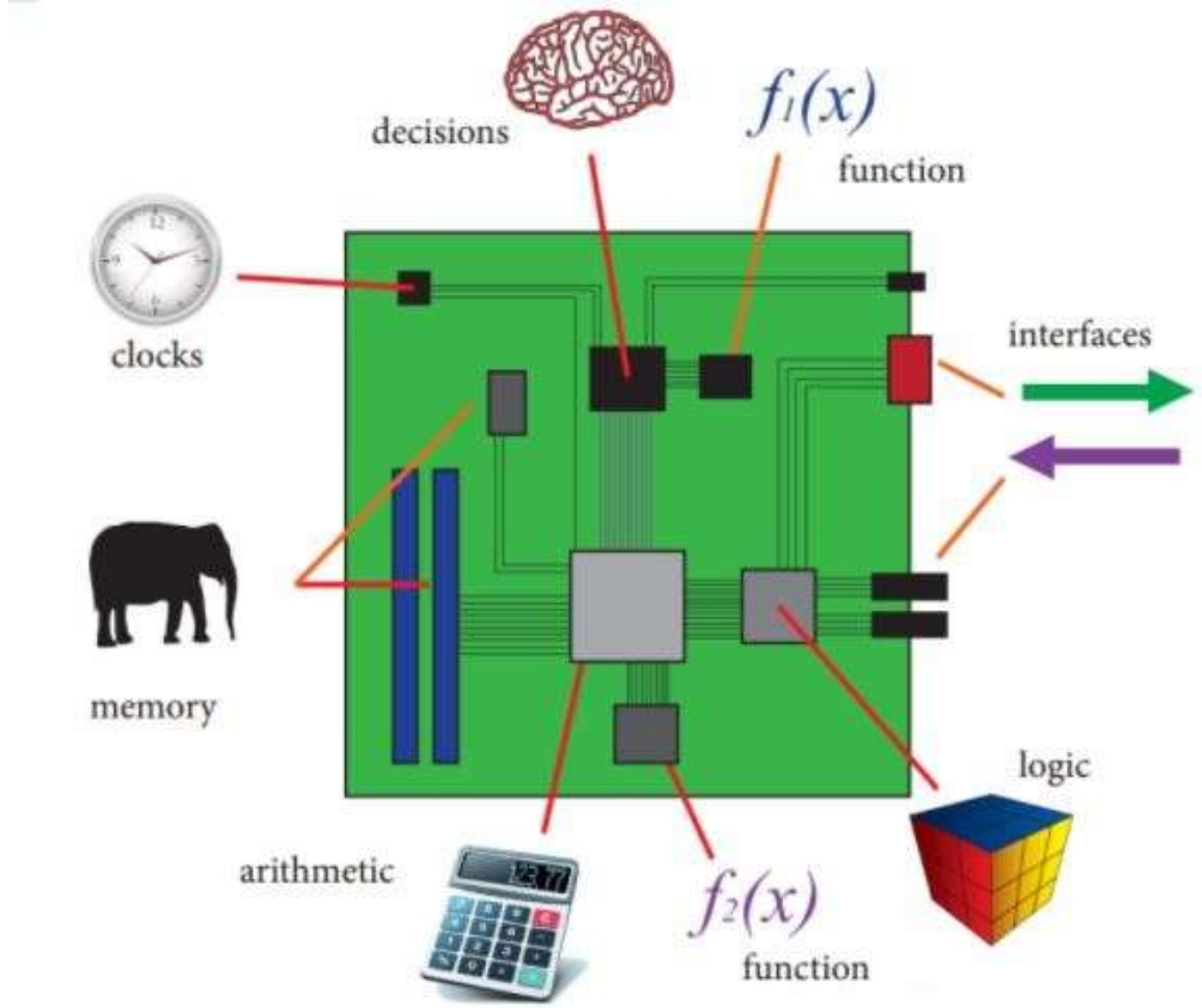
Using no circuitry other than ICs from this family of four, you can create a system with 4096 8-bit bytes of ROM storage and 5120 bits of RAM storage. When you require rapid turn-around or need only a few systems, Intel's available and re-programmable ROM, Type 1701, may be substituted for the Type 4001 mask-programmed ROM.

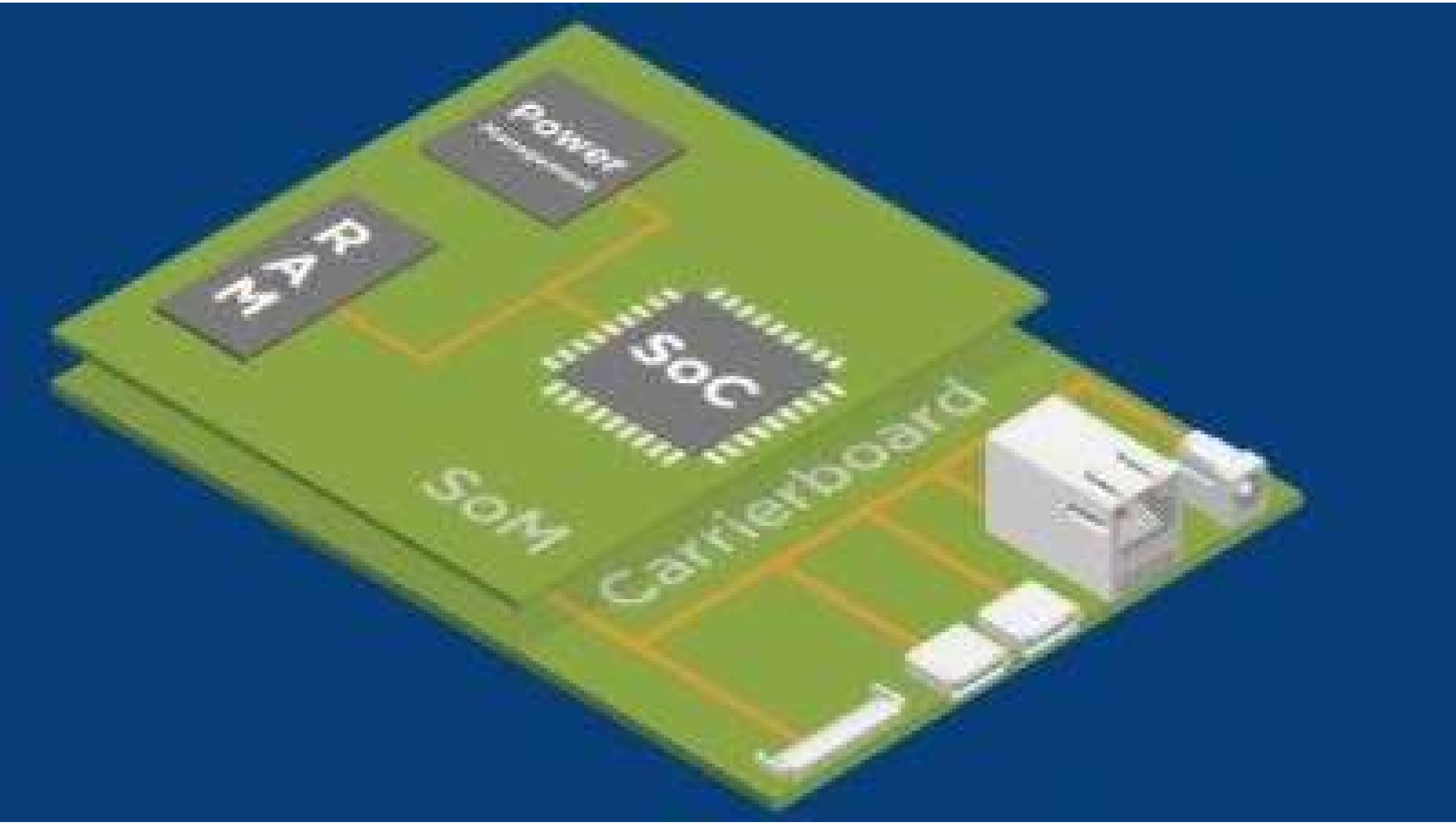
MCS-4 systems interface easily with switches, key-boards, displays, teletypewriters, printers, readers, A-D converters and other popular peripherals.

The MCS-4 family is now in stock at Intel's Santa Clara headquarters and at our marketing headquarters in Europe and Japan. In the U.S., contact your local Intel representative for technical information and literature. In Europe, contact Intel at Avenue Louise 218, B 1050 Bruxelles, Belgium. Phone 460005. In Japan, contact Intel Japan, Inc., Parkside Flat Bldg. No. 4-2-2, Sendagaya, Shibuya-Ku, Tokyo 151. Phone 03-423-3187.

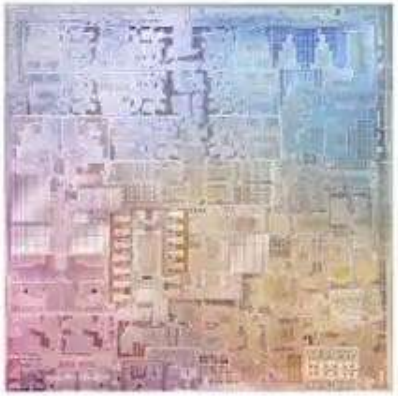
Intel Corporation now produces micro computers, memory devices and memory systems at 3065 Bowers Avenue, Santa Clara, Calif. 95051. Phone (408) 246-7501.

intel


decisions
$f_1(x)$
function
clocks
interfaces
memory
logic
arithmetic
$f_2(x)$
function

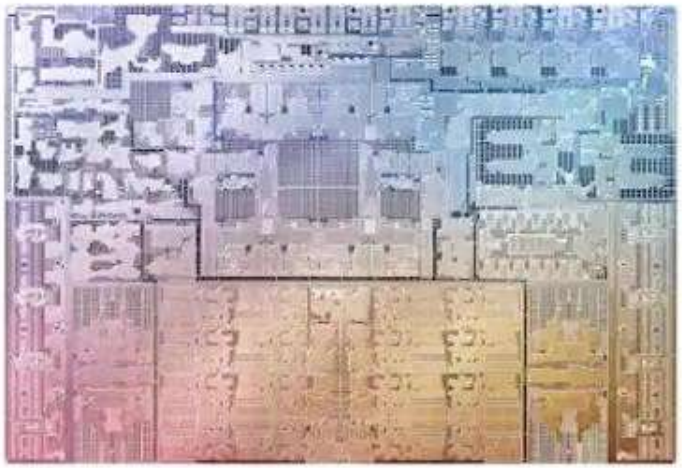

Power
MAP
SoC
SOM
Carrierboard

M1 (2020)



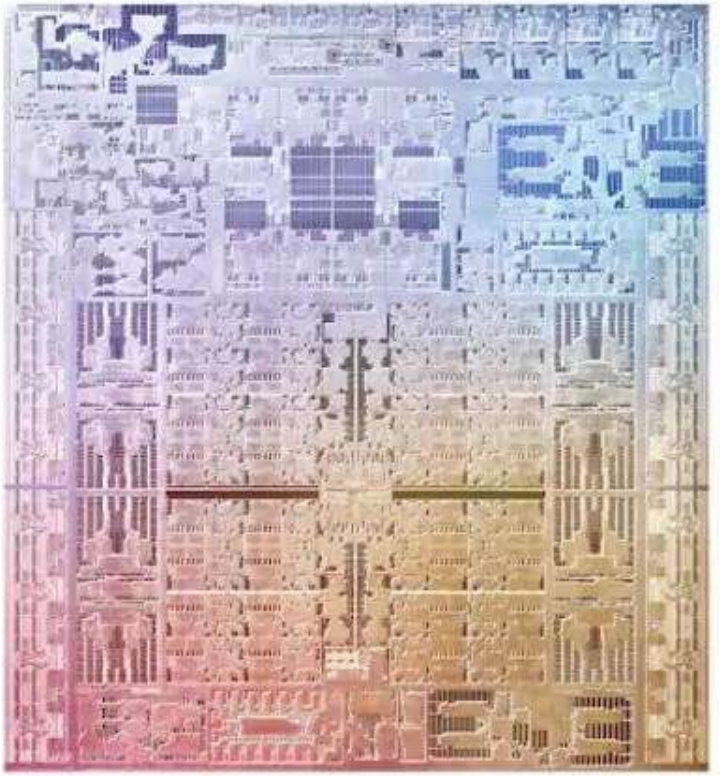
M1

M1 Pro (2021)



M1 Pro

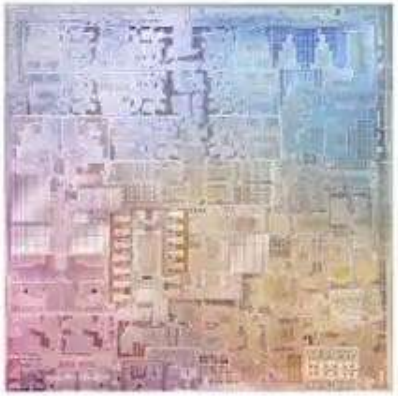
M1 Max (2021)



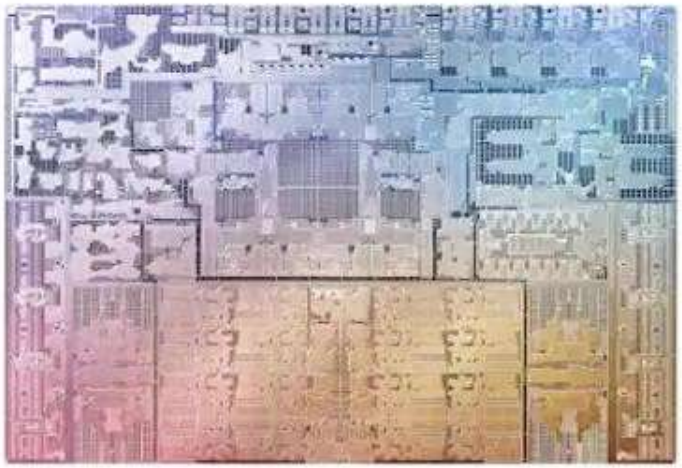
M1 Max

M1

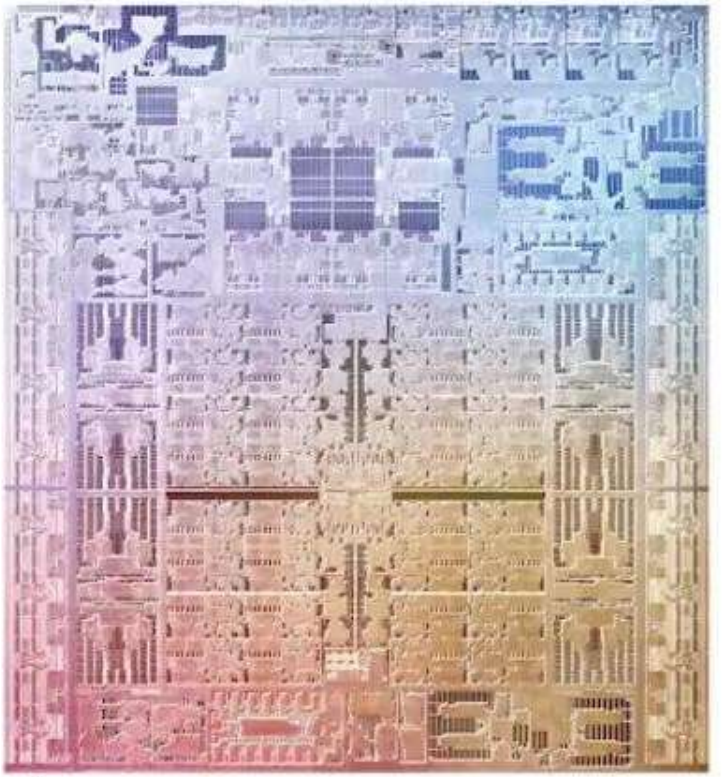
- ~16 miljardit transistorit.
- 8-tuumaline CPU (4 jõudlustuum + 4 energiatõhusat tuuma).
- 8 GPU tuuma.
- Suunatud MacBook Air ja MacBook Pro baasmudelitele.



M1



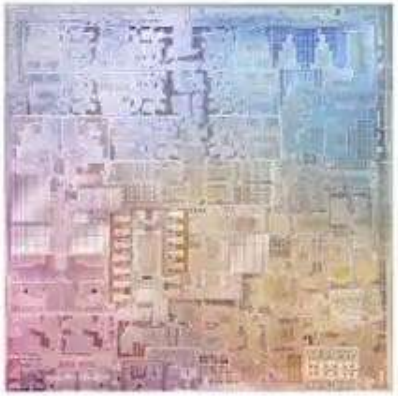
M1 Pro



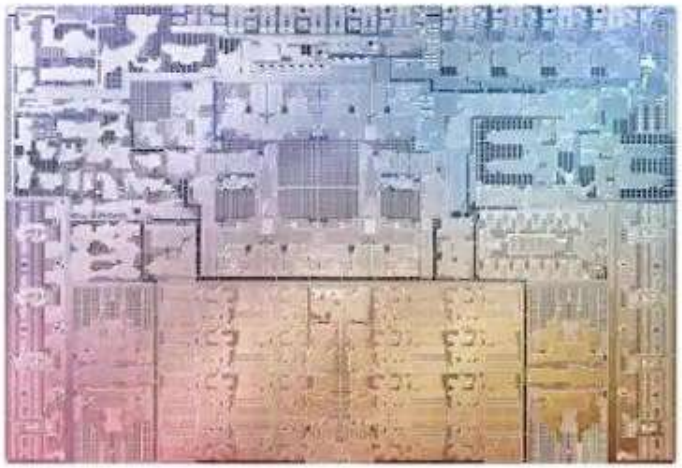
M1 Max

M1 Pro

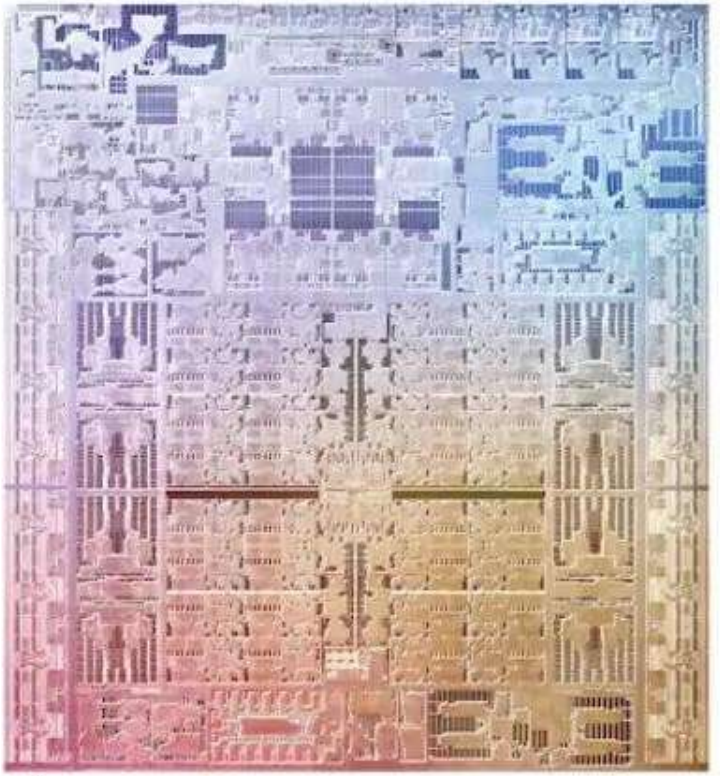
- ~33 miljardit transistorit.
- 8–10 CPU tuuma.
- 14–16 GPU tuuma.
- Laiem mälusiin (200 GB/s).
- Sobib professionaalsetele töövoogudele (video, graafika, andmetöötlus).



M1



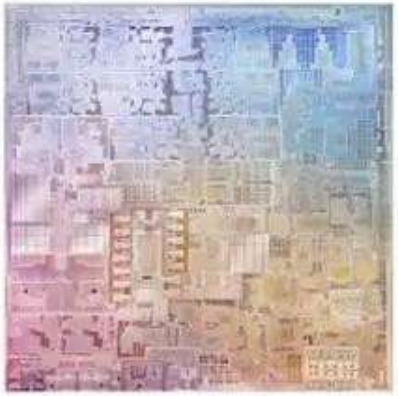
M1 Pro



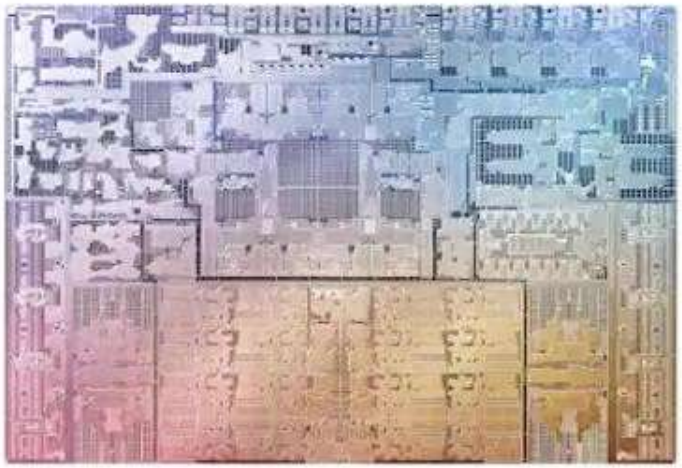
M1 Max

M1 Max

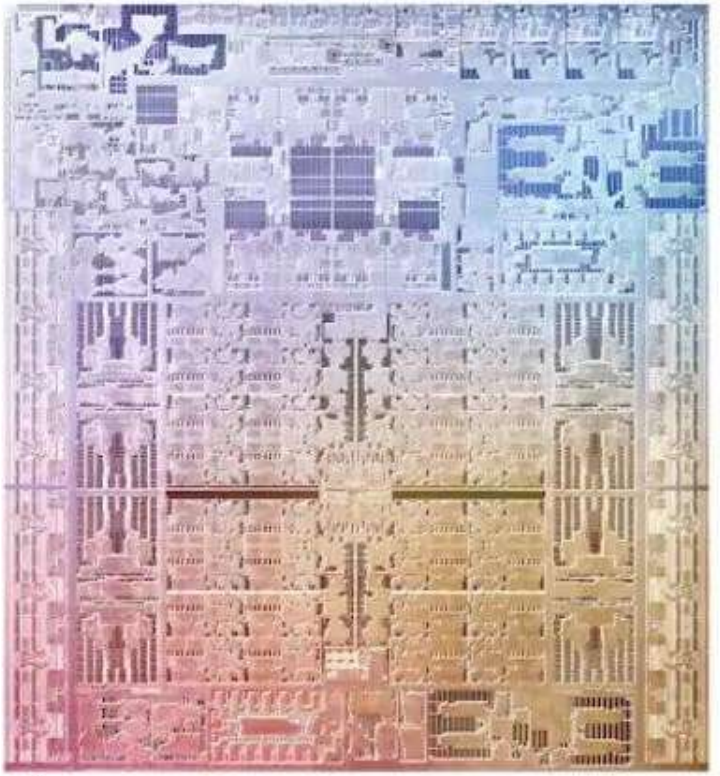
- ~57 miljardit transistorit.
- Sama CPU kui Pro mudelil.
- 24–32 GPU tuuma.
- Veelgi laiem mälusiin (400 GB/s).
- Kasutatakse tippklassi tööjaamades (nt 8K videomontaaž, 3D renderdus).



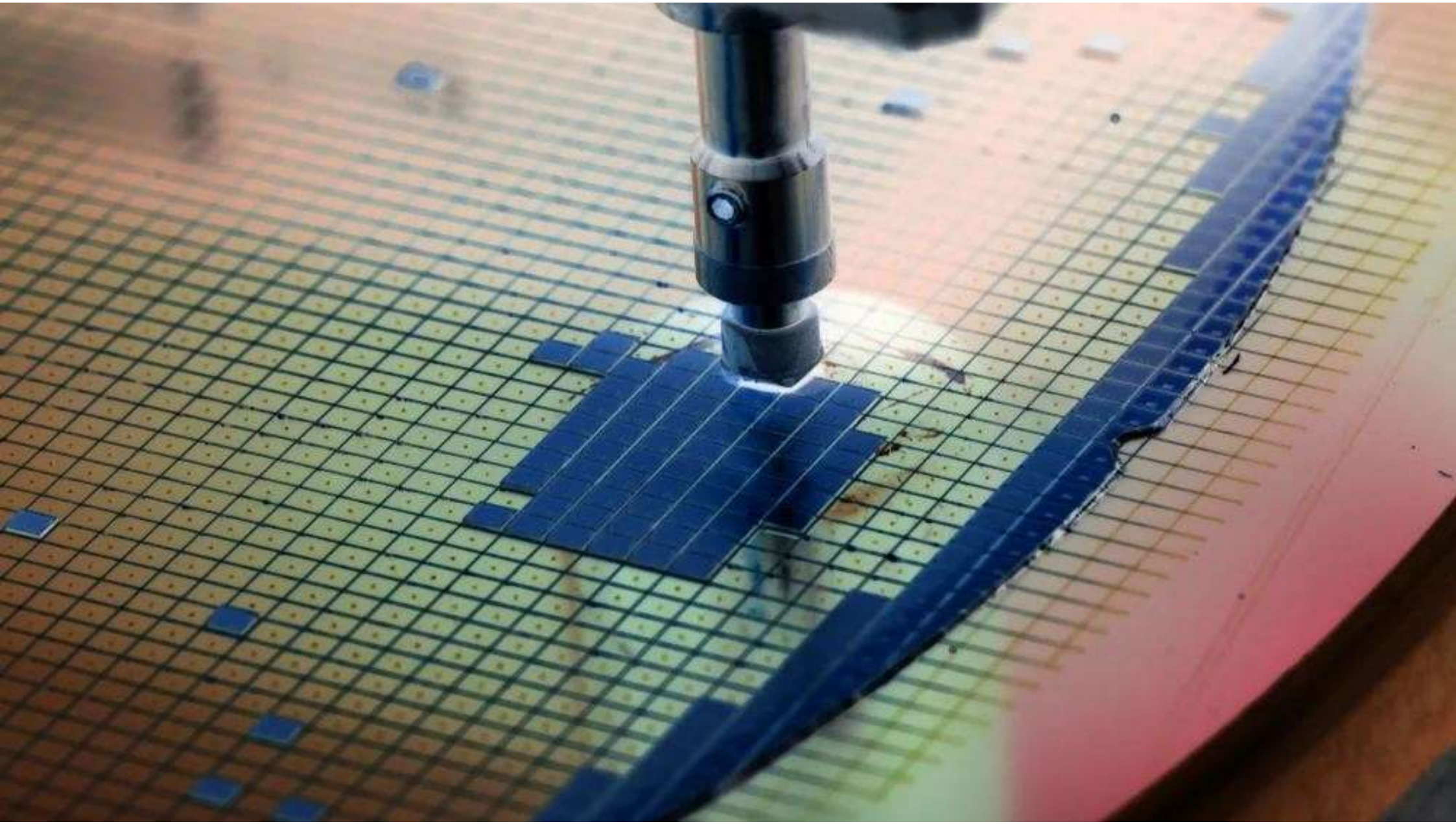
M1

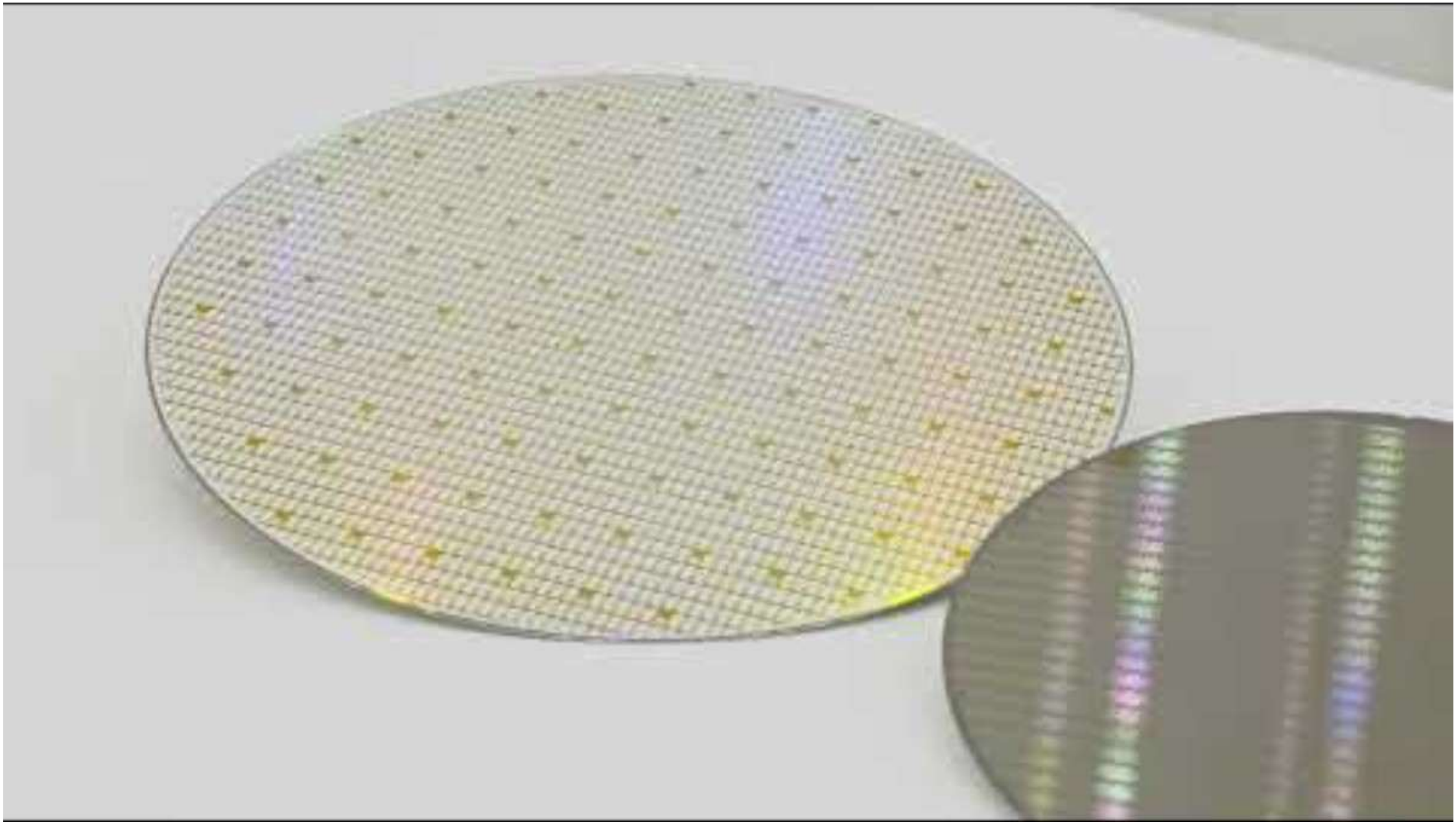


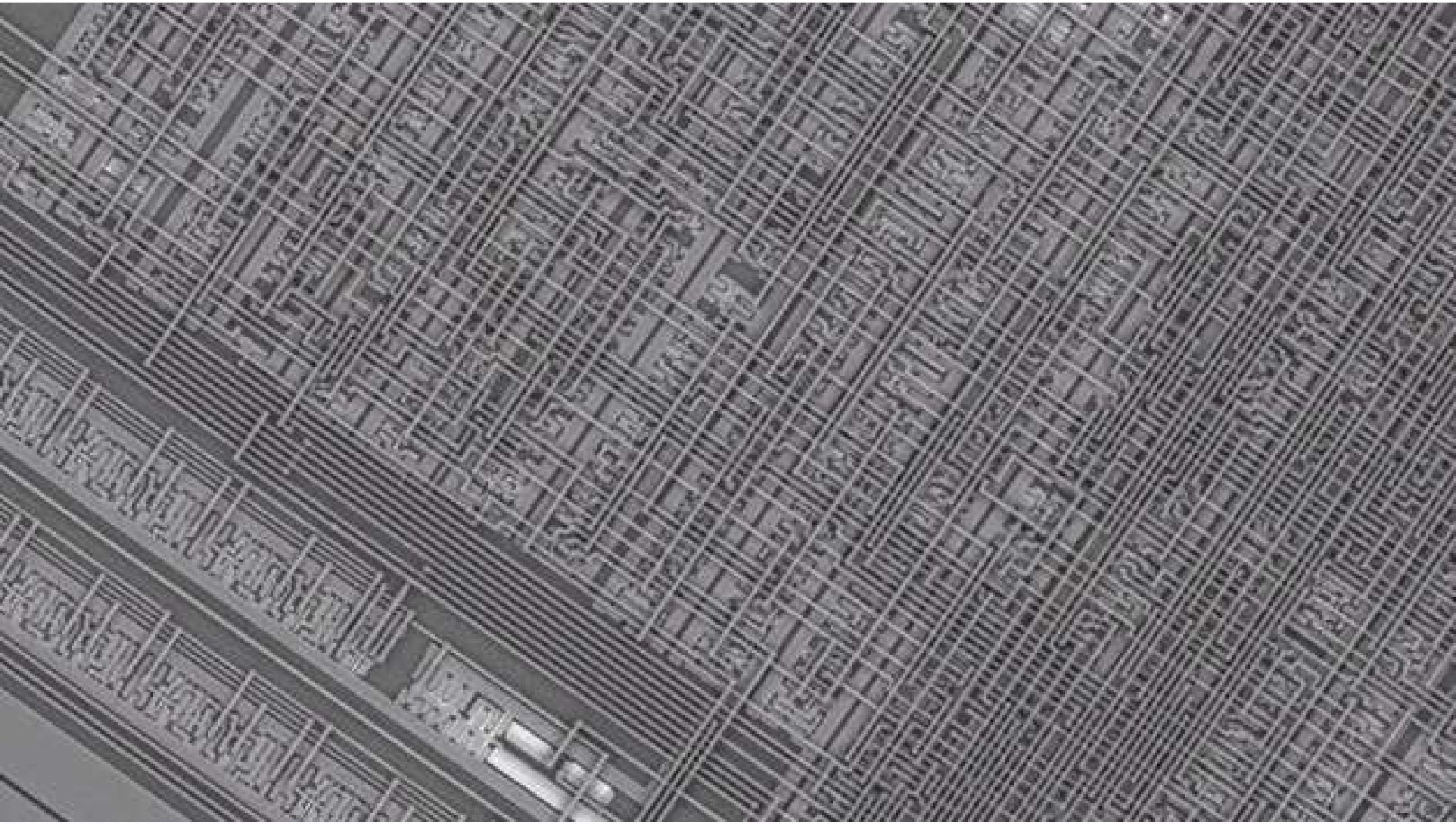
M1 Pro

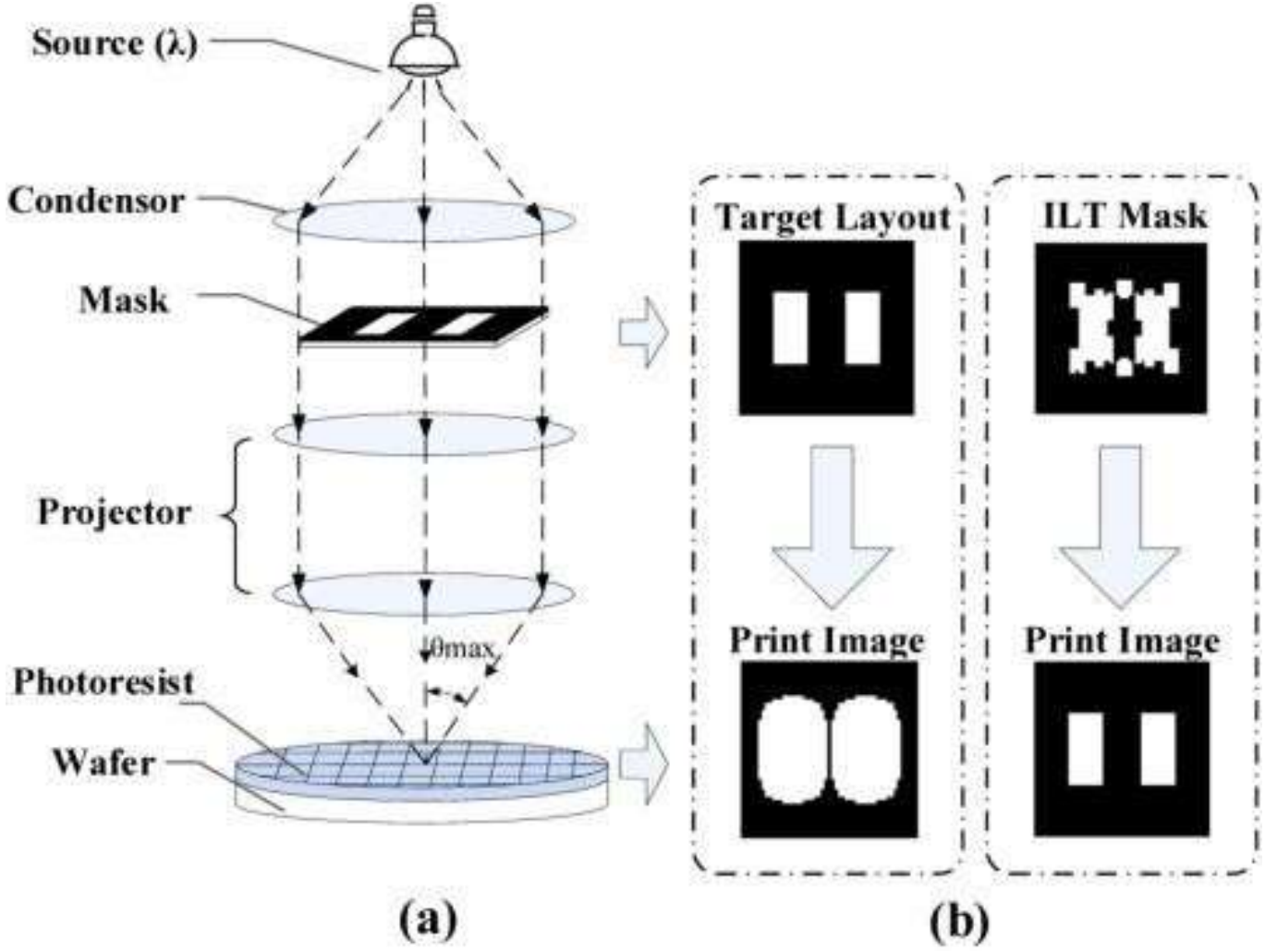


M1 Max



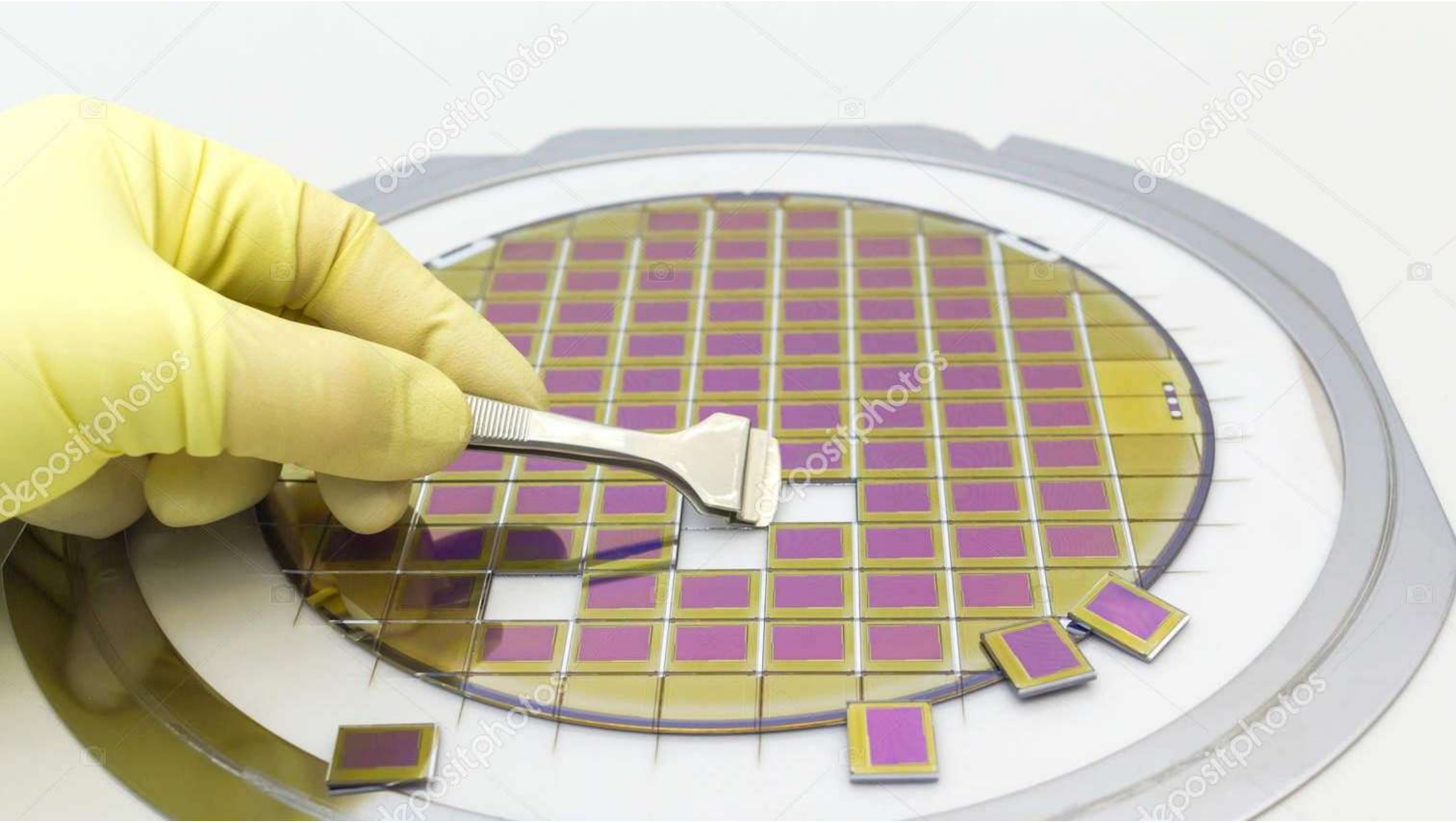


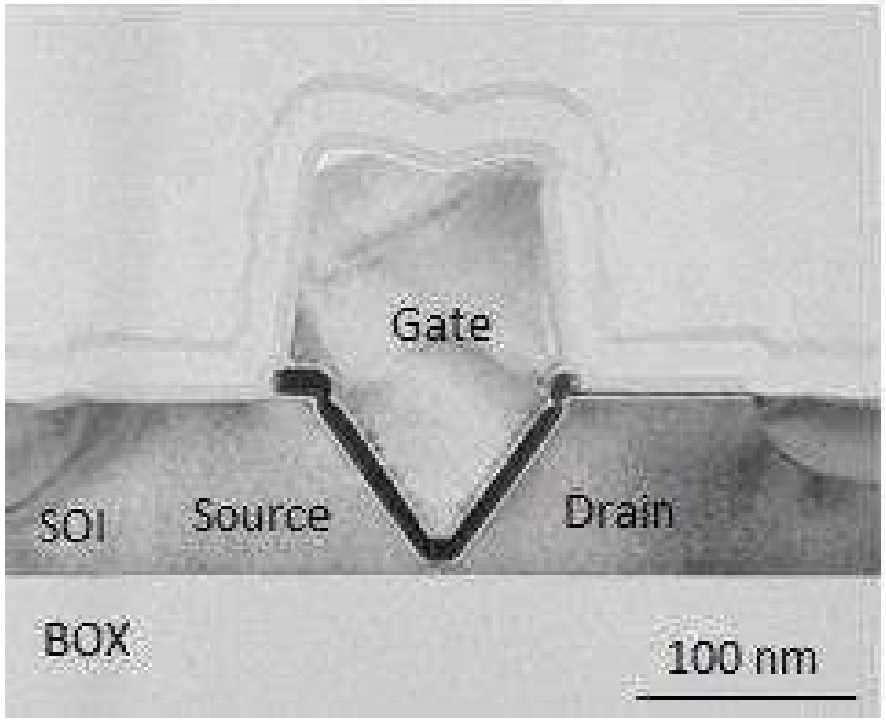


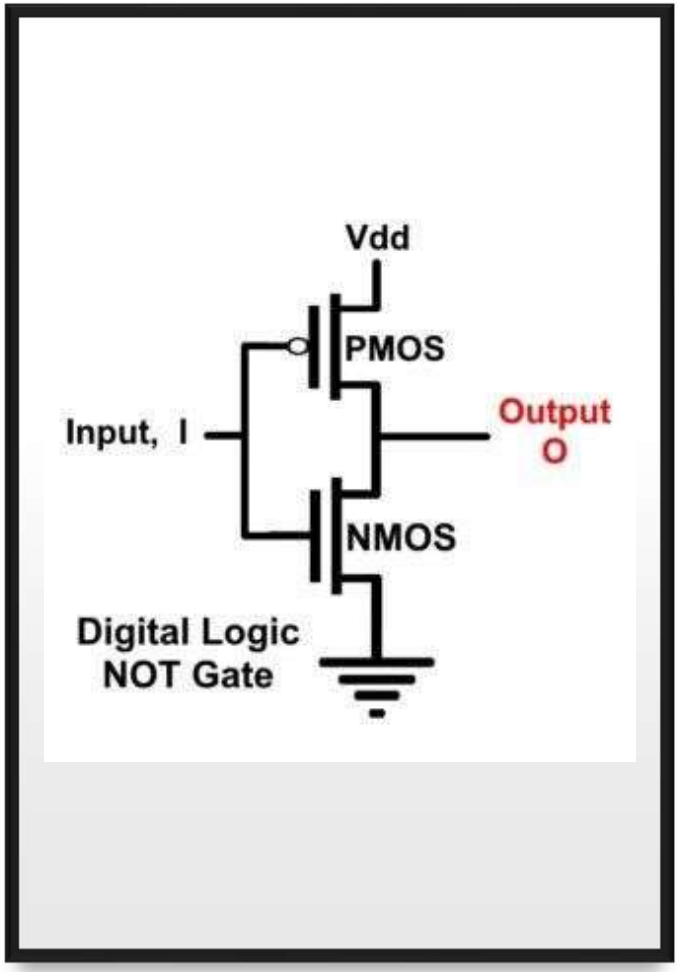

Source (λ)
Condensor
Mask
Projector
θmax
Photoresist
Wafer
Target Layout
ILT Mask
Print Image
Print Image
(a)
(b)

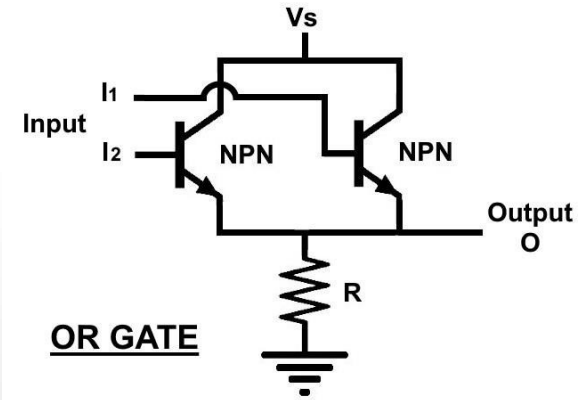
Lithography Basics

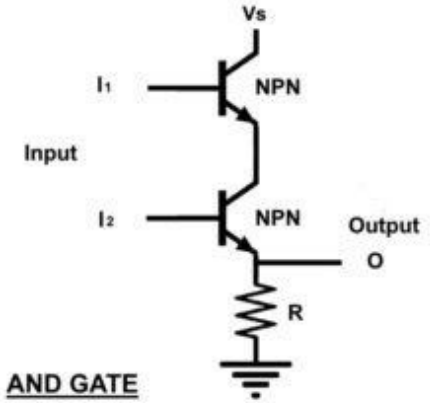
Part 2



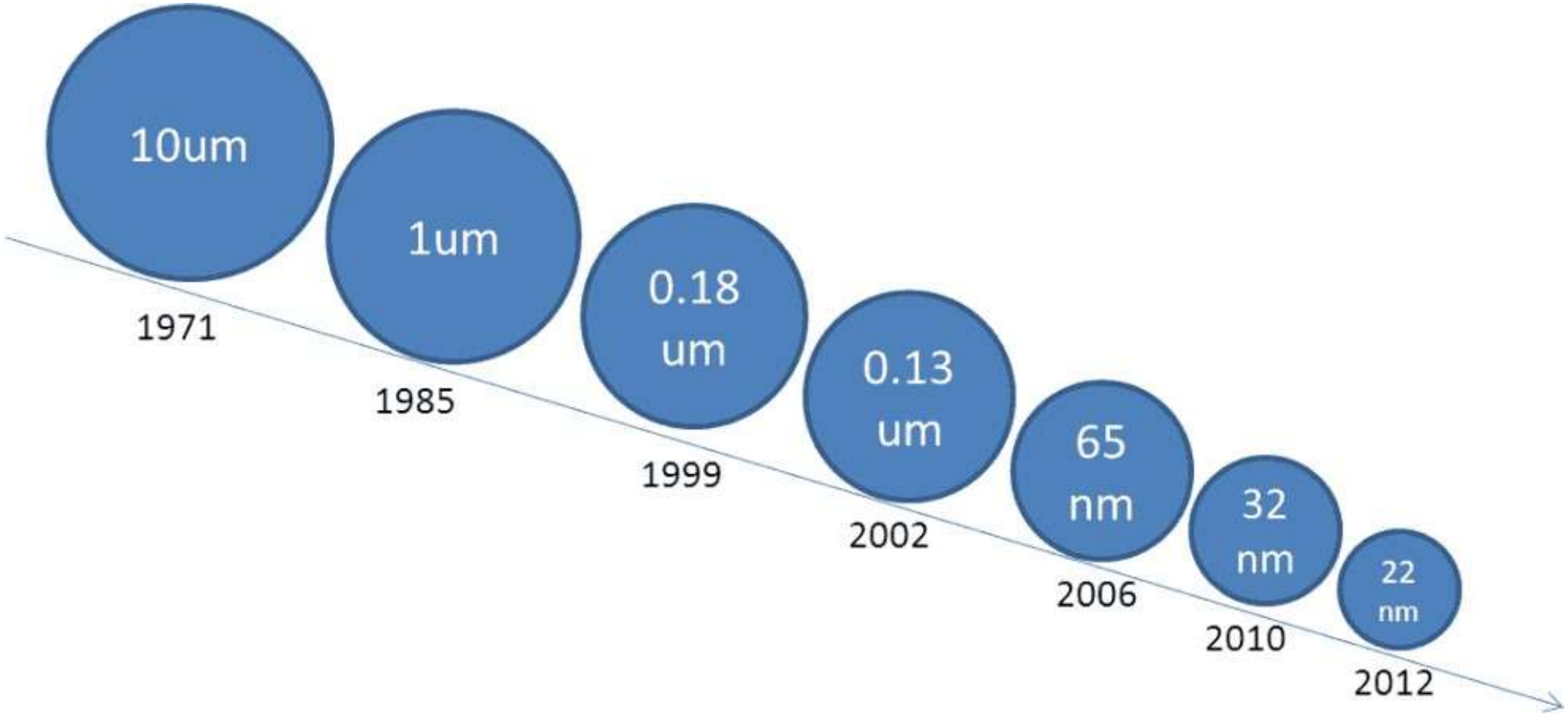

Gate
SOI
Source
Drain
BOX
100 nm

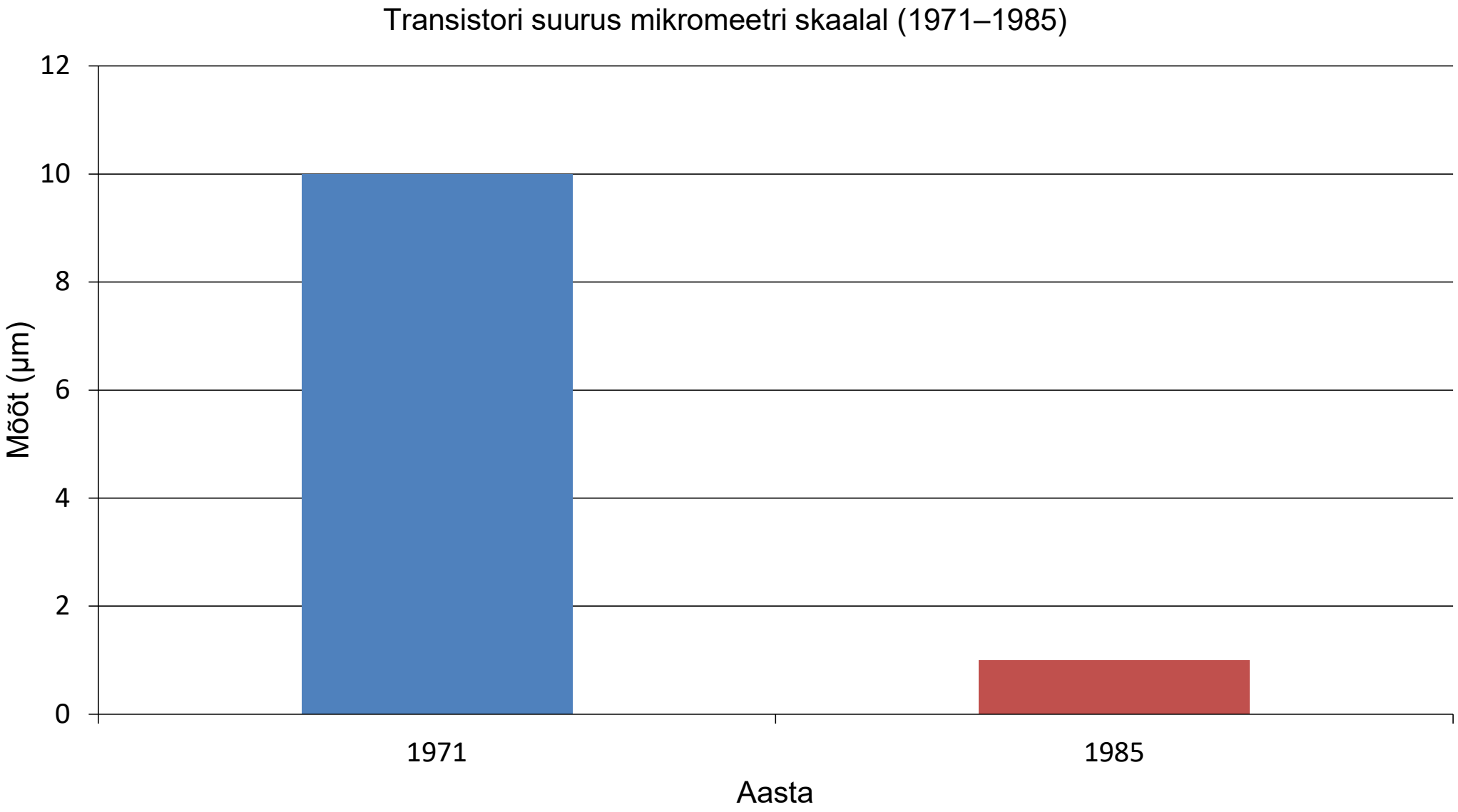

Vdd
PMOS
Input, I
Output
O
NMOS
Digital Logic
NOT Gate

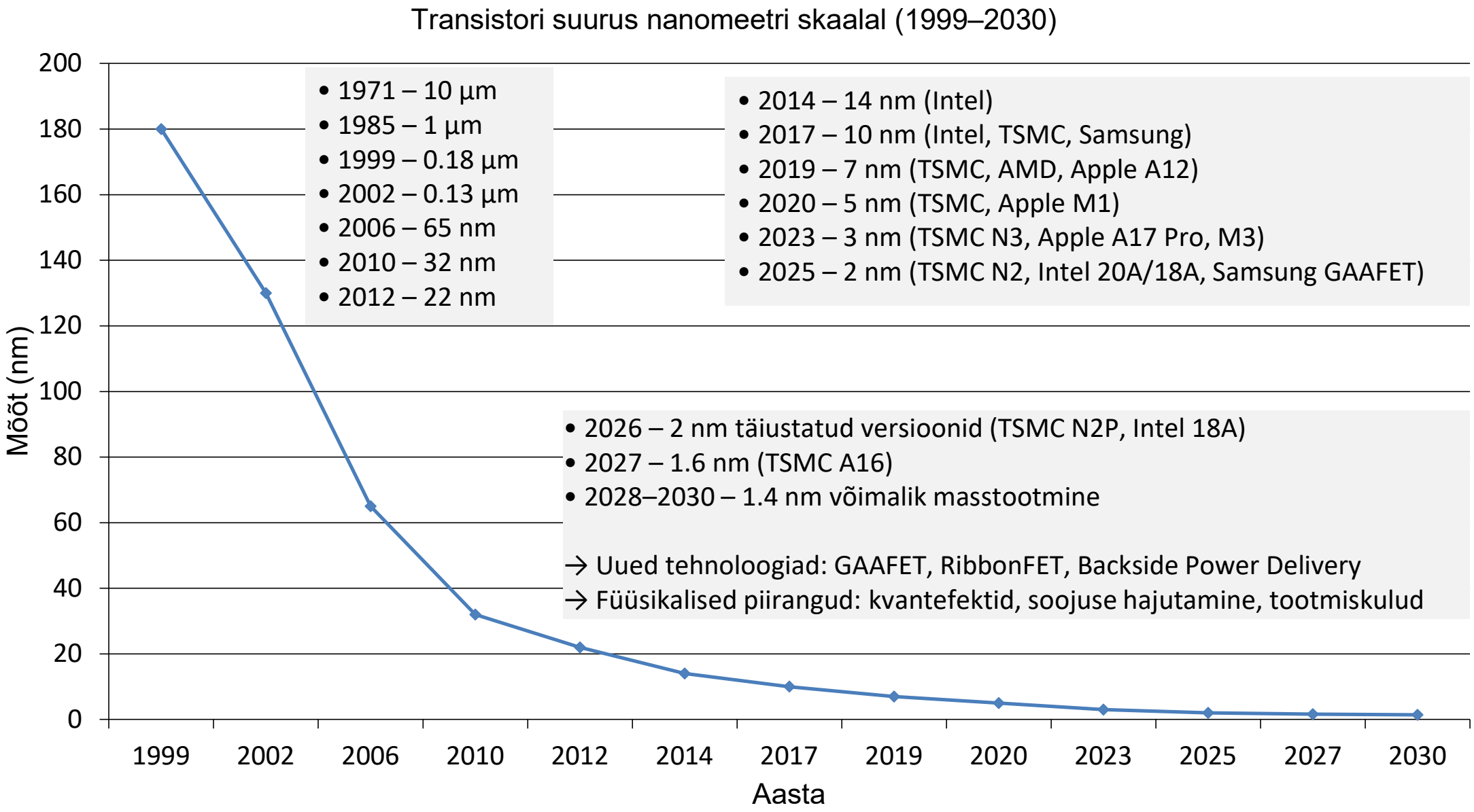

Vs
I1
Input
I2
NPN
NPN
Output
O
R
OR GATE

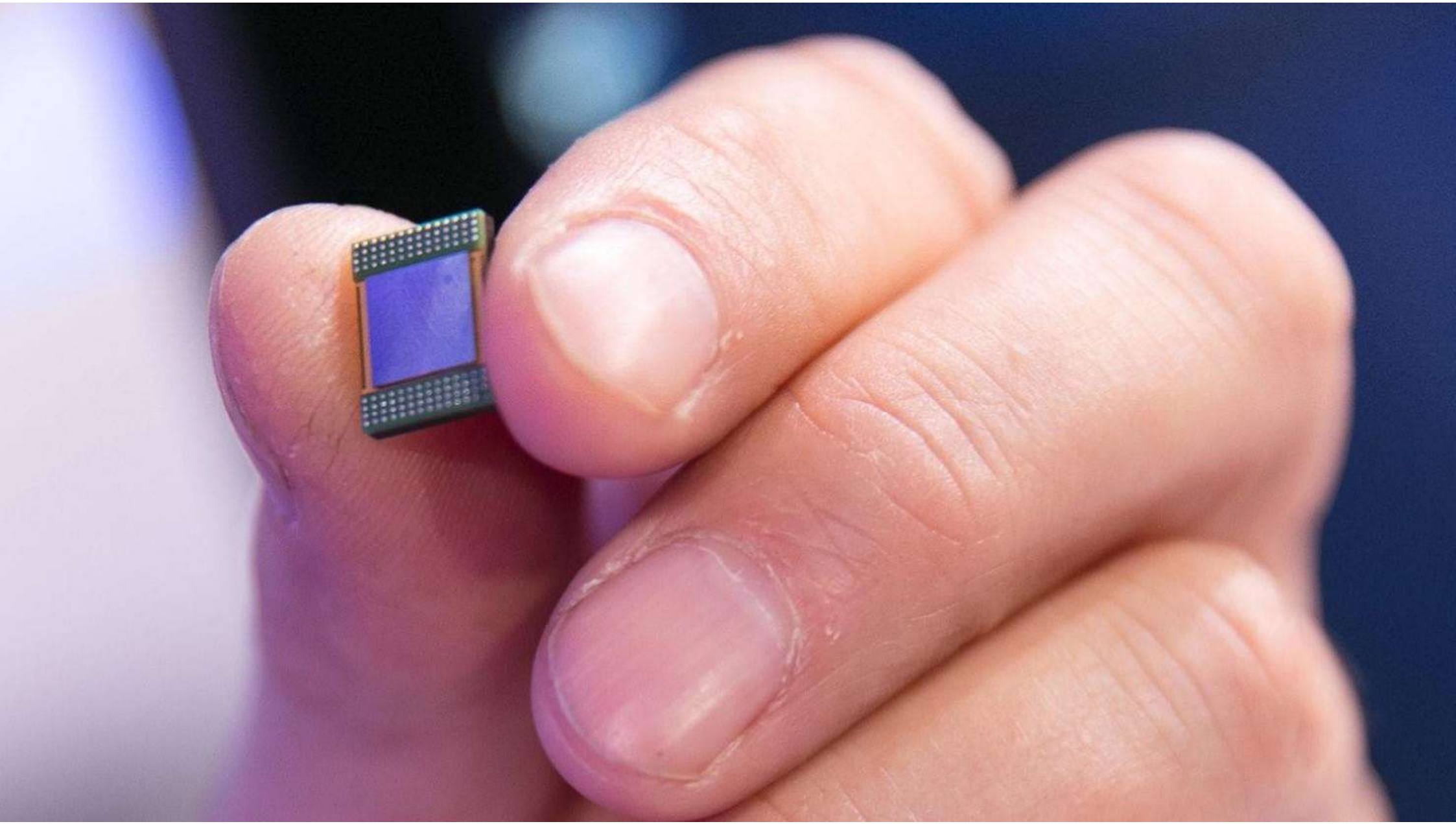

Vs
I1
NPN
Input
I2
NPN
Output
O
R
AND GATE

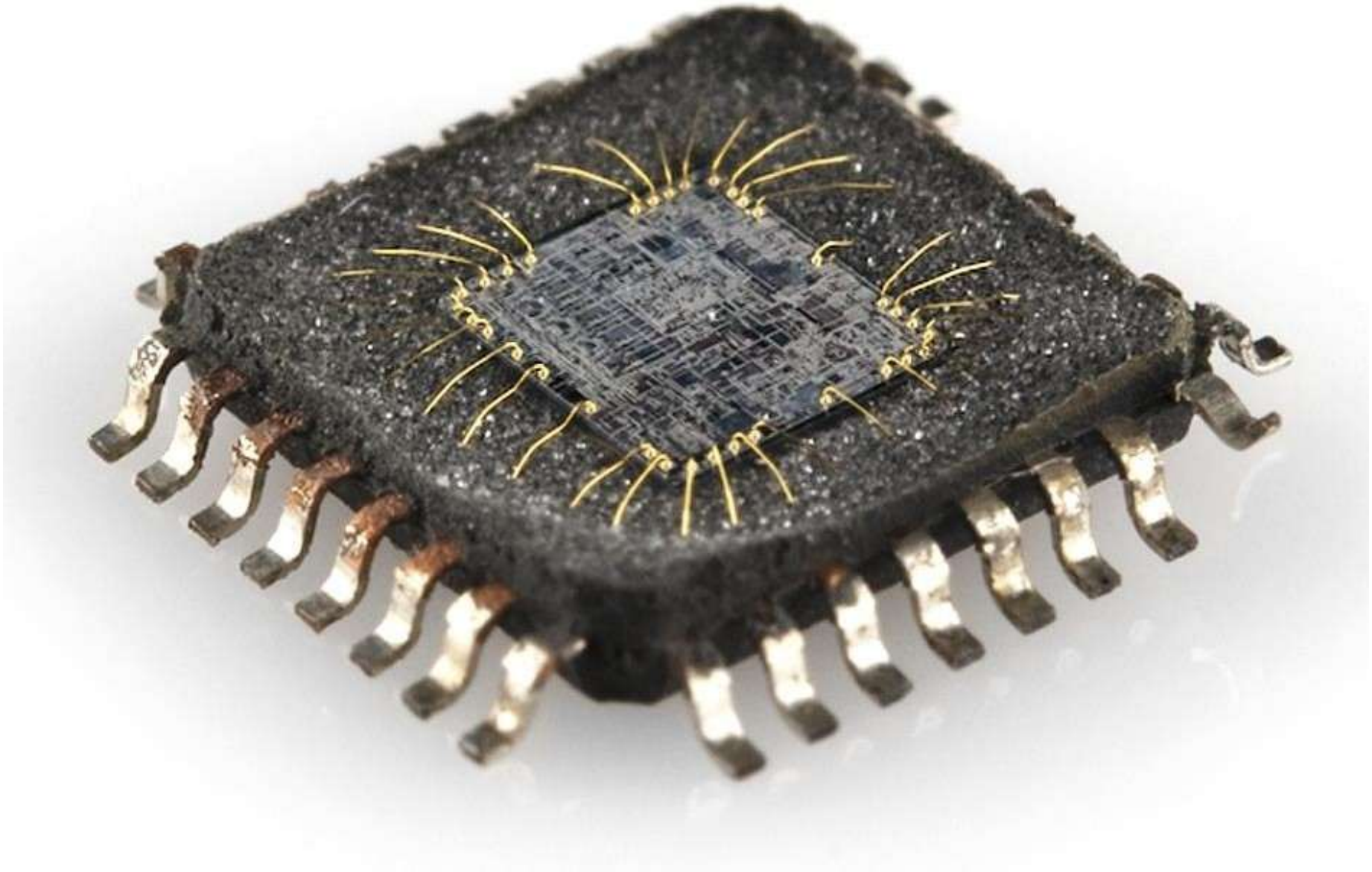
Transistori mõõtmete areng ja tulevik

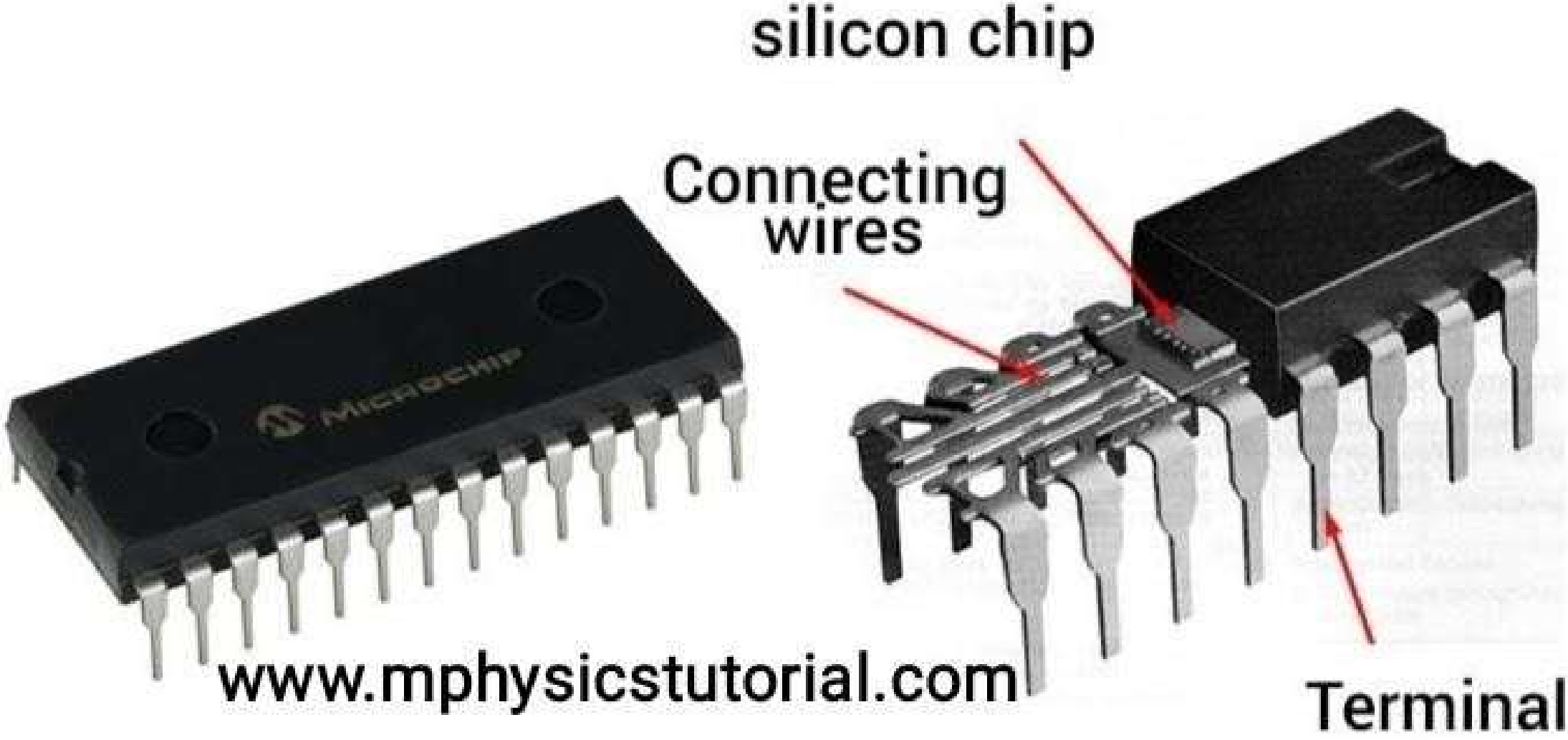


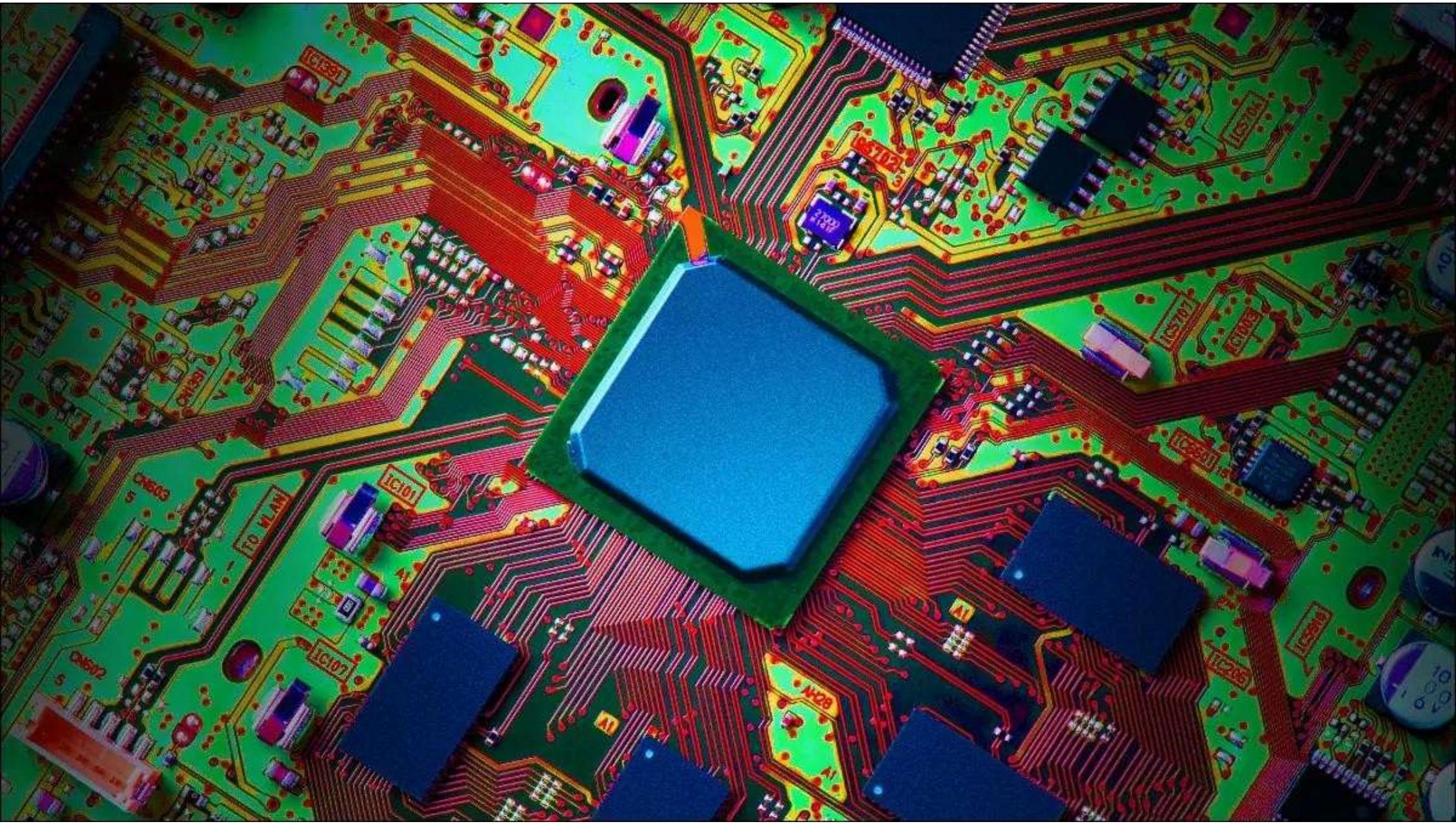

Transistori suurus mikromeetri skaalal (1971–1985)
12
10
8
6
4
2
0
Mõõt (µm)
1971
1985
Aasta


Transistori suurus nanomeetri skaalal (1999–2030)
Mõõt (nm)
200
180
160
140
120
100
80
60
40
20
0
1999
2002
2006
2010
2012
2014
2017
2019
2020
2023
2025
2027
2030
Aasta
• 1971 – 10 µm
• 1985 – 1 µm
• 1999 – 0.18 µm
• 2002 – 0.13 µm
• 2006 – 65 nm
• 2010 – 32 nm
• 2012 – 22 nm
• 2014 – 14 nm (Intel)
• 2017 – 10 nm (Intel, TSMC, Samsung)
• 2019 – 7 nm (TSMC, AMD, Apple A12)
• 2020 – 5 nm (TSMC, Apple M1)
• 2023 – 3 nm (TSMC N3, Apple A17 Pro, M3)
• 2025 – 2 nm (TSMC N2, Intel 20A/18A, Samsung GAAFET)
• 2026 – 2 nm täiustatud versioonid (TSMC N2P, Intel 18A)
• 2027 – 1.6 nm (TSMC A16)
• 2028–2030 – 1.4 nm võimalik masstootmine
→ Uued tehnoloogiad: GAAFET, RibbonFET, Backside Power Delivery
→ Füüsikalised piirangud: kvantefektid, soojuse hajutamine, tootmiskulud






silicon chip
Connecting wires
MICROCHIP
www.mphysicstutorial.com
Terminal



Grupitöö: Kuhu kiibid kadusid?

- Kuidas tekkis kiibikriis ja mida see tähendab?
- Kuidas saaks lahendada kriisi?
- **Miks on kriisi keskmes just kiibid?**