# ECS404: Computer Systems and Networks

**Computer Architecture**

Week 1 Pt 3: A look inside

# Aims

- In this video we look at the internal structure of some computers.

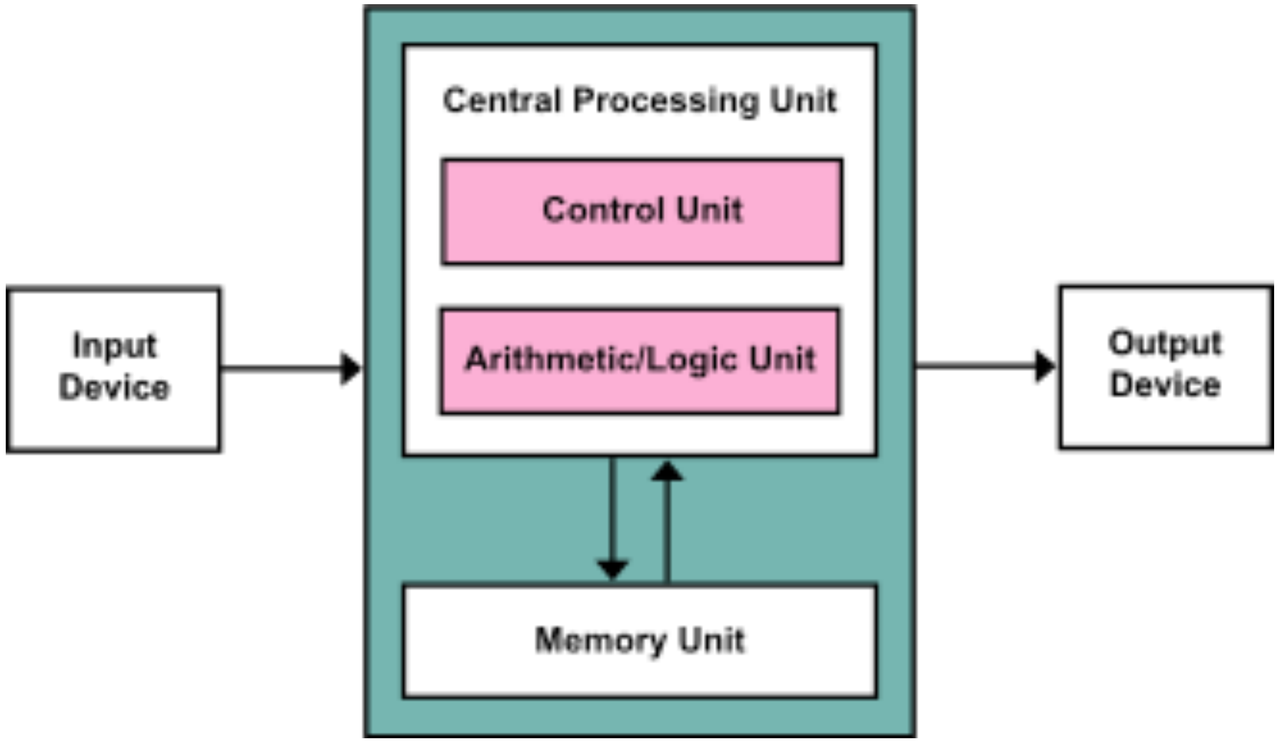
# Learning objectives

- Learn what the von Neumann architecture is
  - see examples where computers do and do not follow this architecture.
- Learn about the basic components of a computer
  - see examples of teardowns of computational devices showing these components.

# Basic Architecture

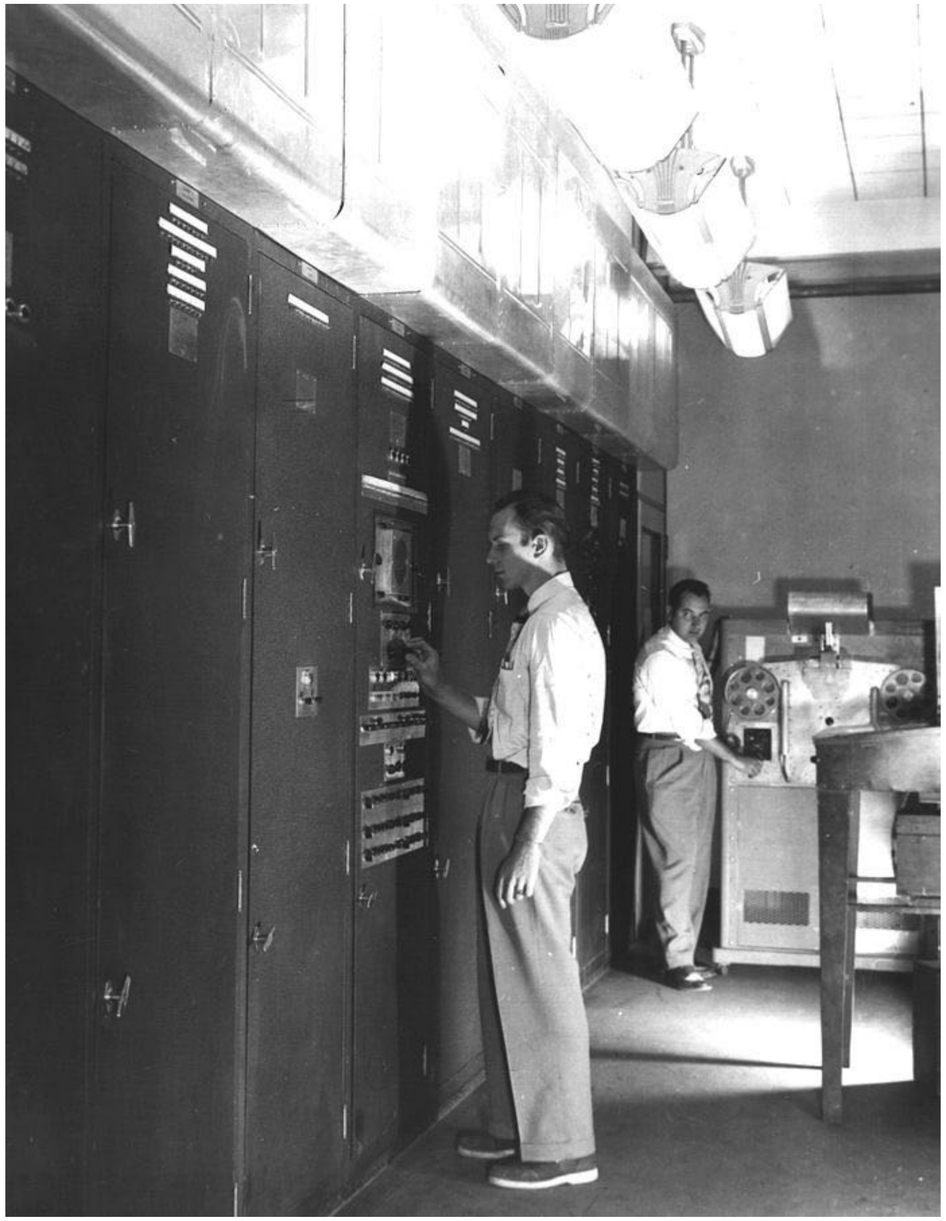
- Goes back to c1945, and the very first computers.

# von Neumann Architecture



# von Neumann Architecture

- John von Neumann: Hungarian mathematician working in the US. Made fundamental contributions to game theory (economics) and computer programming.
- 1945: First Draft of a Report on the EDVAC
- Described what others had been doing to build computers.
- This is right at the start of the production of actual working computers.

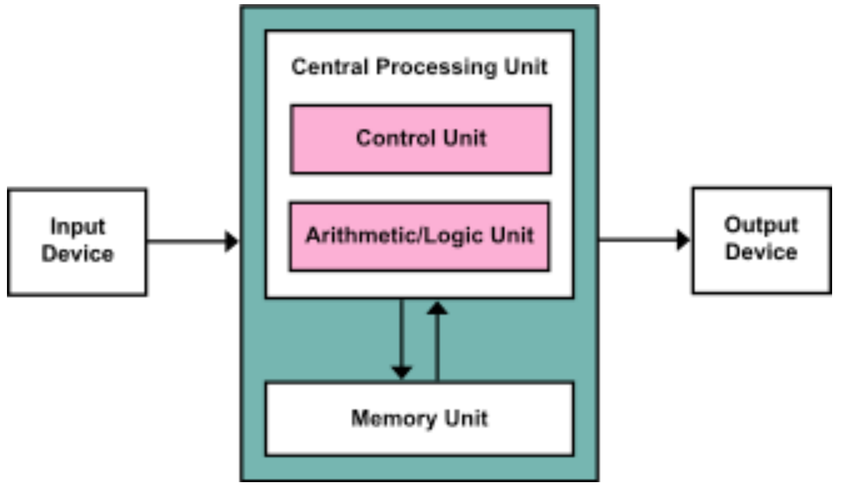


Edvac

# First Draft of a Report on the EDVAC

by

John von Neumann




Contract No. W–670–ORD–4926

Between the

United States Army Ordnance Department

and the

University of Pennsylvania

# Key parts

- Processor (Control and Arithmetic/Logic)

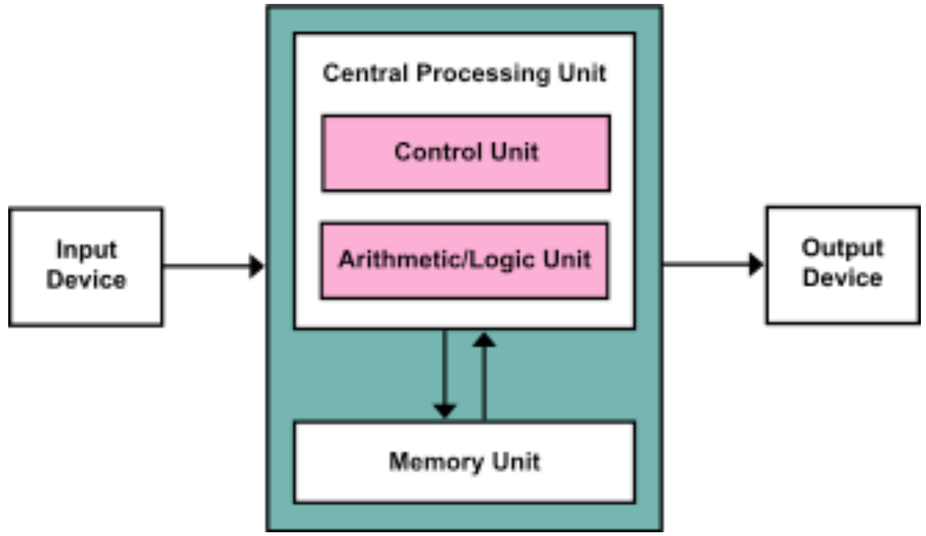
connected to

- Memory

via a single channel

that carries both data

and program instructions.

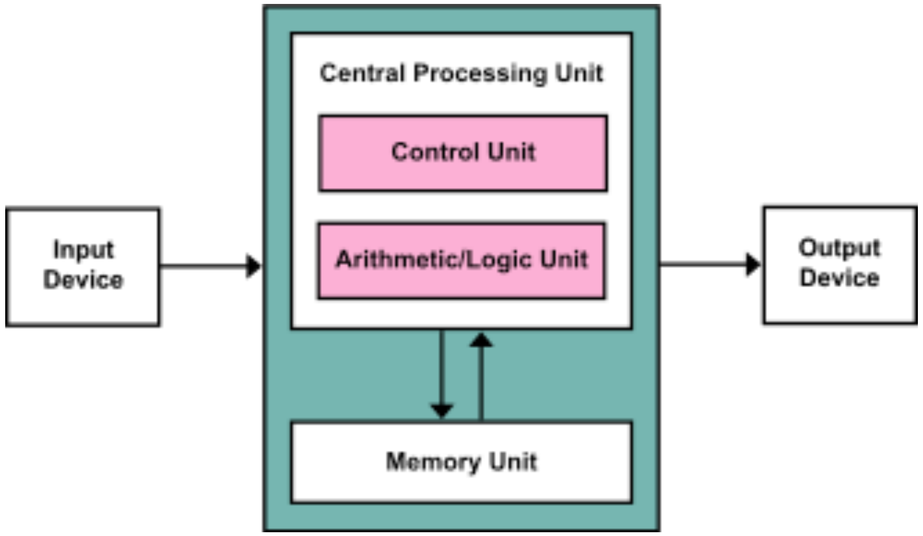


# Key parts

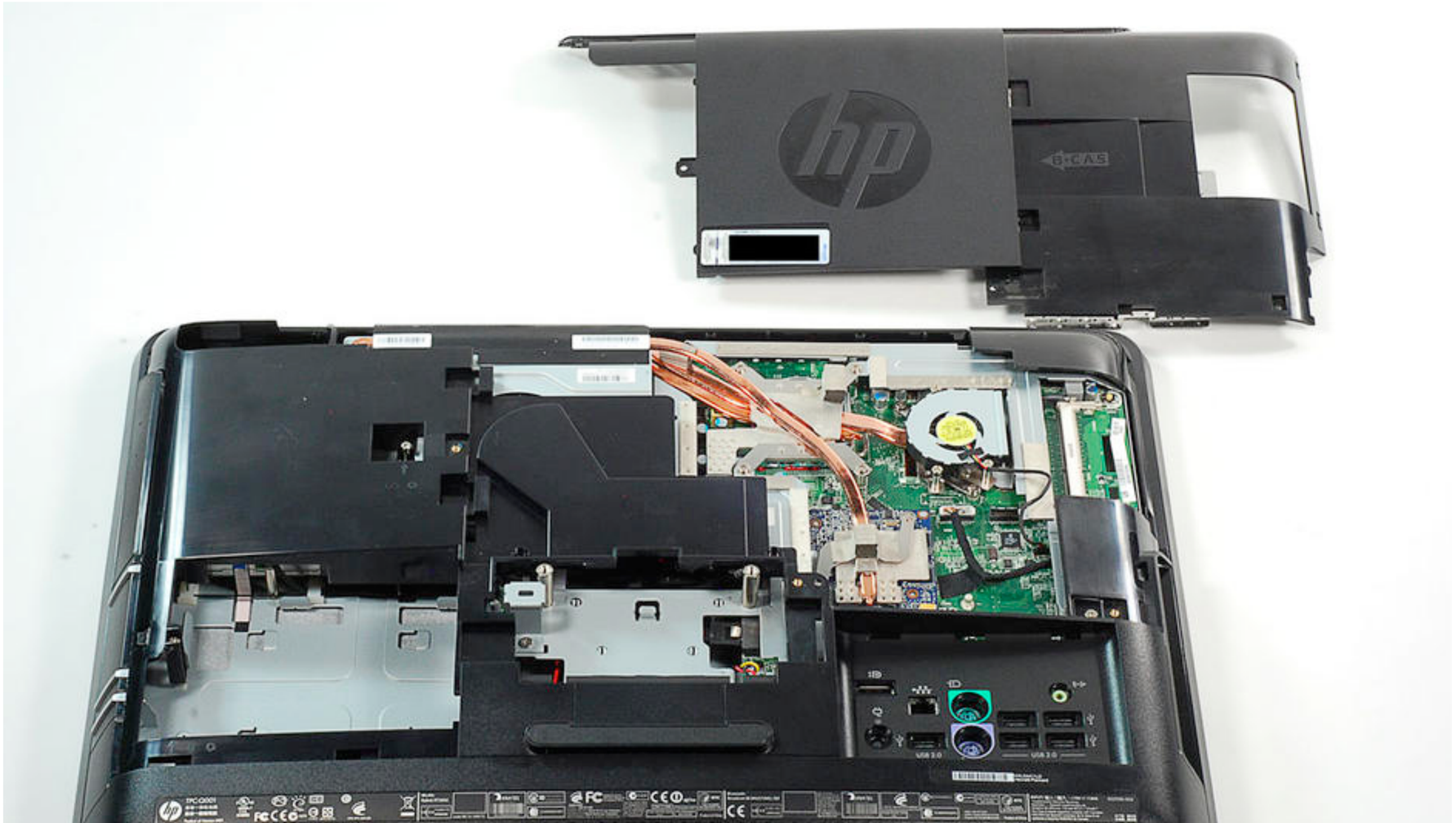
and there also have to be

input and output

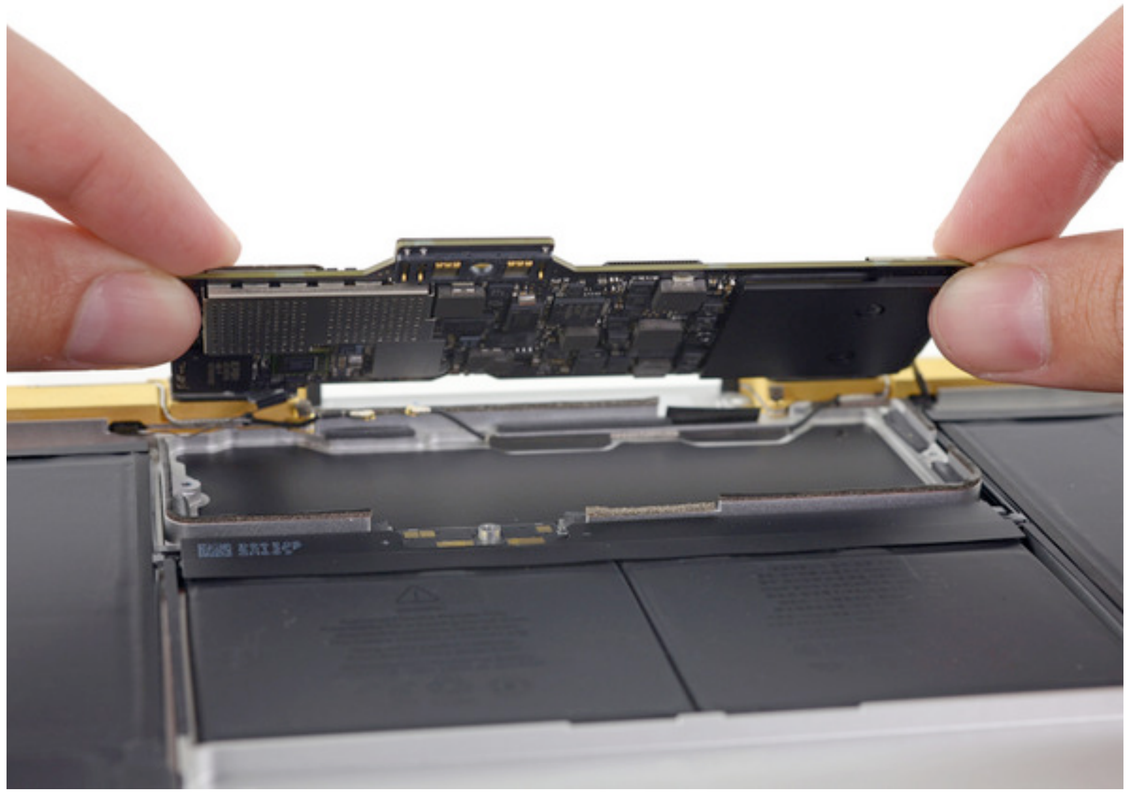
devices.



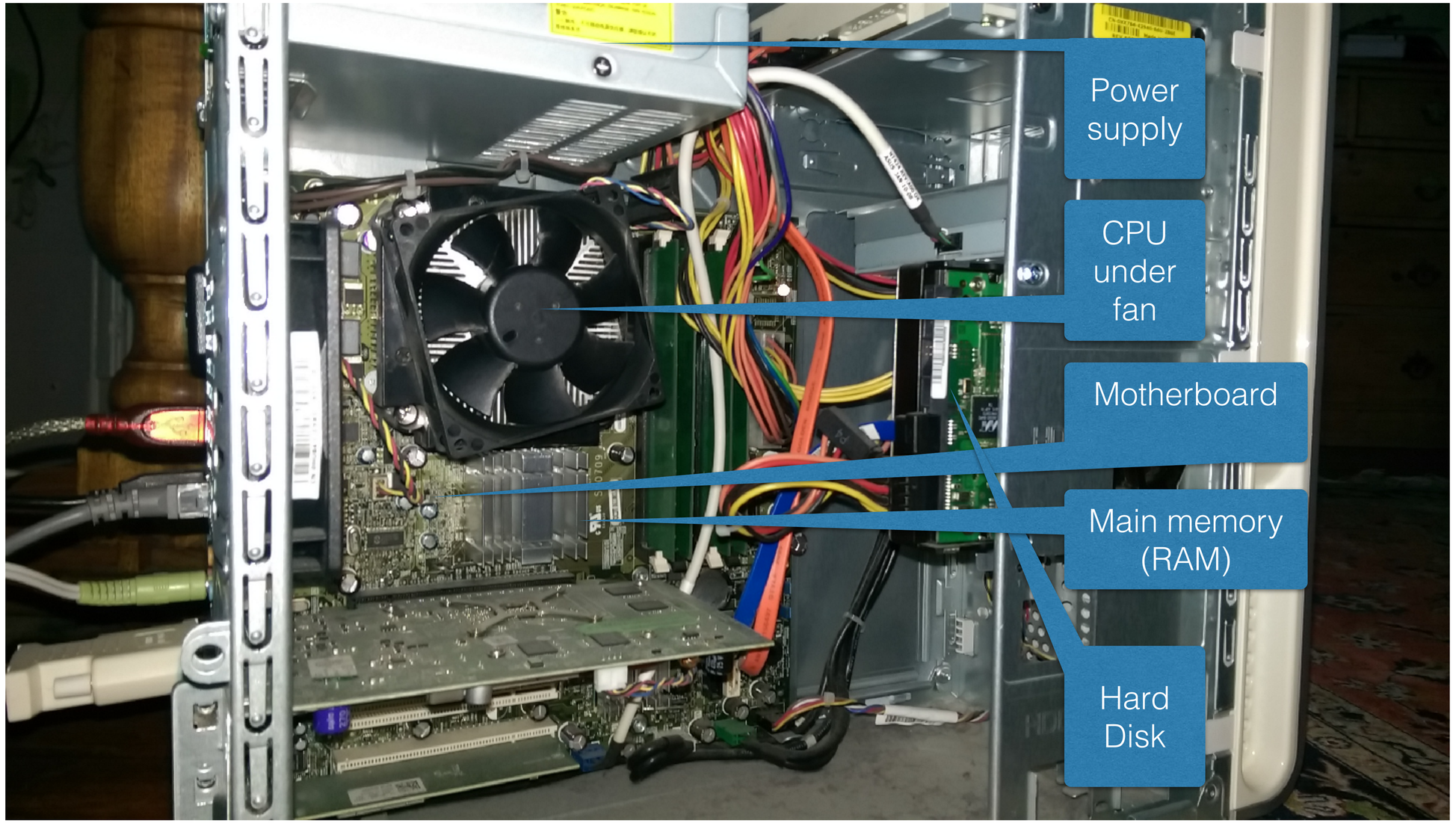
# Newer



# A 2015 MacBook Air

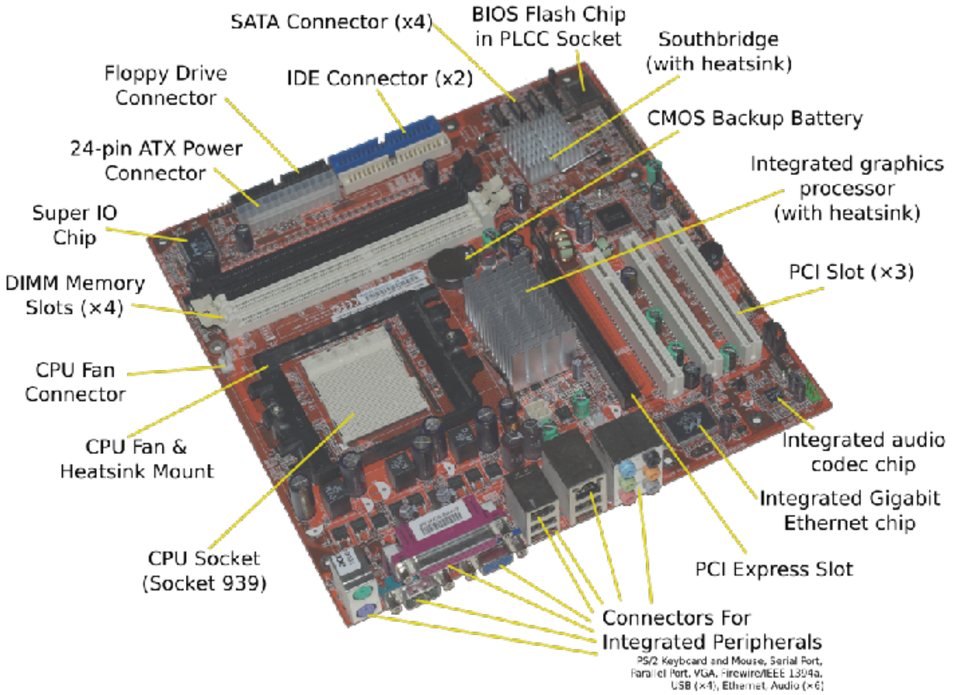


# Old style


Power supply
CPU under fan
Motherboard
Main memory (RAM)
Hard Disk

# Traditional PC

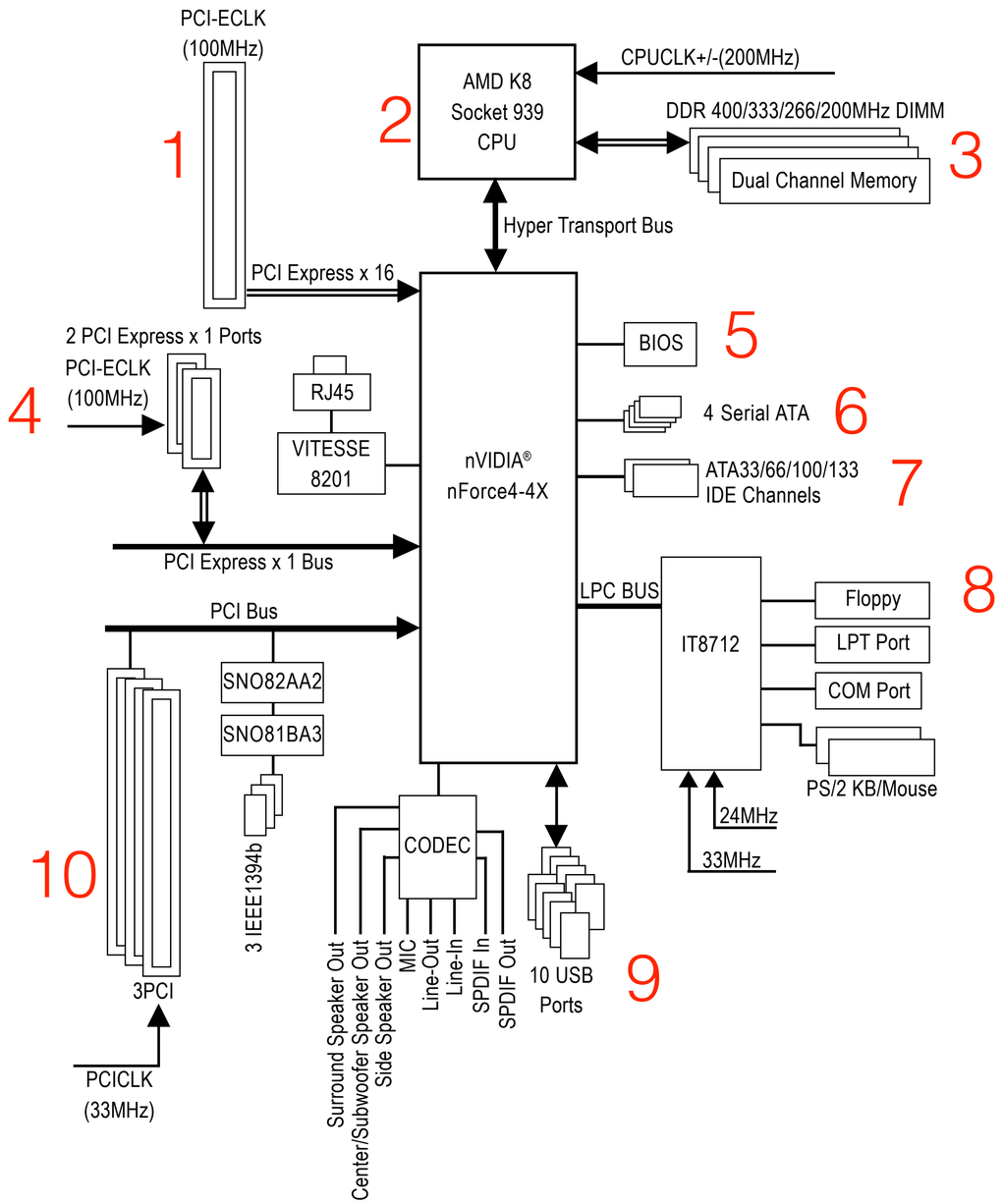
- Standardised components connected through a motherboard



# Traditional PC

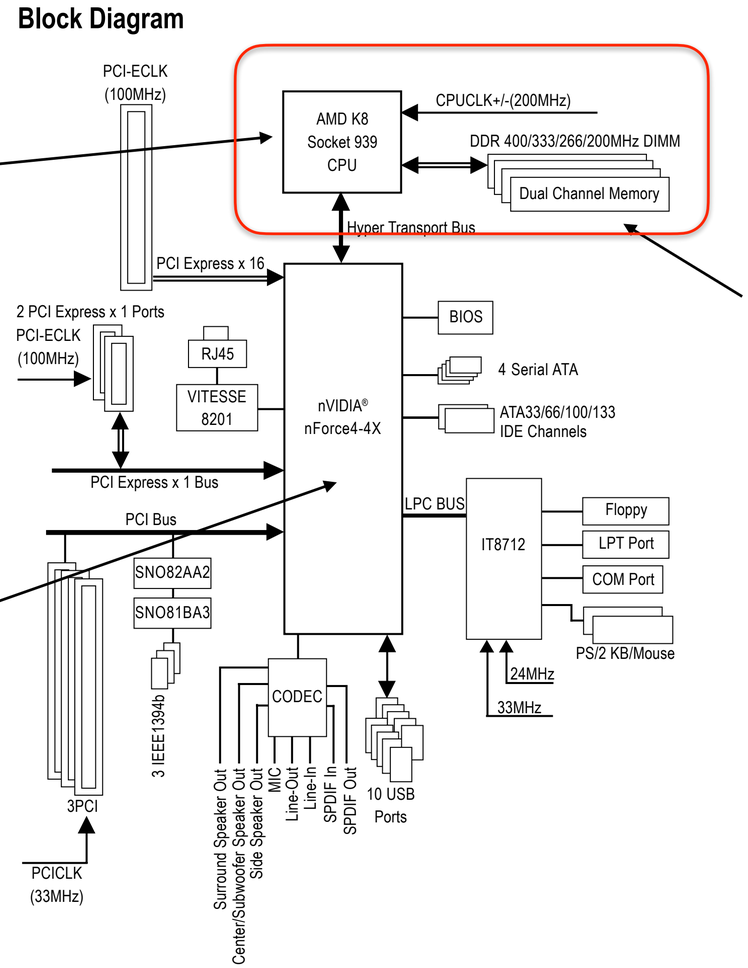
- Which has connectors for peripherals and the internet

# Block Diagram



# A Gigabyte motherboard

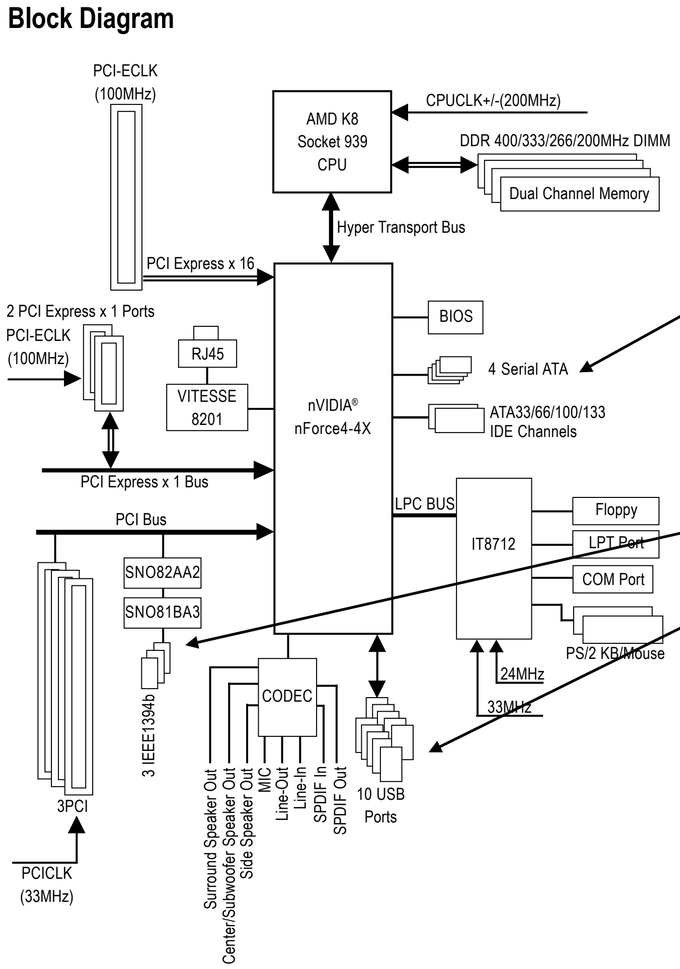
CPU at top




Directly connected to main memory, as in von Neumann

And to a comms chip handling comms to slower devices

# A Gigabyte motherboard



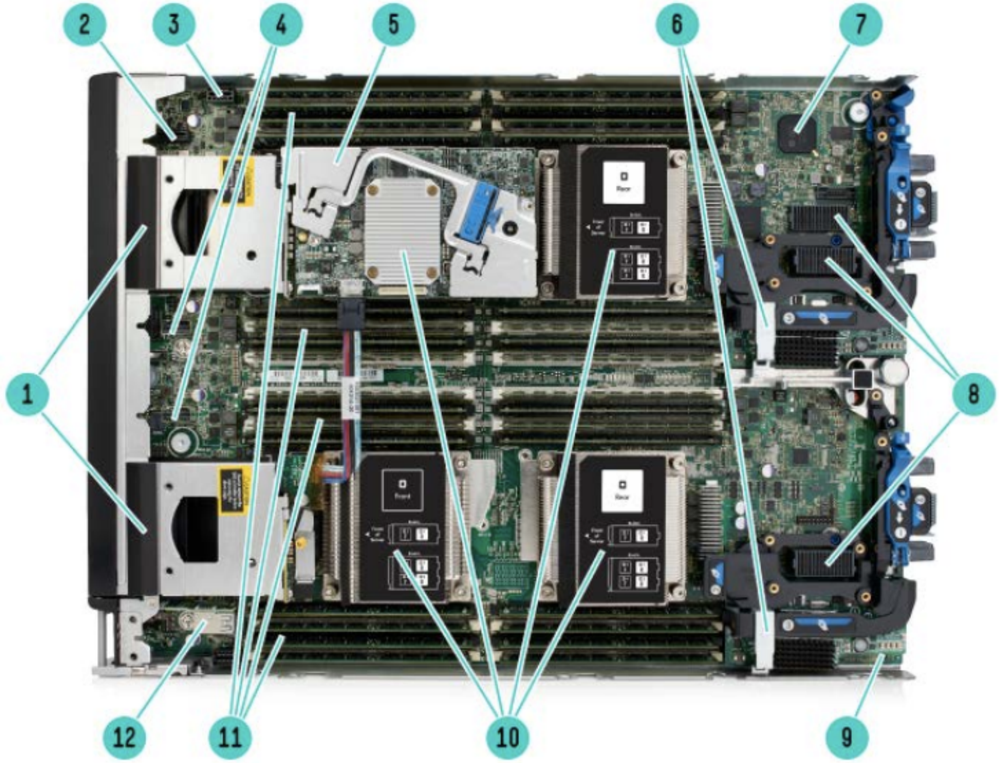

Hard disk would go on Serial ATA

Motherboard had USB and Firewire

But needed a separate sub board for ethernet.

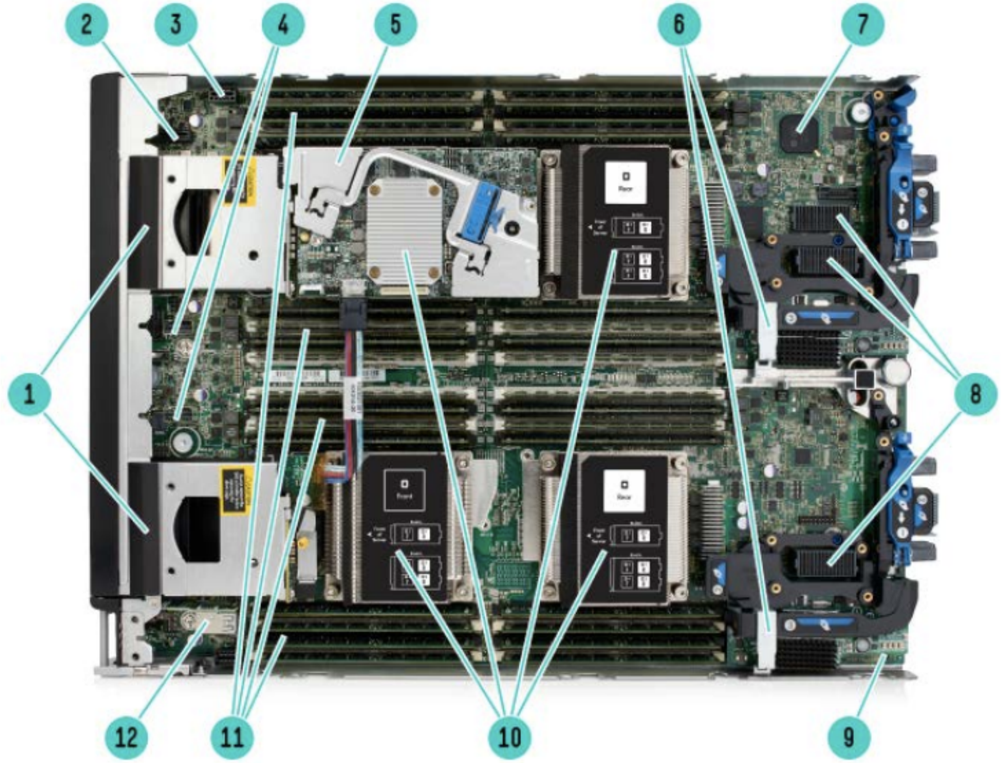
# Server construction
# HP Proliant BL660c

- Multiple CPU’s
- Up to four processors (each with up to about 20 cores) (10)



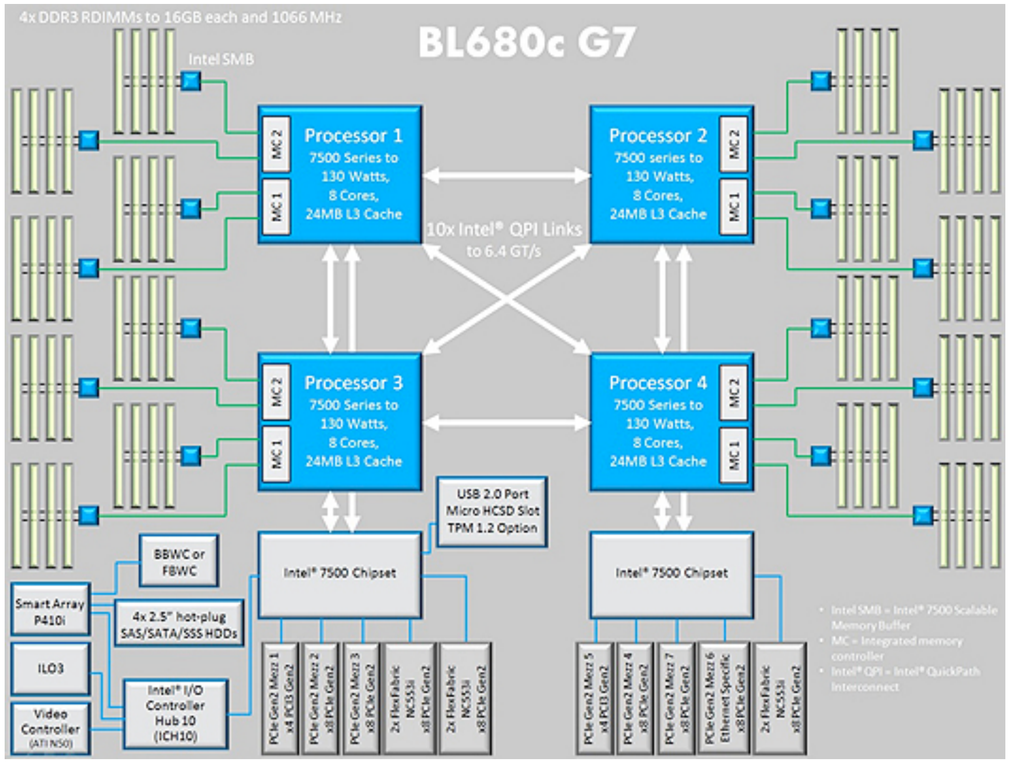
# Server construction
# HP Proliant BL660c

- Up to 2 TB main memory (11)
- Up to four hard disks (1)



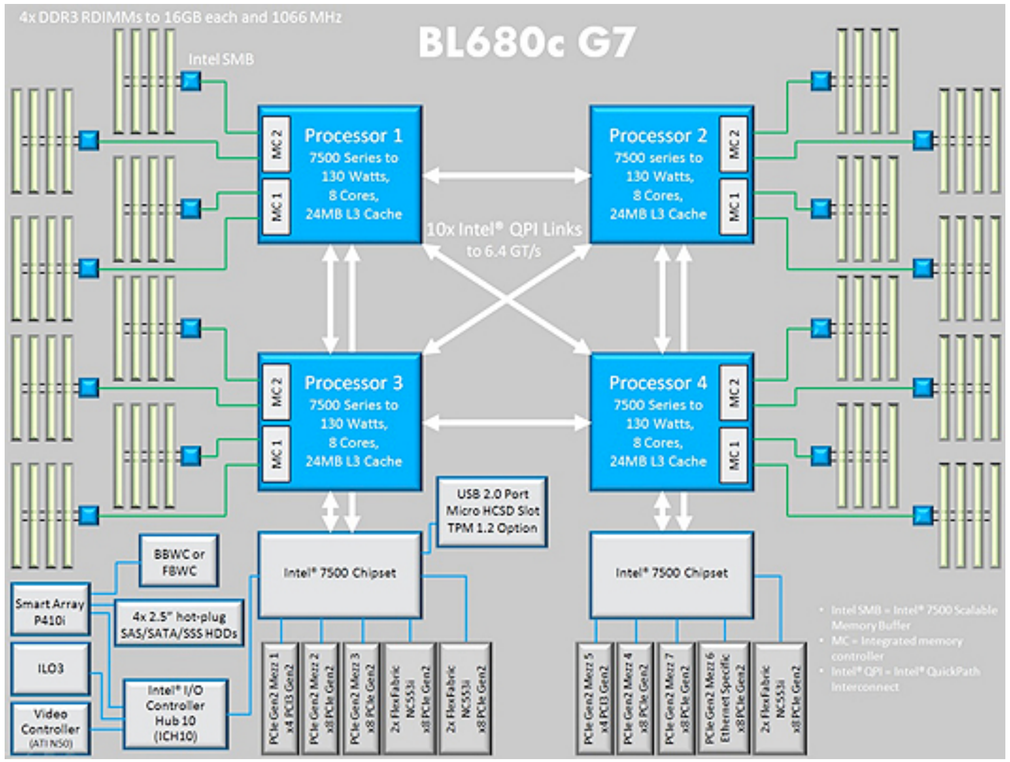
# Server construction
# HP Proliant BL680c

- This is not a von Neumann architecture.
- Up to four interlinked processors (each with up to 8 cores)
- Processors directly linked to separate main memories (each processor four links to four separate areas).



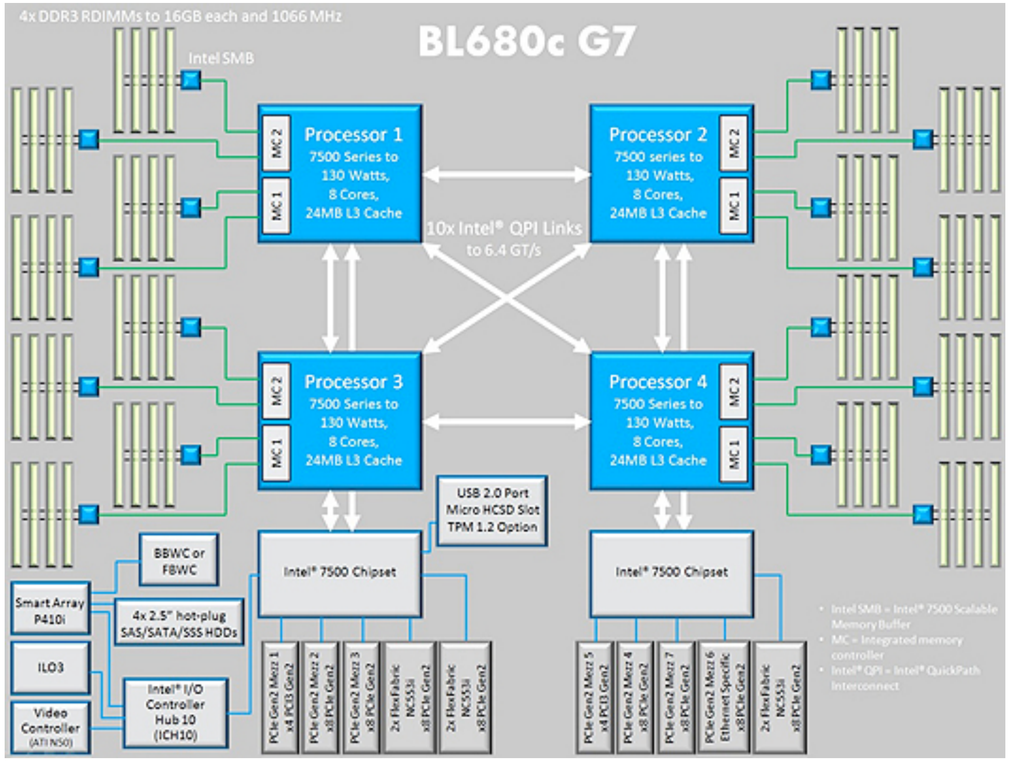
# Server construction
# HP Proliant BL680c

- Long-term memory is primarily outside machine on network.
- IO is away from processors in separate area.



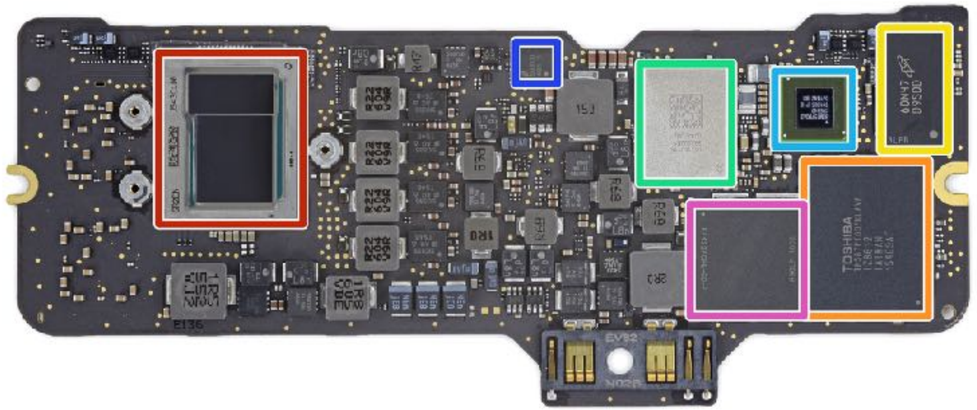
# Server construction
# HP Proliant BL680c

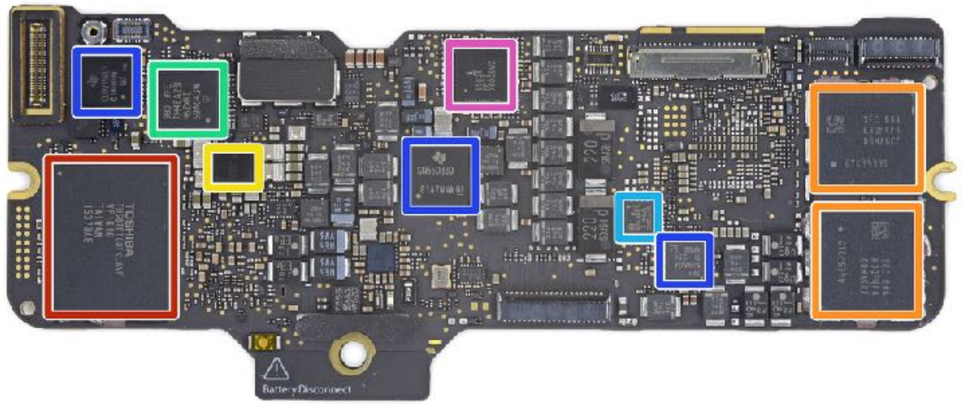
- Echo of von Neumann: processor area linked to memory, IO goes through processors.



# Teardowns and components

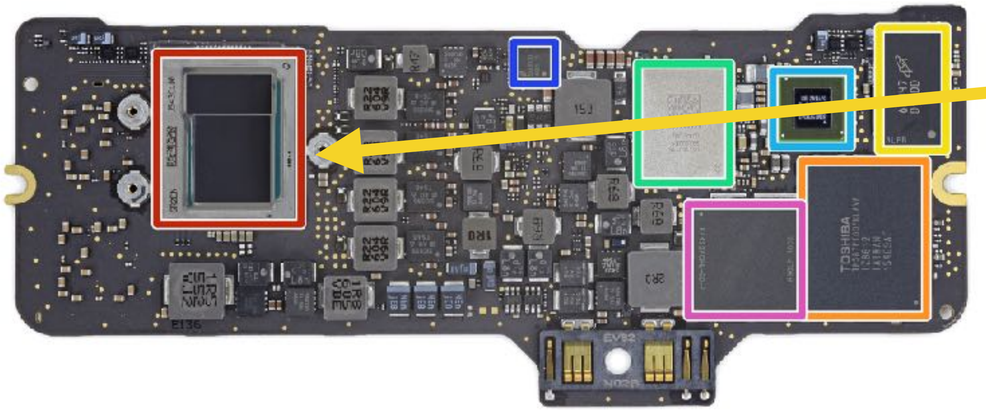
# Modern Laptop Construction (Macbook Air 2015)



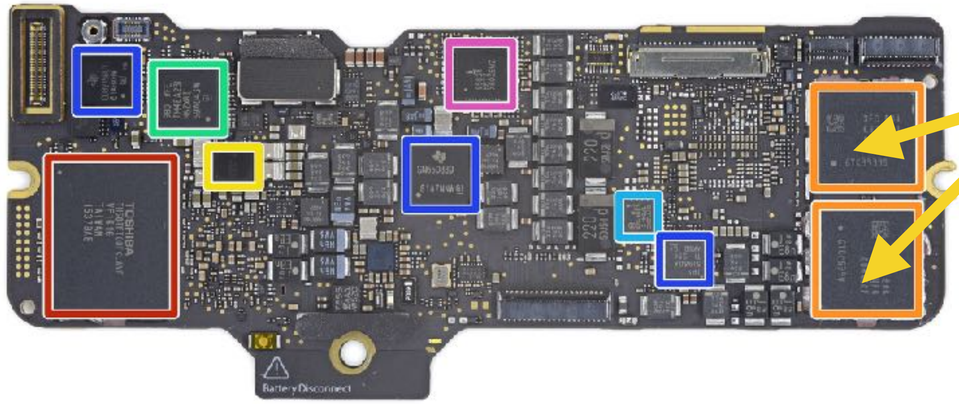


Special-purpose construction using particular chips on both sides of motherboard.

# Modern Laptop Construction (Macbook Air)

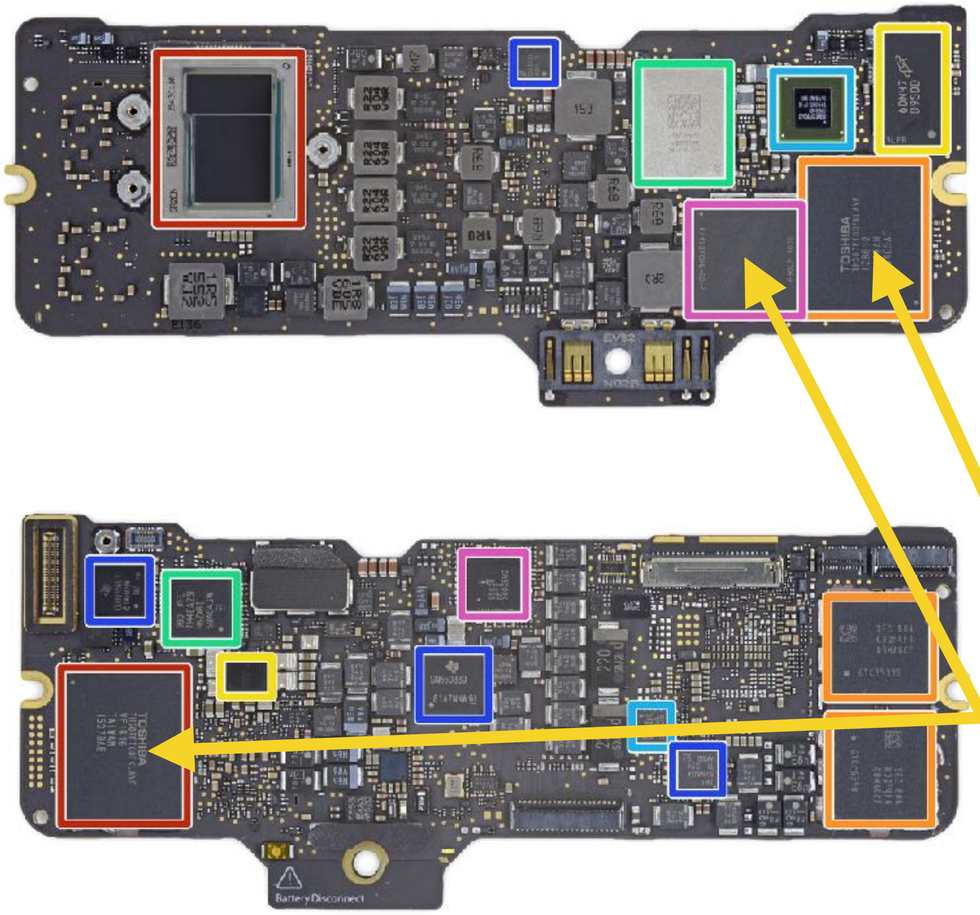


CPU: Intel SR2EN
Intel Core m3-6Y30
Processor



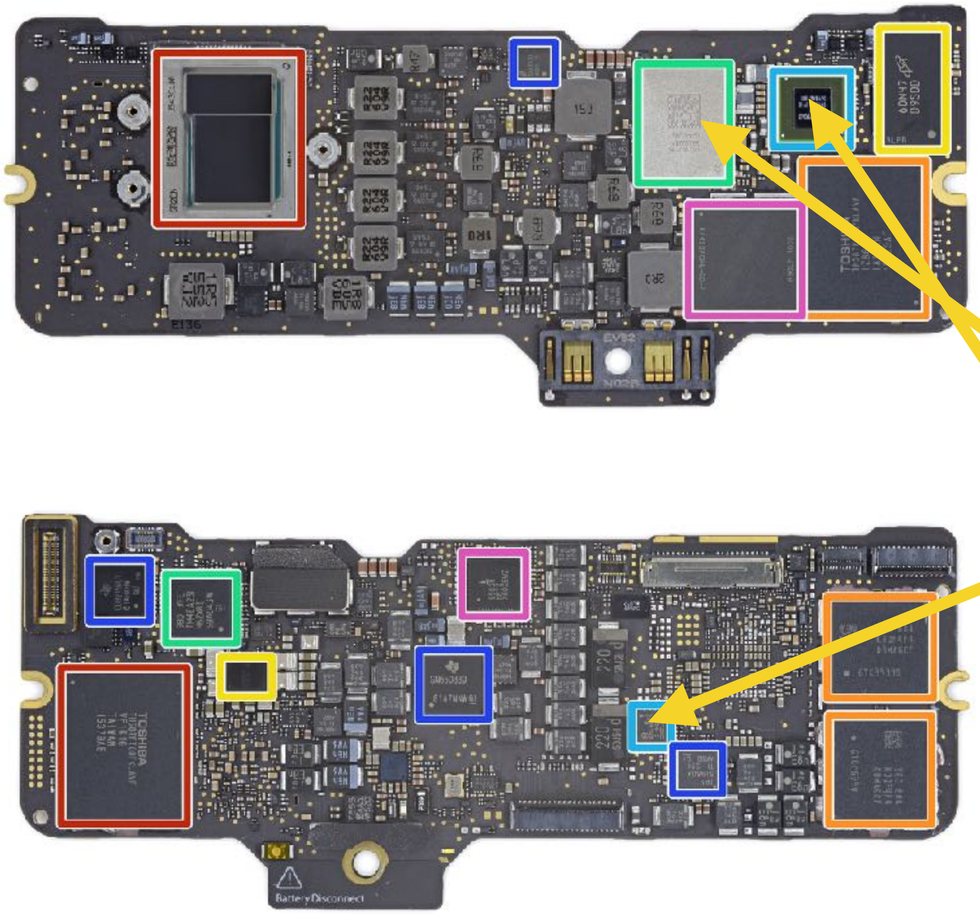
Main Memory: 2 x
Samsung K3QF4F4
4 GB LPDDR3 RAM
(total 8 GB)
just behind the cpu

# Modern Laptop Construction (Macbook Air)



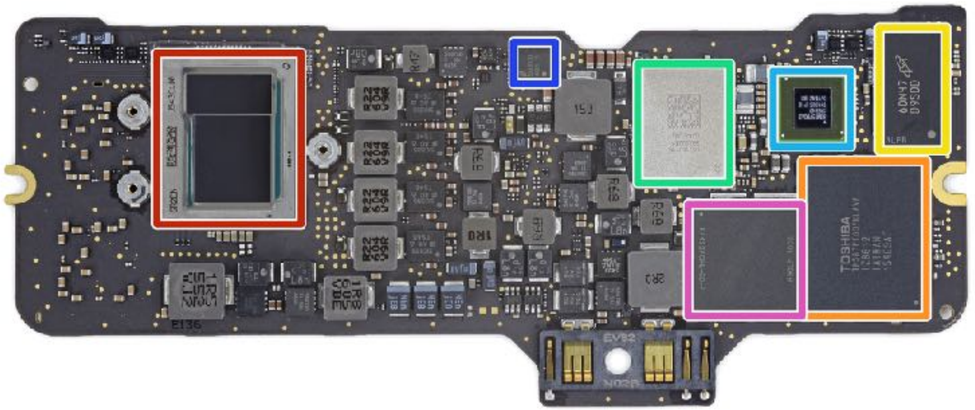

Long-term memory:
solid state disk
consisting
of 2 x Toshiba
TH58TFT0DFKLAVF
128 GB MLC NAND
Flash mounted
front
and back
with
controller (beneath).

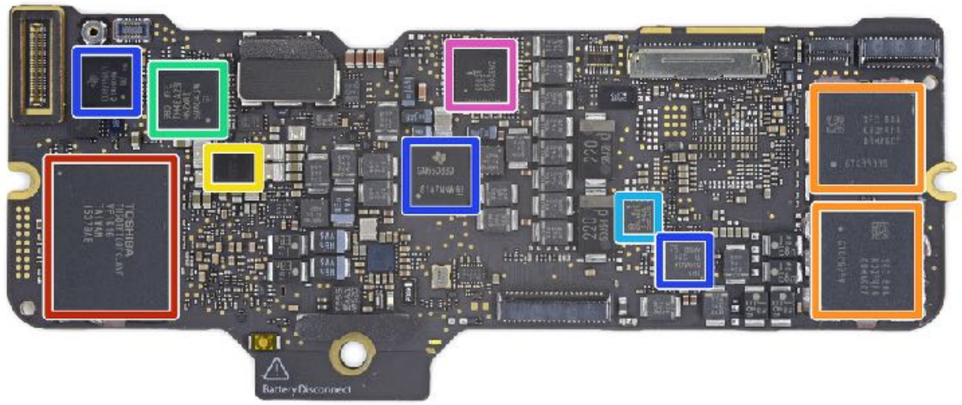
# Modern Laptop Construction (Macbook Air)



Other chips include:
WIFI
Camera controller?
Temperature sensor

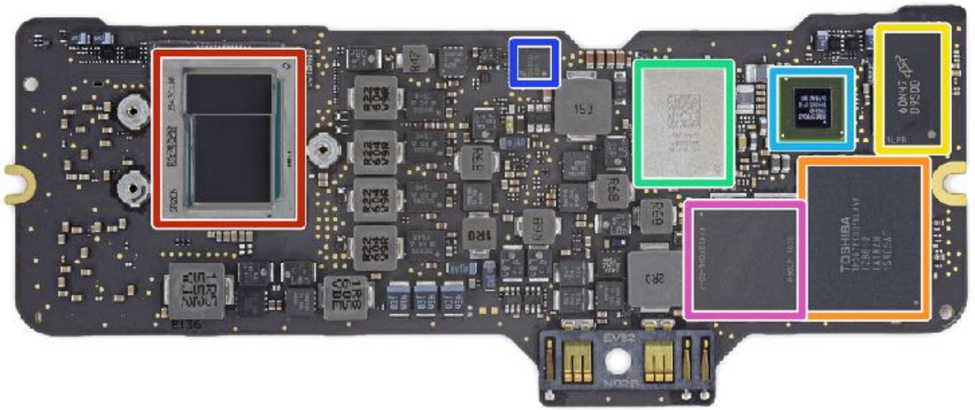
# Modern Laptop Construction (Macbook Air 2015)

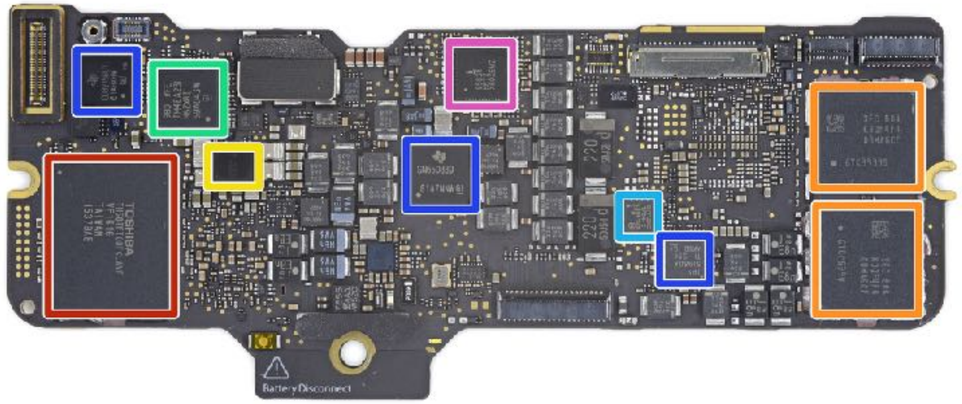



Differences: all based on a single motherboard (no wired connectors, memory chips directly wired in, not on small subboards).
Components not user changeable.
Long-term memory as flash memory chips and controller, not separate disk.

# Modern Laptop Construction (Macbook Air 2015)

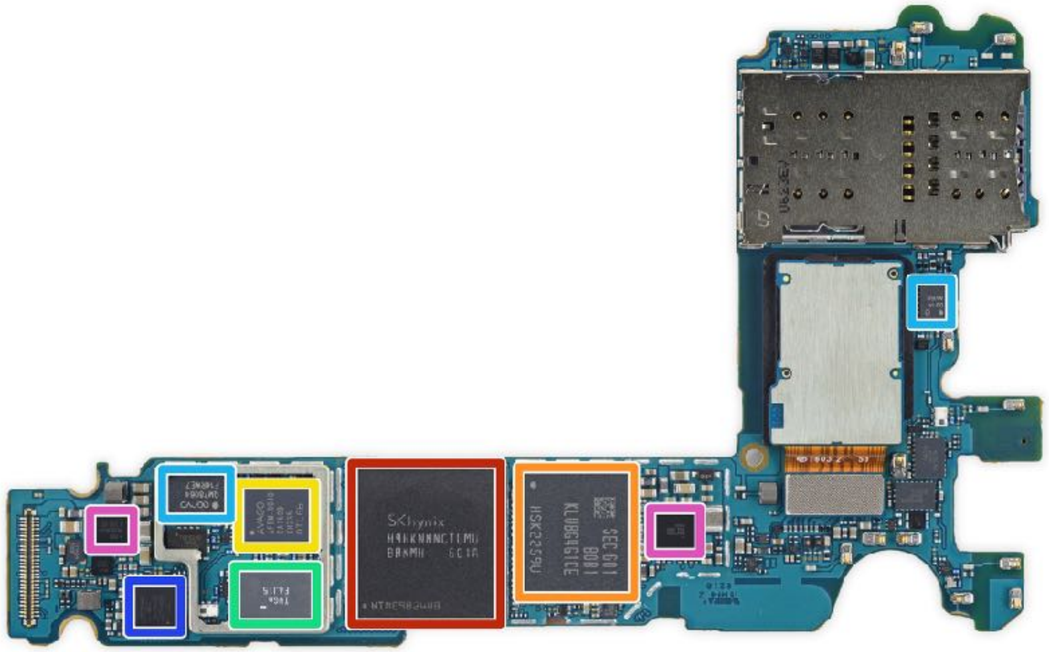



Similarity: motherboard, cpu, short and long-term memory, IO all still there.

# Smartphone construction (Samsung Galaxy S7)

- A bit like the Macbook

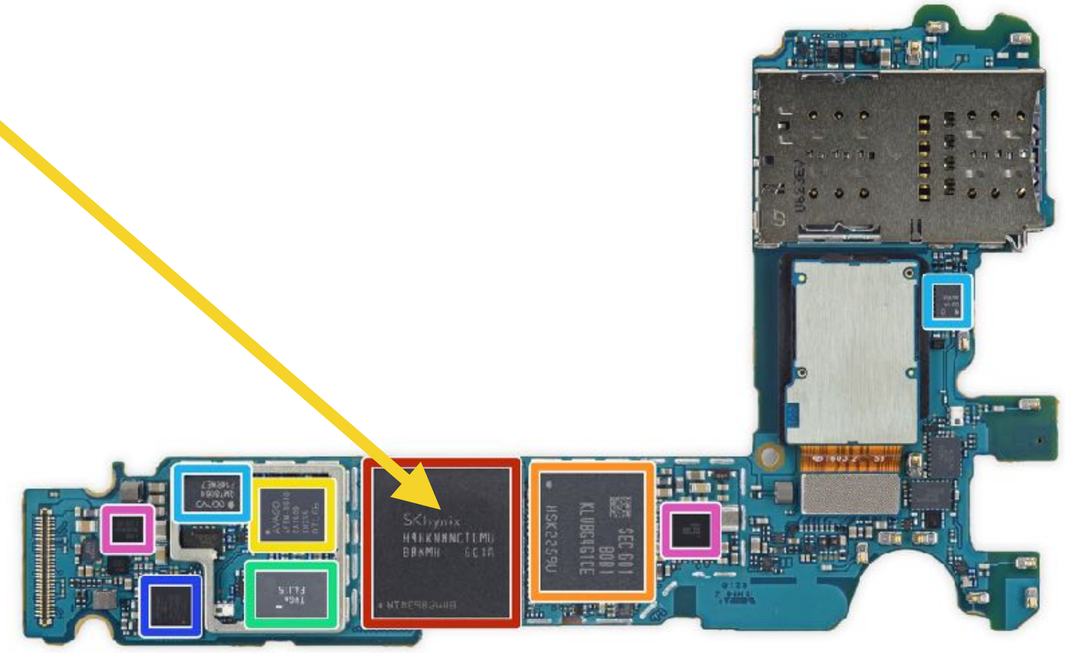


# Smartphone construction (Samsung Galaxy S7)

- CPU: Qualcomm MSM8996 Snapdragon 820

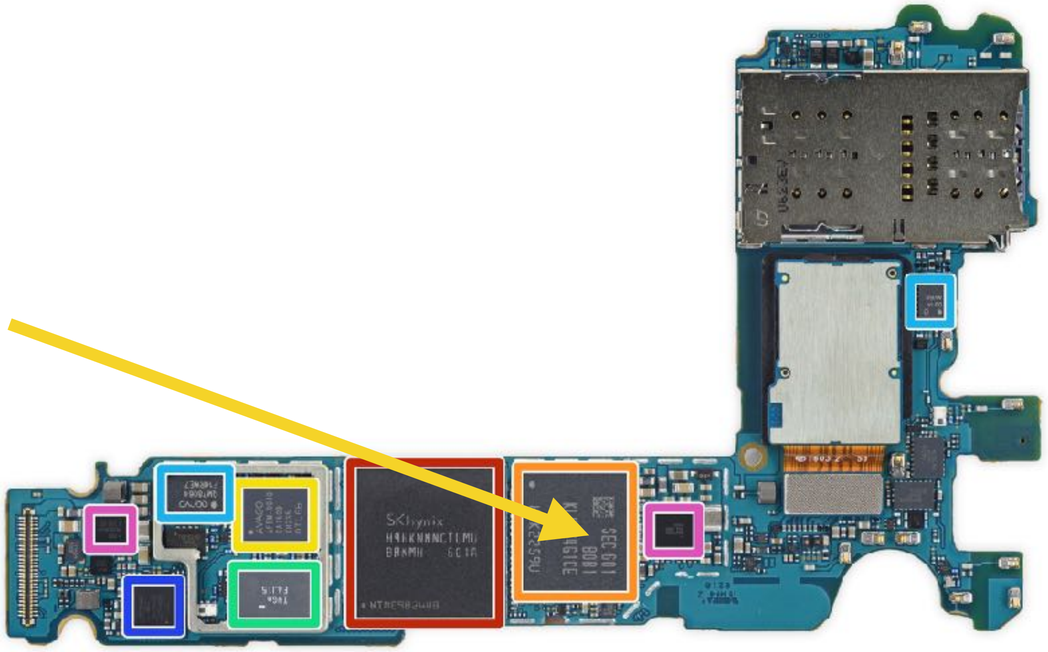
hidden under

- Main memory: SK Hynix H9KNNNCTUMU-BRNMH 4 GB LPDDR4 SDRAM

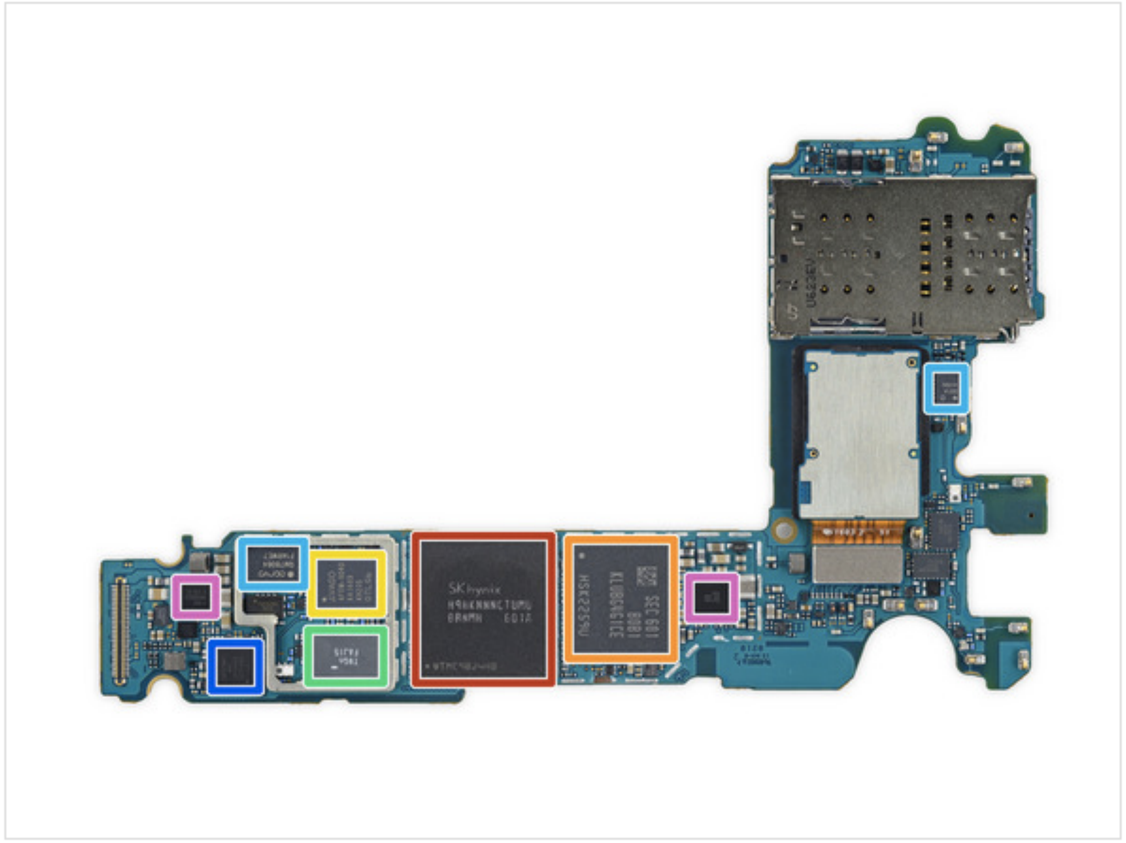


# Smartphone construction (Samsung Galaxy S7)

- Long-term memory: Samsung KLUBG4G1CE 32 GB MLC Universal Flash Storage 2.0



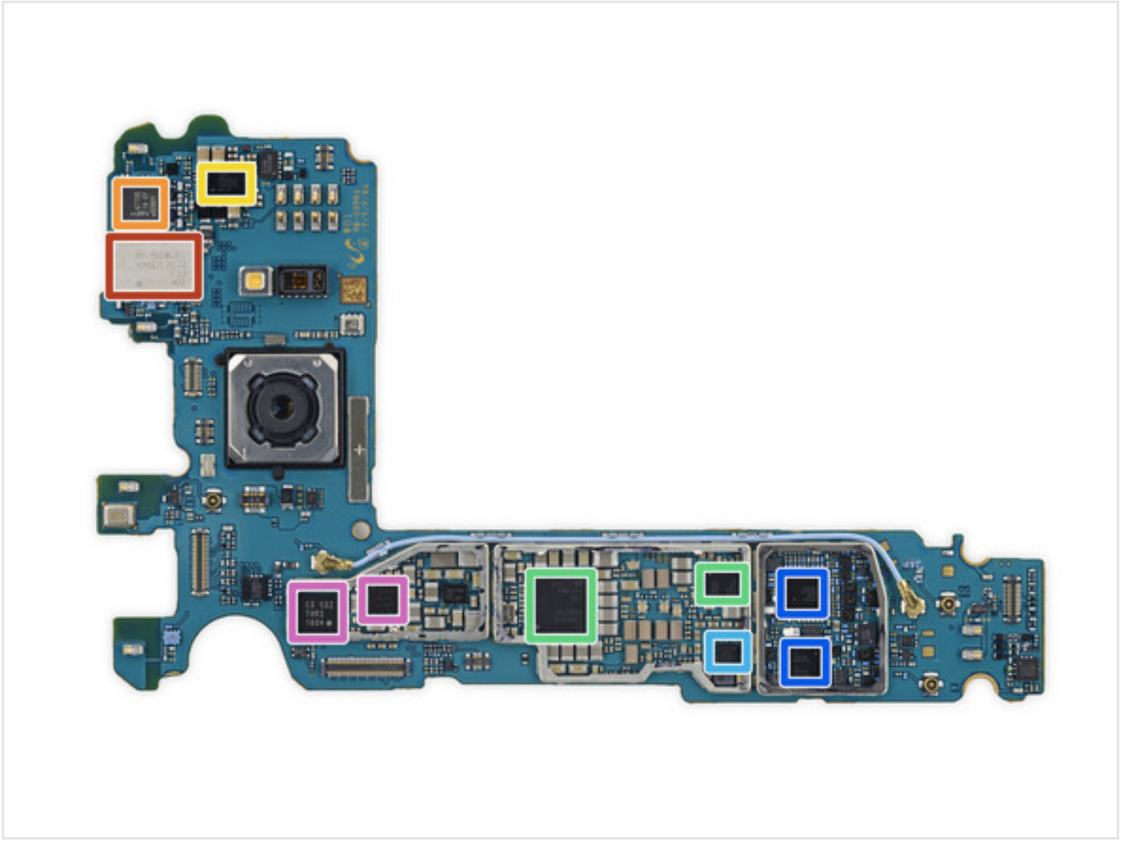
# Details from teardown on iFixit



## Step 7

Edit 5

- With that, it's time to digitally convey some chip ID. On the front side of the motherboard, we note:
  - SK Hynix H9KNNNCTUMU-BRNMH 4 GB LPDDR4 SDRAM layered over the Qualcomm MSM8996 Snapdragon 820
  - Samsung KLUBG4G1CE 32 GB MLC Universal Flash Storage 2.0
  - Avago AFEM-9040 Multiband Multimode Module
  - Murata FAJ15 Front End Module
  - Qorvo QM78064 high band RF Fusion Module and QM63001A diversity receive module
  - Qualcomm WCD9335 Audio Codec
  - Maxim MAX77854 PMIC and MAX98506BEWV audio amplifier



## Step 8

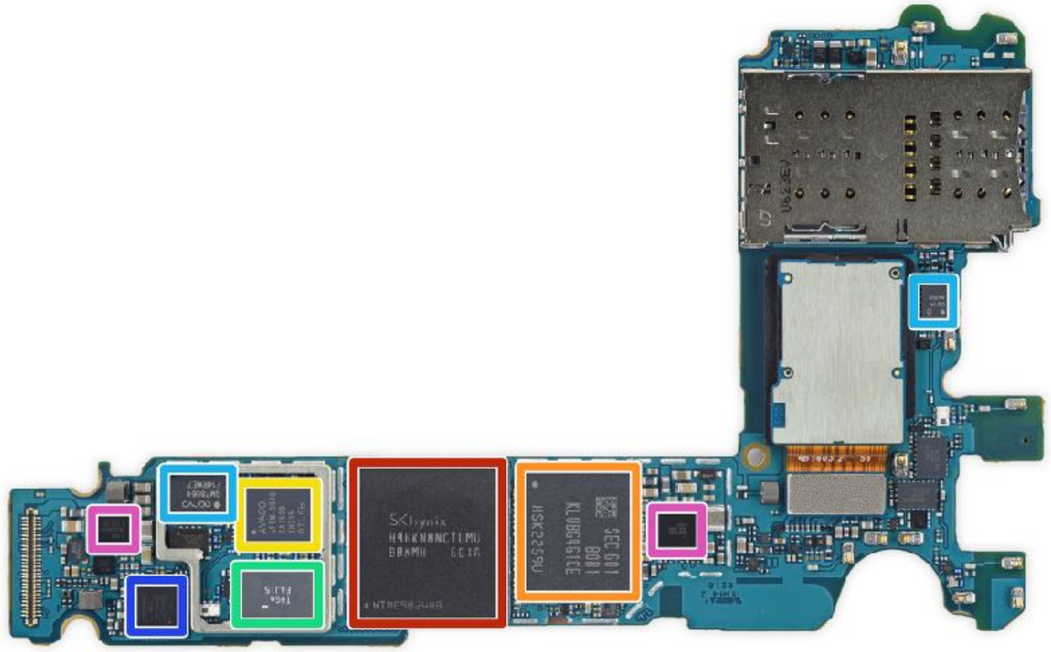
Edit

- With so many similarities to the standard S7's chipset, it almost feels like we're repeating the computer:
  - Murata KM5D17074 Wi-Fi module
  - NXP 67T05 NFC Controller
  - IDT P9221 Wireless Power Reciever (likely an iteration of IDT P9220)
  - Qualcomm PM8996 and PM8004 PMICs
  - Qualcomm QFE3100 Envelope Tracker
  - Qualcomm WTR4905 and WTR3925 RF Transceivers
  - Samsung C3 image processor and Samsung S2MPB02 PMIC

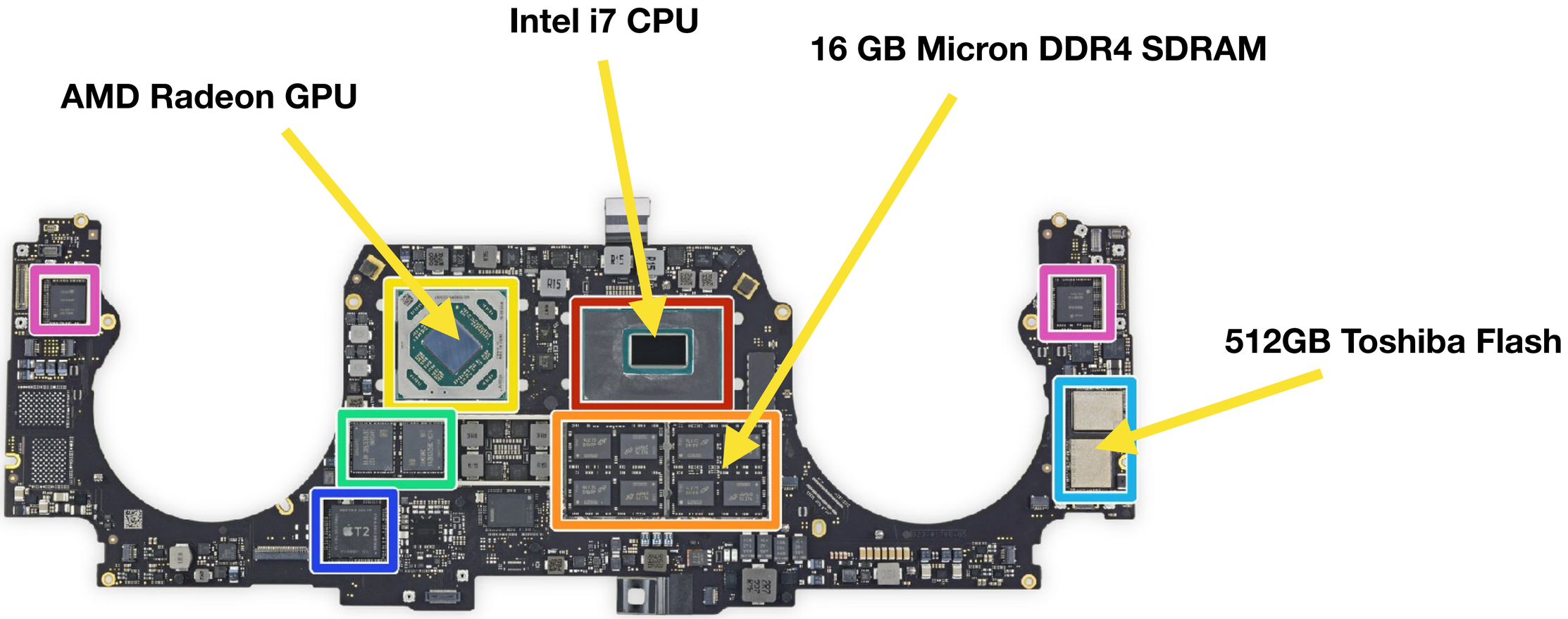
# Smartphone construction (Samsung Galaxy S7)

As for MacBook:

Components not user changeable, but motherboard, cpu, short and long-term memory, IO all there.



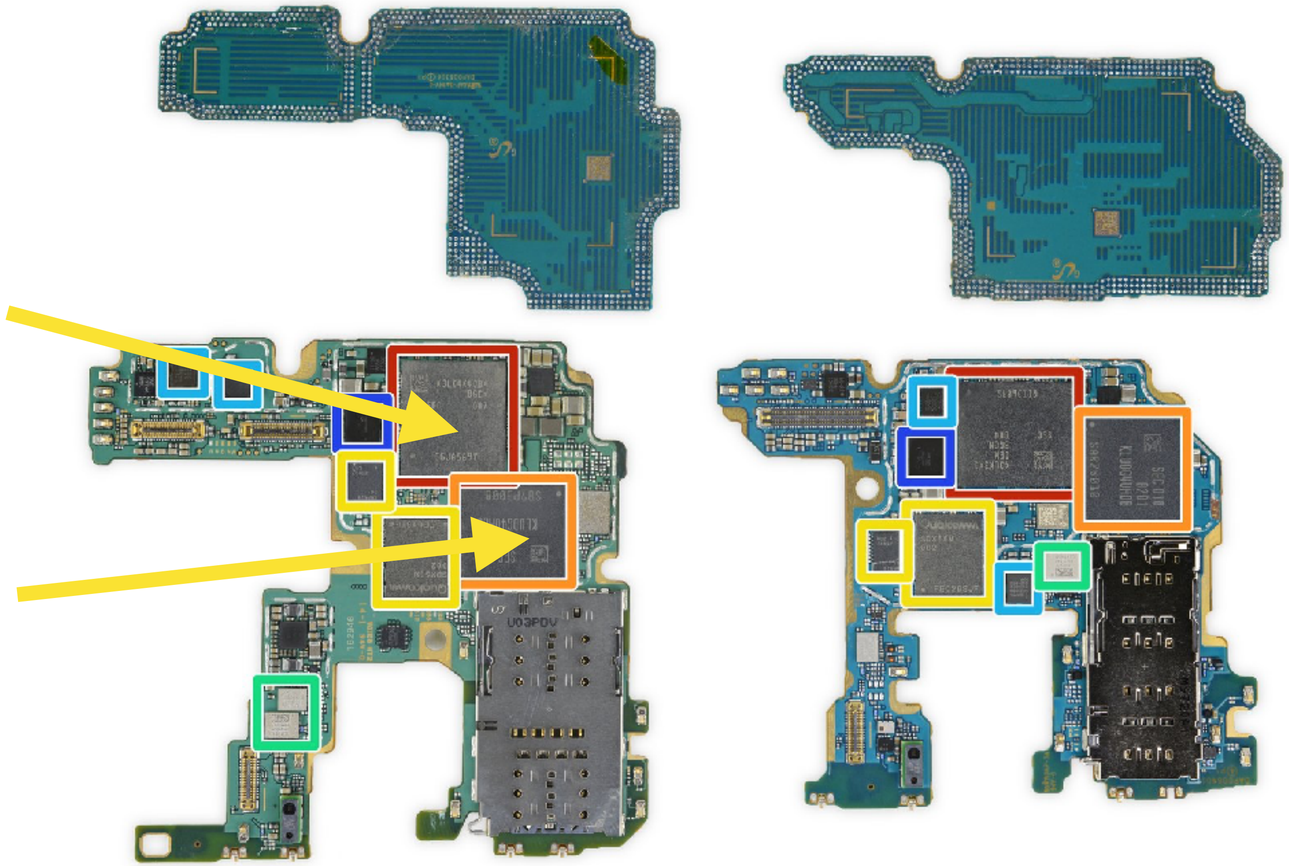
# 2019 16in MacBook Pro



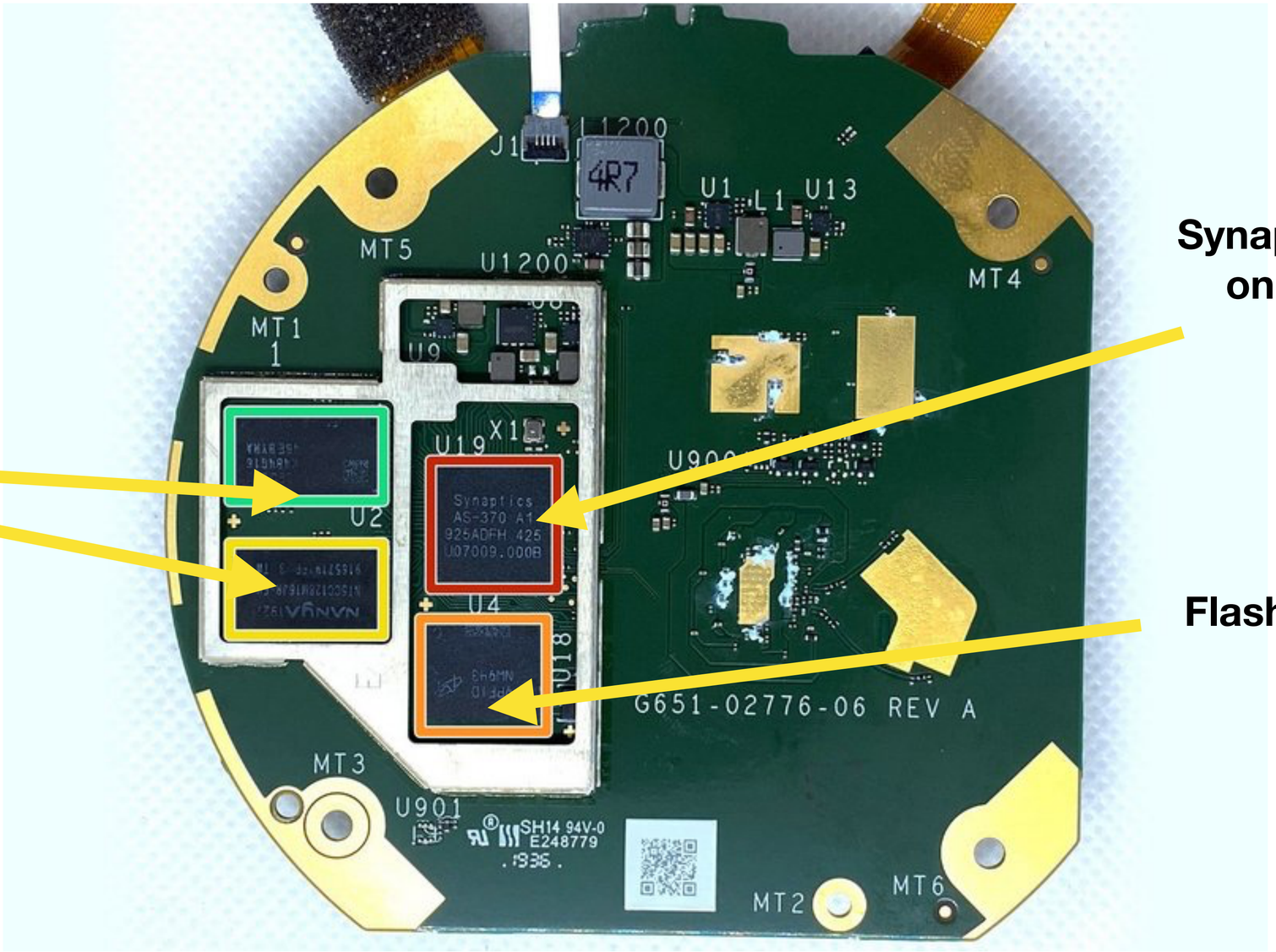
# Samsung Galaxy Note 20 and Note 20 Ultra

**Snapdragon CPU layered under Samsung RAM**

**128GB Samsung Flash**



# Google Nest Wifi Point




RAM

Synaptics System on Chip CPU

Flash memory

# Architecture: Components

- **Central Processing Unit (CPU)** - responsible for execution of main program, carries out the core computation functions.

- **Main memory (RAM - random access memory)** - a fairly large temporary memory (currently approx 2-10Gb) used by the cpu as a working space. Any information stored here is lost when the computer is turned off.

- **Long-term memory** (disk, eg HDD - hard disk drive, SSD - solid state drive/disk, or flash memory) - usually much larger than RAM; stores programs, documents and other information (eg OS-level configuration data). Information stored here persists when the computer is turned off and is still available when it is turned on again.

# Architecture: components

- **Motherboard**: the main role of the motherboard is to provide a data network enabling the other components to communicate. Physically it is an integrated circuit board containing (slots for) cpu, ram, and slots to connect peripherals.

- **IO**: a range of components handling input and output, mainly classified by the connection technology (eg usb, sata, pci).

# Architecture: layout

- In many cases, structure is a **tree**: i.e. there is only one route between any two components (ignoring the possibility of doubling back).
- (You'll meet trees in lots of courses).