Memory technologies

Digital storage evolution

1928: Magnetic tape

1956: Hard disk drive

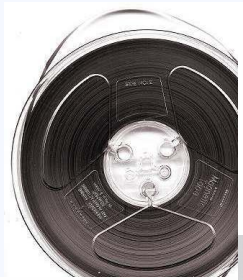
1967: Floppy disk

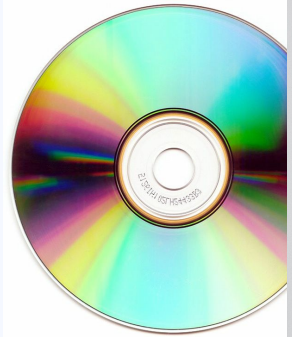
1982: CD

1995: Flash-based SSD

1998: USB drive

2006: Cloud storage





(image sources linked)

Combinational v. Sequential Circuits

Combinational

Output is always the same for a given input (“pure functions”)

No memory (e.g. LED only stays on while button is held down)

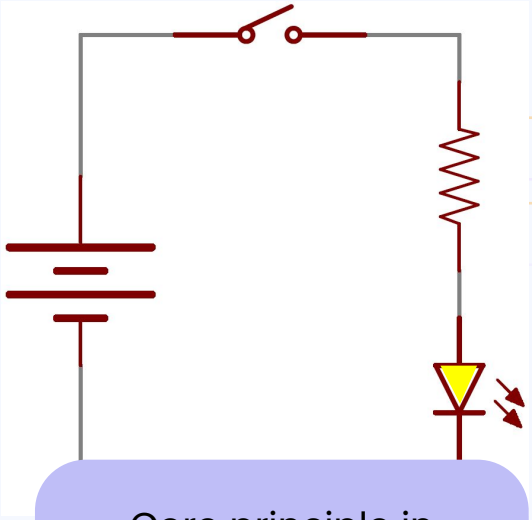
Logic gates, multiplexers, ALUs

Sequential

Output depends on current input and sequence of past inputs (such as “enable” signals)

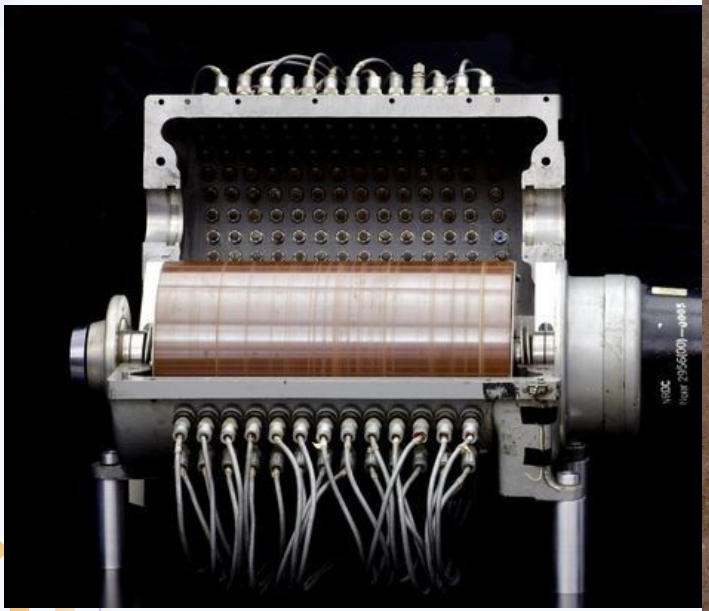
(e.g. LED would stay on after button released)

Memory components

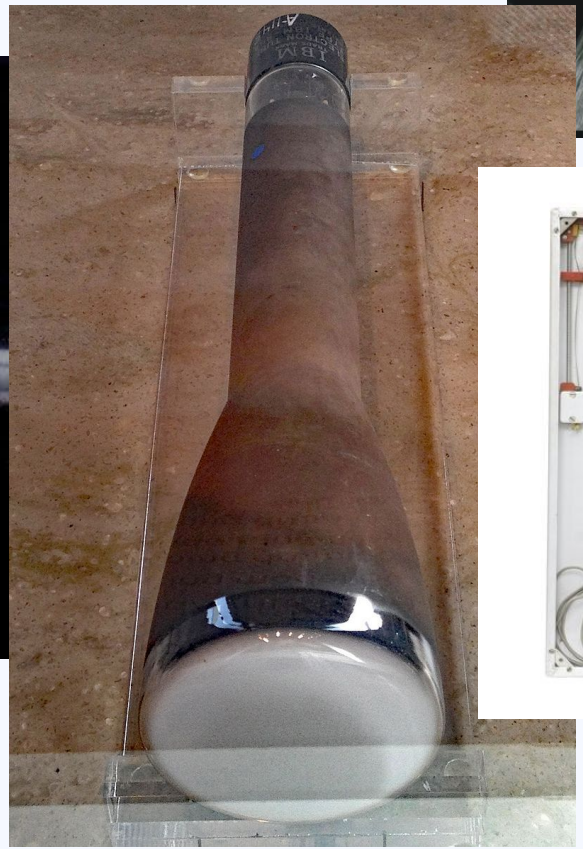


Core principle in circuits for computers: affect outcome/state of a circuit using electrical signals

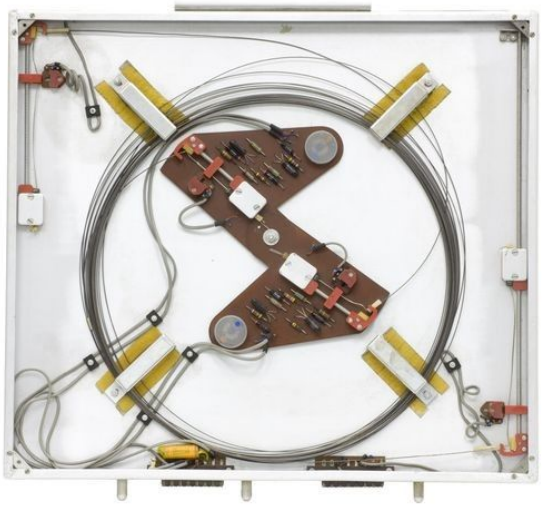
Early memories



Magnetic drum memory, *image source*



Williams-Kilburn Tubes, *image source*



Delay Lines, *image source*

Magnetic core memory

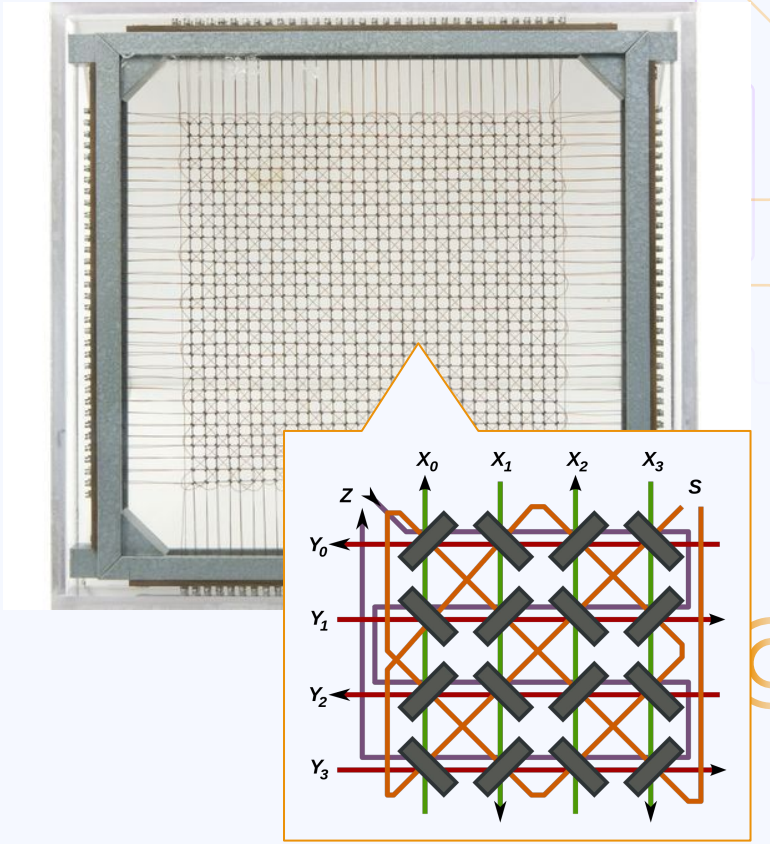
image source (photo)
image source (diagram)

x-y array of magnetic rings with x/y write lines and diagonal sense lines

power one x and one y line at half power to magnetize specific ring (write a bit of memory)

Use diagonal lines to try to flip polarity to 0 – if no voltage sensed, bit was 0, otherwise, 1

Reliable, non-volatile form of RAM used in the 50s-70s



Recognize anything?

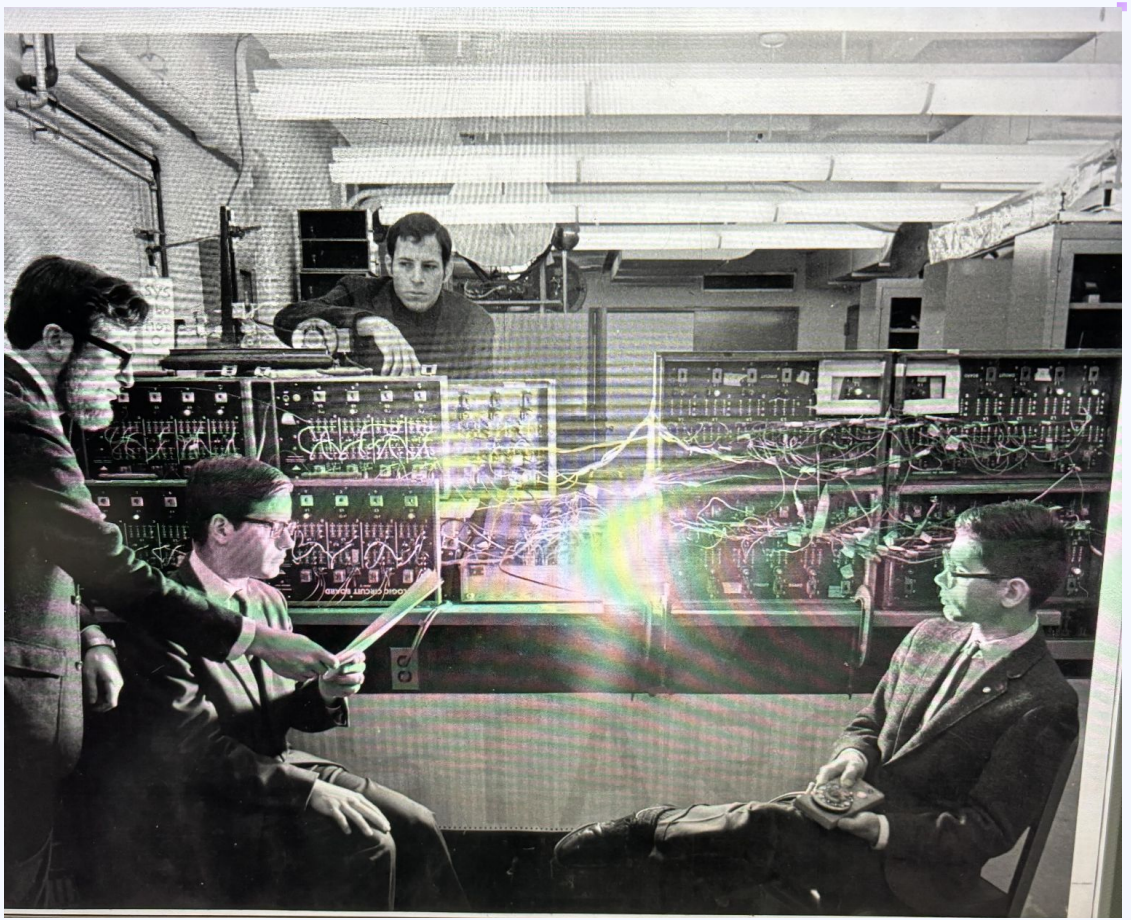


Photo courtesy of Andries van Dam

Relays: electromechanical switches

Allow us to switch between two circuits based on (electrical) input!

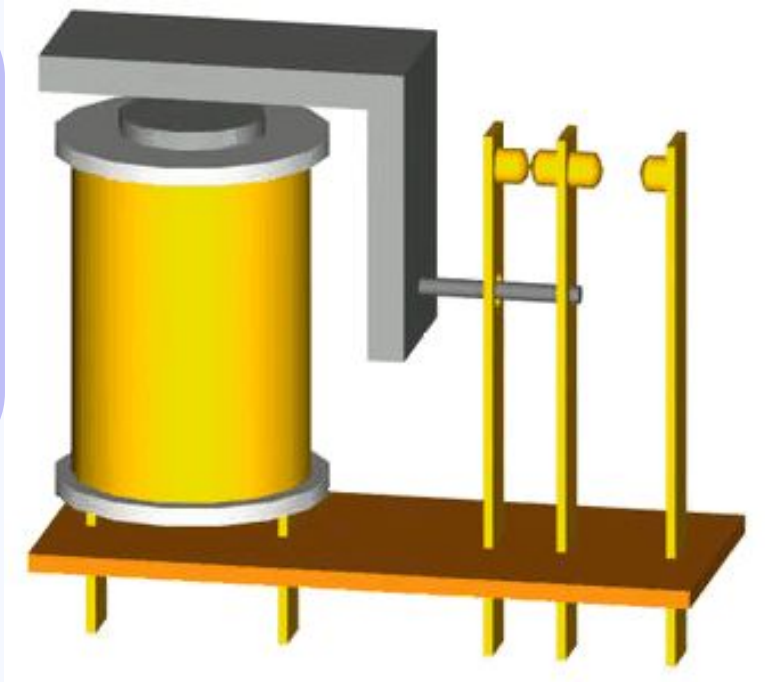


image source

image source

circuits

Vacuum tubes

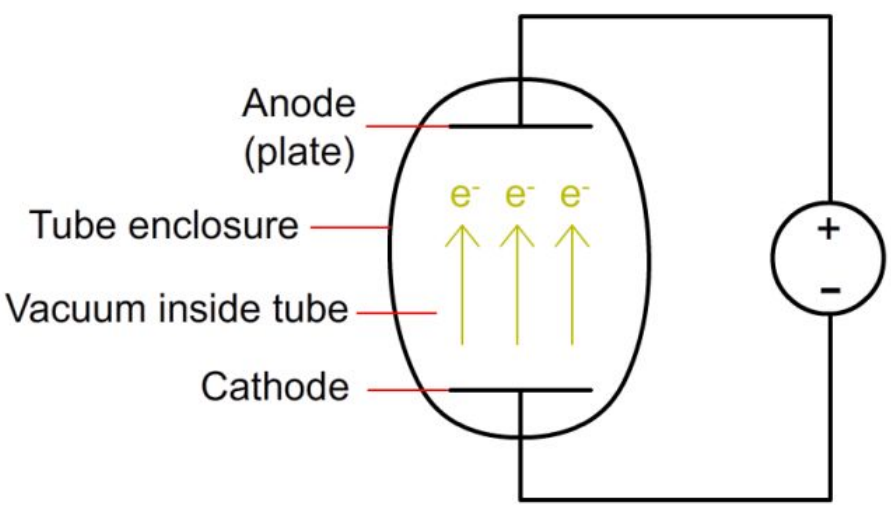


image source

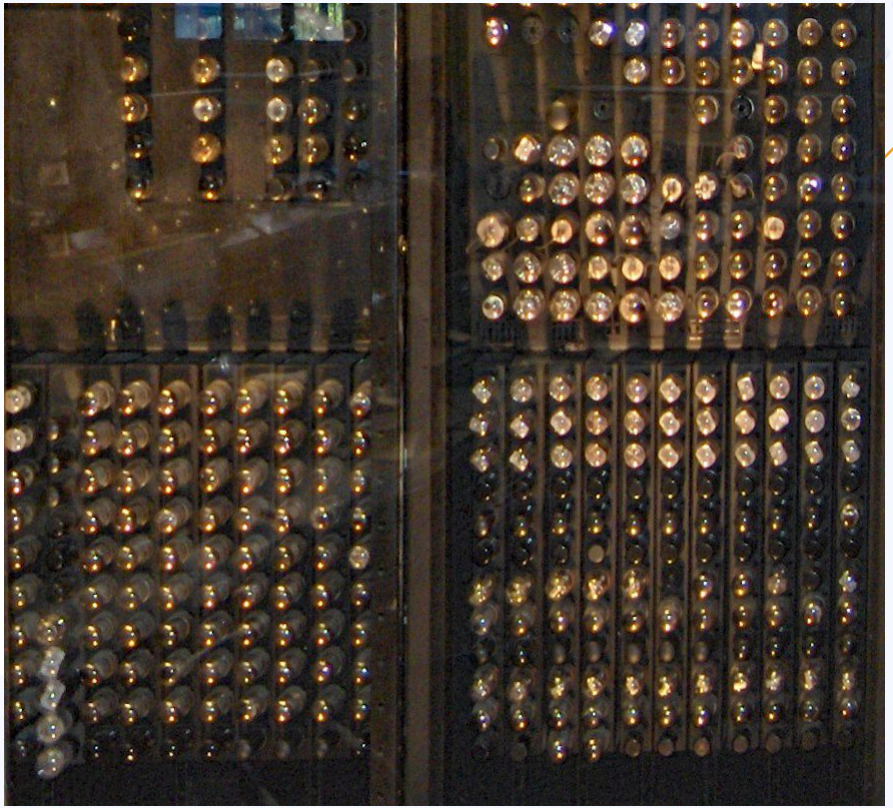


image source

Transistors

Act like switches - voltage at gate (or base) allows current to flow between drain and source (or collector/emitter)

In reality: much more complicated; can be used as amplifiers; have complex properties

Made out of layers of semiconductive material (silicon, germanium)

Can be used for combinational logic… and sequential logic!

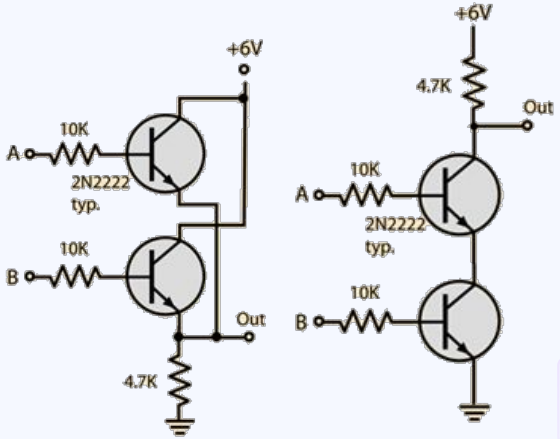


image source

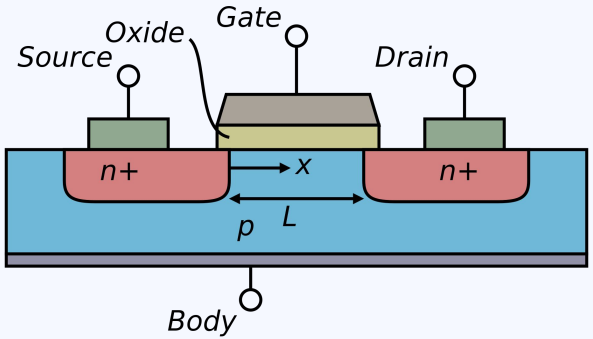


image source

DRAM cells

Falstad simulation link

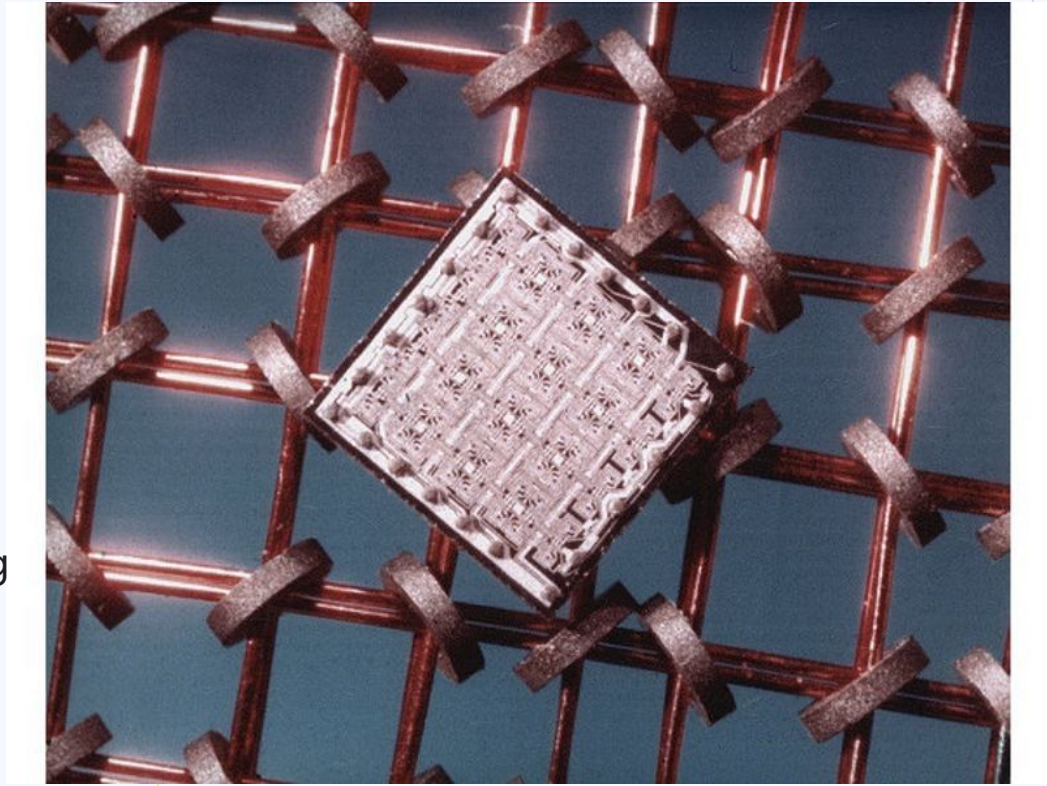


image source
(this is actually a marketing image for IBM SRAM but still makes a point)

image source

SRAM, Flash, the future

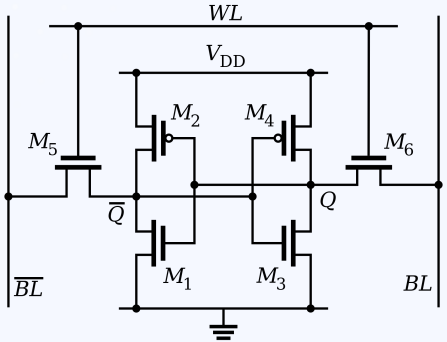
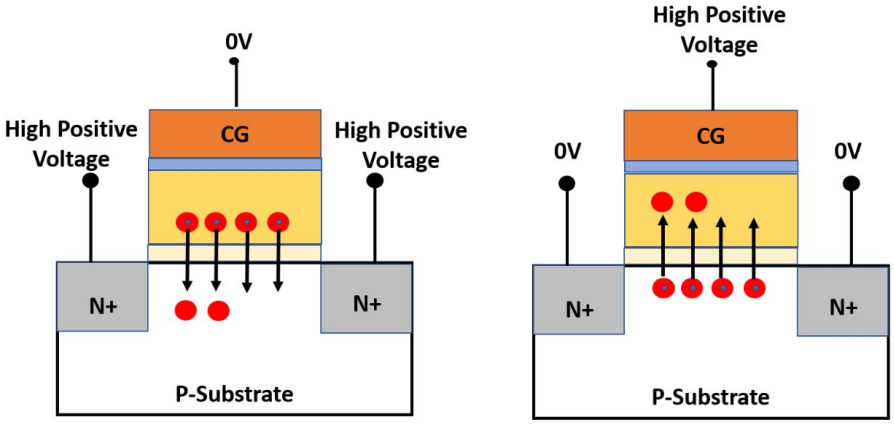
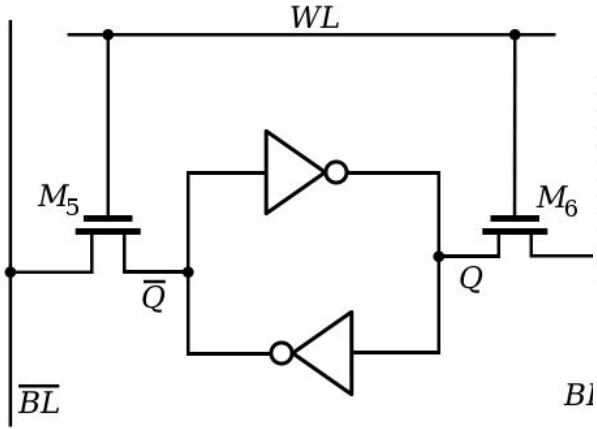


Image source





source

Thursday, January 4, 2024

Researchers Create First Functional Semiconductor Made From Graphene

The technology could allow for smaller and faster electronic devices and may have applications for quantum computing.

Researchers at the Georgia Institute of Technology have created the world's first functional semiconductor made from graphene, a single sheet of carbon atoms held together by the strongest bonds known. Semiconductors, which are materials that conduct electricity under specific conditions, are foundational components of electronic devices. The team's breakthrough throws open the door to a new way of doing electronics.

SDRAM standards

DDR (and DDR2-5): standard for PCs

LPDRR: Mobile applications (use less power)

GDDR (1-6): “Narrow and fast” (smaller width bus, higher clock speeds)

HBM (high-bandwidth memory): Wide and slow” (higher width bus, lower clock speed); 3d stacked

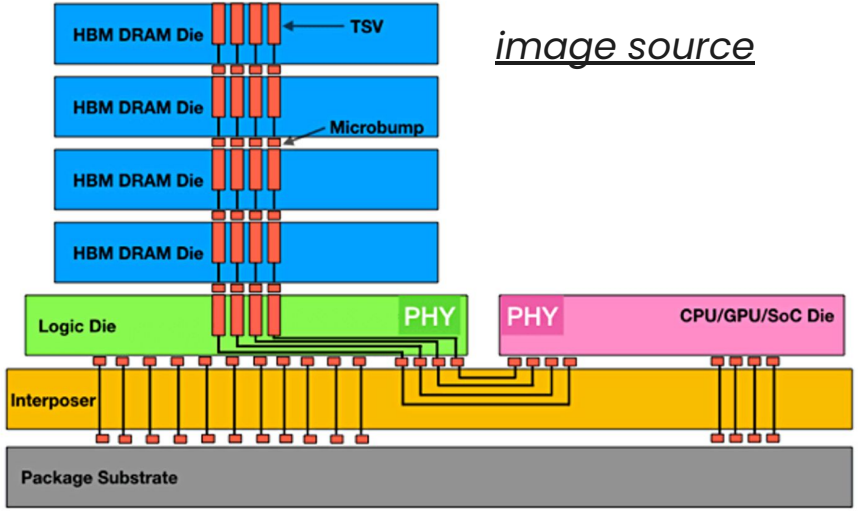


image source

image source

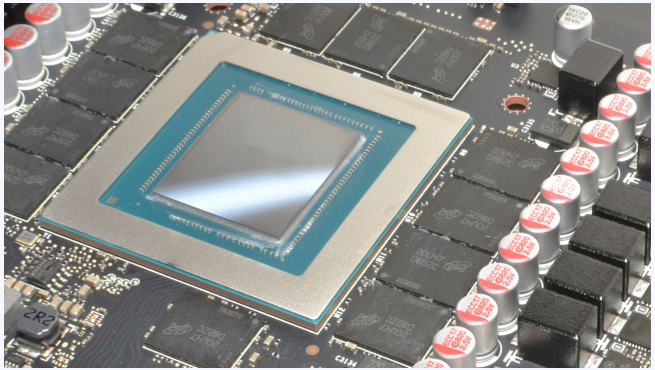


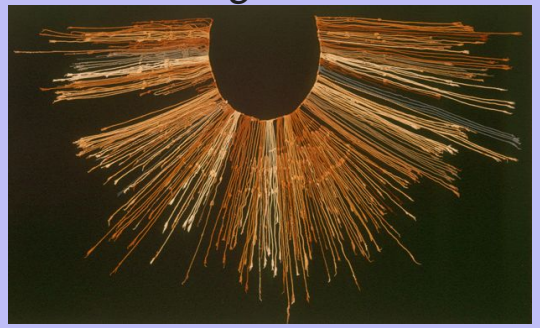
image source

? ? ?

Discussion (if time):

- Potential for a digital dark age? (Risks, potential for preservation, stakeholders)
    - Should we also worry about software/hardware preservation? How does one relate to the other?

image source



Resources

Falstad circuit simulator

The Man Made World: Lab manual, Student manual, article

Constructing a DRAM

CHM Memory & Storage Exhibit (online gallery)