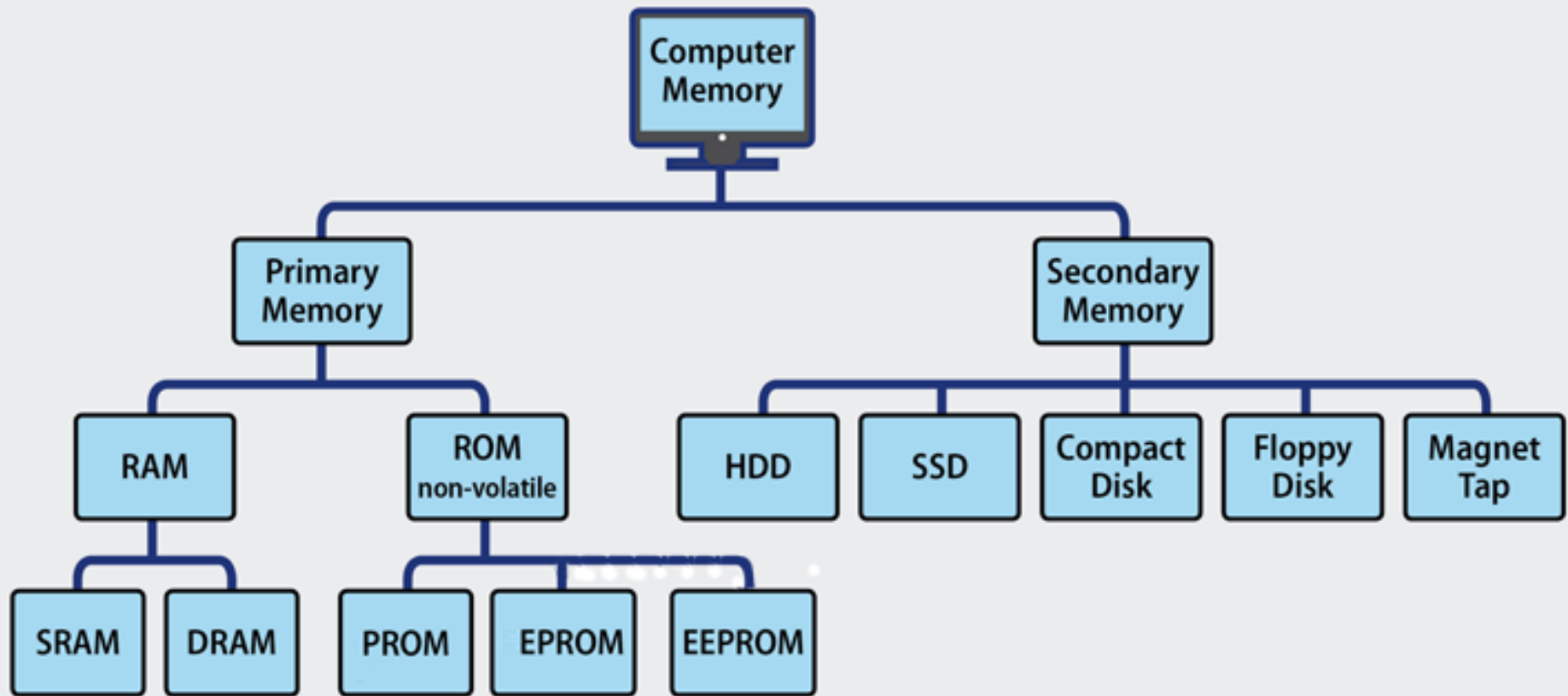


Lecture 10

Computer and Information Technology

➤ Primary Memory


Types of Computer Memory



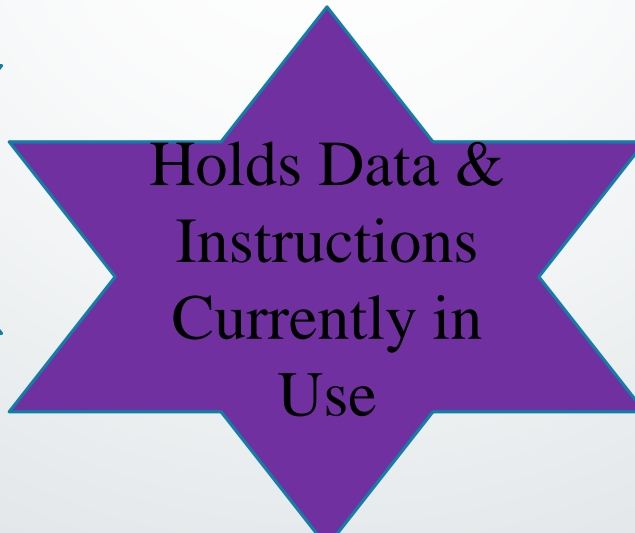
*We have excluded cache memory and registers here. Check lecture 9 for details regarding cache and registers.

Primary Memory

Primary memory is also known as main memory and in some case referred as internal memory. In computer systems, RAM and ROM are known as primary memory and they are accessed by the CPU directly. CPU can bring instructions from and store results into a primary memory directly via Data Bus. Any data coming from secondary memories are brought and stored in primary memory first before the CPU uses them for processing.



Directly
Accessed
by CPU

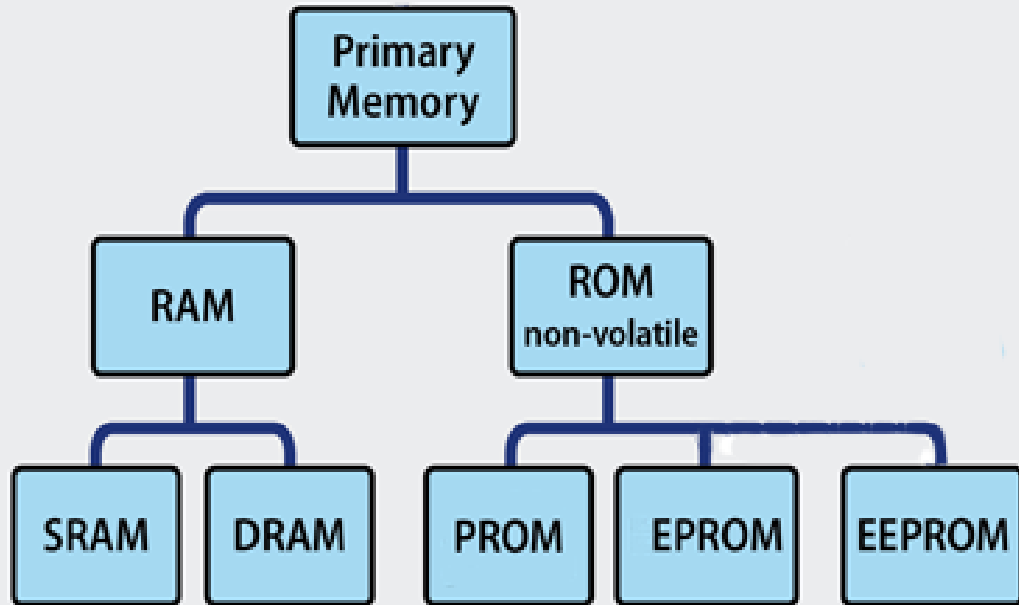


Holds Data &
Instructions
Currently in
Use



Limited
Capacity but
Faster Read
Write Speed

Primary Memory



ROM

ROM also known as **Read Only Memory** is special type of primary memory that can retain its data without power supply and hence get the title “non-volatile”. ROM is accessed by the CPU when the system starts up.

RAM

RAM or **R**andom **A**ccess **M**emory gets its name from the way the CPU accesses any of its memory location by using that location’s unique address. This access method is known as random access.

**Cache Memory
is also one kind
of primary
memory**

Primary Memory



RAM vs. ROM

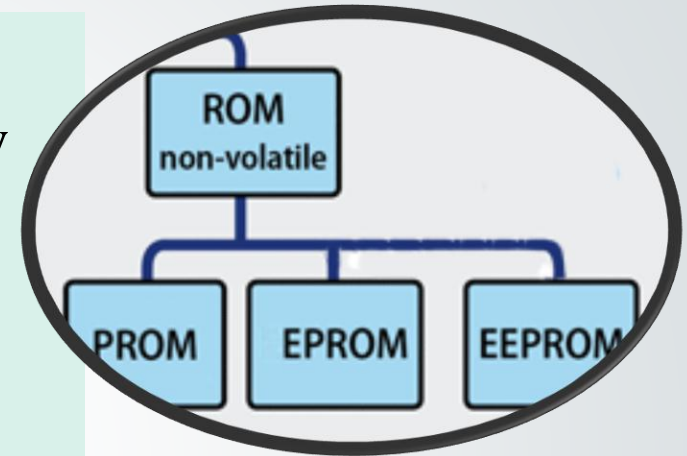
RAM	ROM
RAM is Random Access Memory.	Read Only Memory.
Volatile - Can't retain its data when the system is powered down.	Non-volatile - Designed in such a way that data stays without power.
Stores data and instructions for running applications and services.	Stores start-up related information and hardware configuration.
RAM is accessed and used by CPU right after it collects all the necessary instruction from ROM.	This part of the memory is accessed during system startup mainly.
During its use, RAM is both read and written all the time.	Data from ROM is read mainly. Writing is seldom performed.
Large capacity with faster read/write speed.	Small but adequate capacity with slower read/write speed.

Primary Memory - ROM

Types of ROM:

There are few types of RAM chips currently available in market. They are:

- 1) PROM
- 2) EPROM
- 3) EEPROM



PROM: Programmable Read Only Memory or PROMs are like blank paper pages where one can write something once, read from that as many times as one wants but can't be erased. PROMs are no longer used in computers but still in use in amateur projects, robots and even in house hold appliances which require a firmware.



Primary Memory - ROM

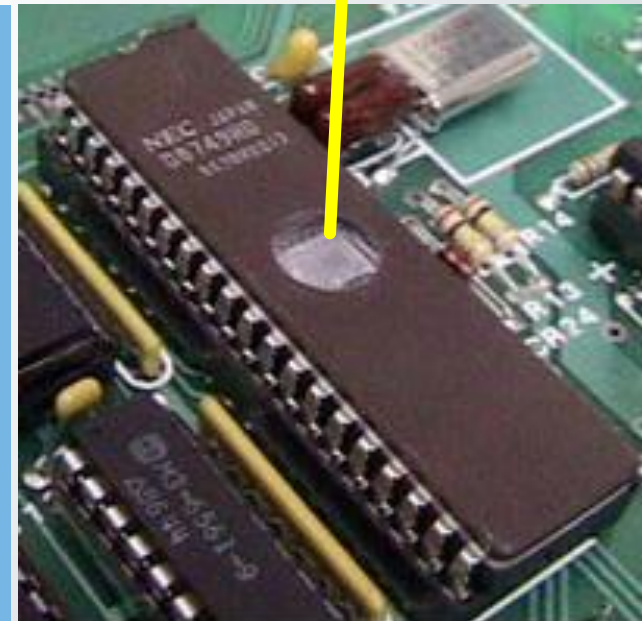
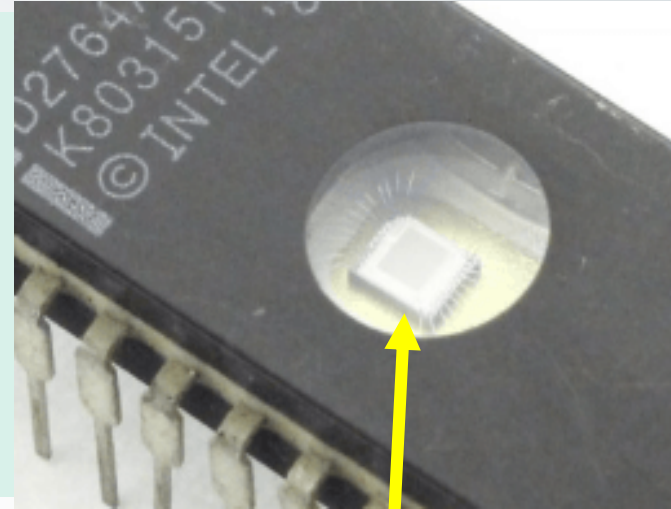
Types of ROM:

There are few types of RAM chips currently available in market. They are:

- 1) PROM
- 2) EPROM
- 3) EEPROM

EPROM: Erasable Programmable Read Only Memory or EPROMs can be erased to store new or updated data or firmware. It requires UV ray that goes through the on chip window to delete the data inside.

EPROMs can't be erased partially and sometimes are required to be removed from the board to perform data erase process.

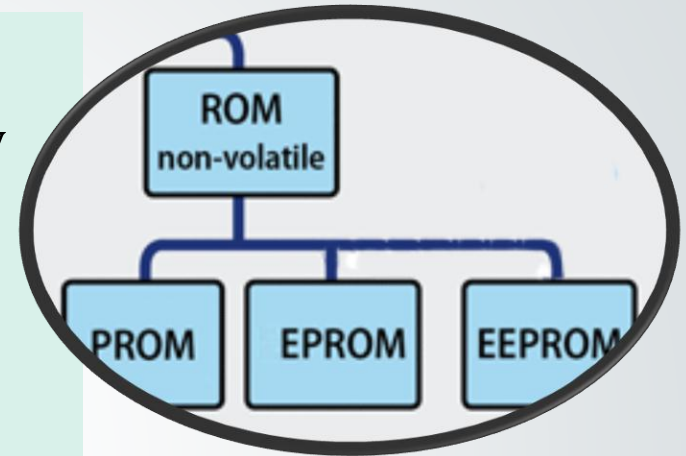


Primary Memory - ROM

Types of ROM:

There are few types of RAM chips currently available in market. They are:

- 1) PROM
- 2) EPROM
- 3) EEPROM



EEPROM: Electrically Erasable Programmable Read Only Memory or EEPROMs can be deleted and re-programmed keeping the chip on board as it can be erased using electrical signal or voltage.

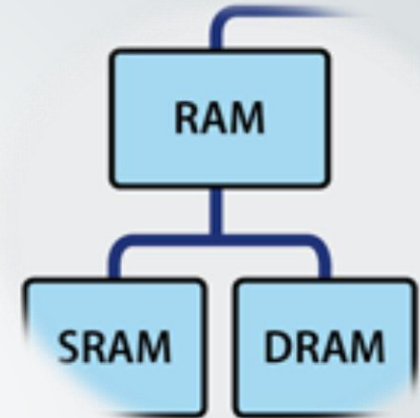


Primary Memory - RAM

Types of RAM:

There are two types of RAM chip currently in commercial production. They are:

- 1) SRAM or Static Random Access Memory
- 2) DRAM or Dynamic Random Access Memory



SRAM: Static RAM is made using Latching circuits or Flip-Flops and can retain data as long as the power supply is on and requires no periodic refreshing. SRAM has faster read/write speed but its limited packing density and costly nature makes it unsuitable for general consumer computer primary memory. However SRAM chips are built into the processor and serve as cache memory. (check lecture 9)

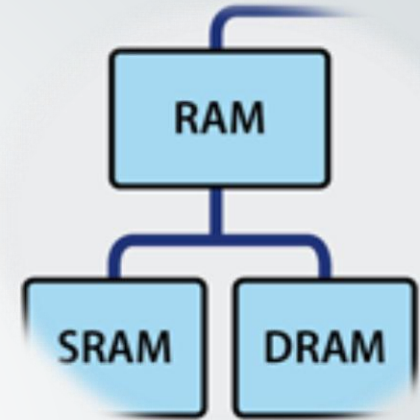
Packing density or degree of compactness gives an idea about how much data can be stored inside a memory of a given size.

Primary Memory - RAM

Types of RAM:

There are two types of RAM chip currently in commercial production. They are:

- 1) SRAM or Static Random Access Memory
- 2) DRAM or Dynamic Random Access Memory



DRAM: Dynamic RAM or DRAM uses tiny capacitors to store bits instead of flip-flops (made from transistors). Capacitors holding charges are considered 1s whereas empty capacitors are considered holding 0s. With time capacitors lose charges and required to be refilled periodically. This refill process is known as refreshing. DRAMs have very good packing density compared to SRAMs but suffers from poor read/write speed compared to its SRAM counterpart. But because of its low price point and good packing density, DRAM is chosen as main memory.

Primary Memory - RAM

SRAM vs. DRAM

Static RAM	Dynamic RAM
SRAM uses flip-flops made from transistors to store bits.	DRAM uses tiny capacitors to store bits.
No periodic refreshing is required, only constant supply of power retains data.	Capacitors are like “buckets with a hole” and so DRAM can’t retain data without refreshing.
Low packing density.	High packing density.
Very fast read/write speed.	Slower read/write speed.
SRAM is costly.	DRAM is a cheaper alternative to SRAM
Used as CPU cache.	Used as main memory.

Primary Memory - RAM

Good to Know

Evolution of DRAM

A clock signal is feed to the RAM to have it synchronized with CPU to reduce latency	SDRAM (S for synchronous)
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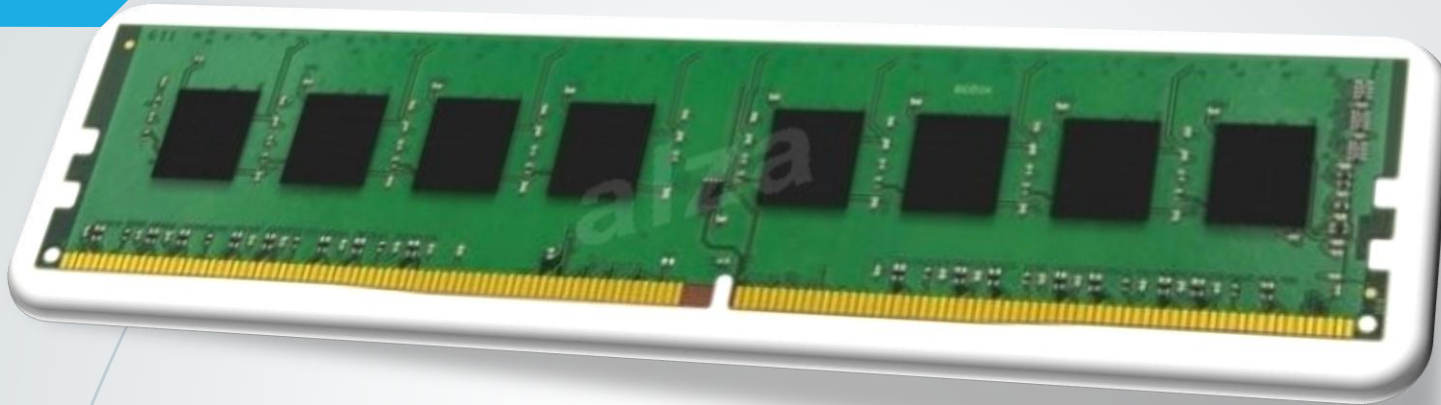
Better timing control, improved clock and storage method	DDR1 SDRAM (DDR = Double Data Rate)
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Transfers data during both PGT & NGT	DDR2 SDRAM
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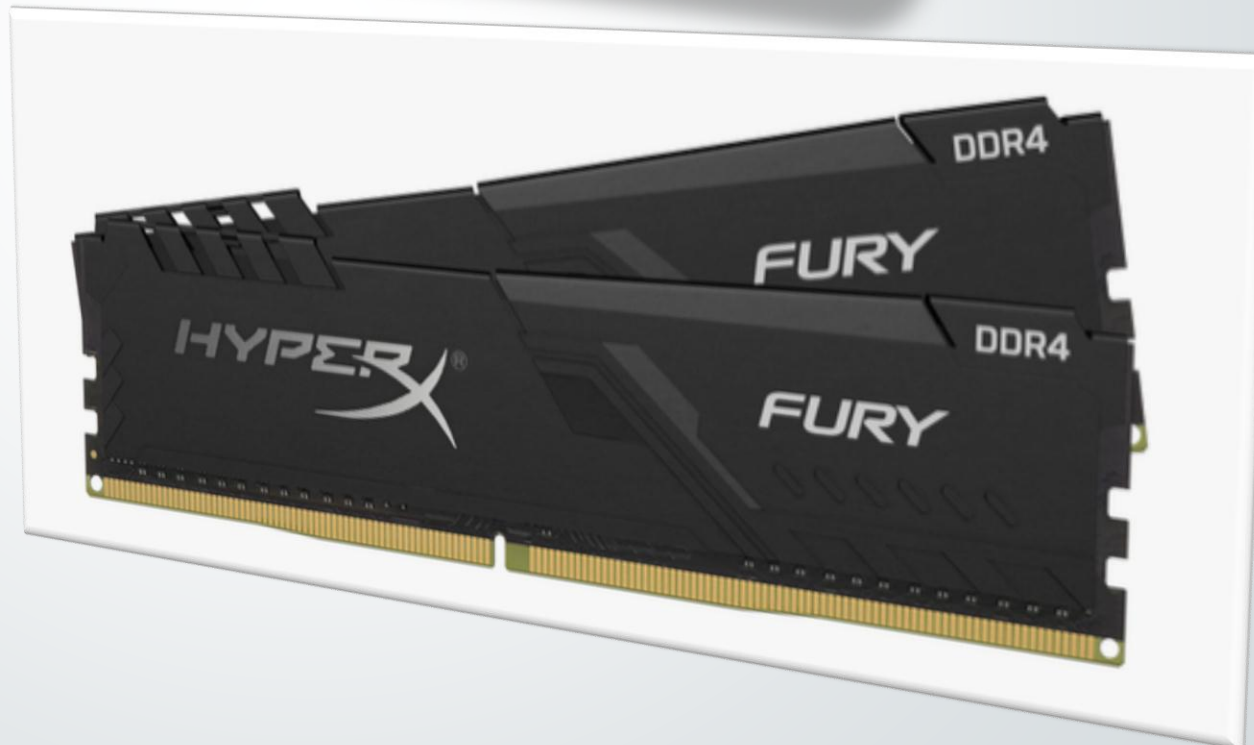
Improved technology allows to transfer more data in each memory clock cycle	DDR3 SDRAM
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Higher packing density, lower voltage requirement & better transfer rate	DDR4 SDRAM
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Primary Memory - RAM

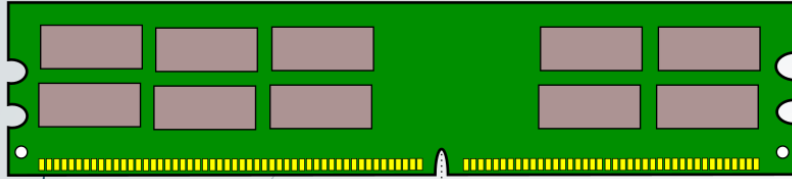


DDR4
RAMs

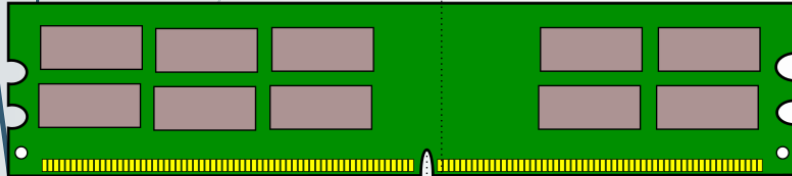


RAM Buying Guide – Good to Know

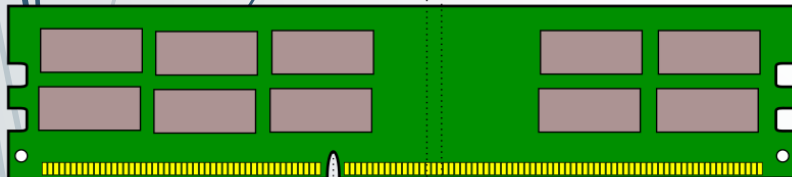
DDR



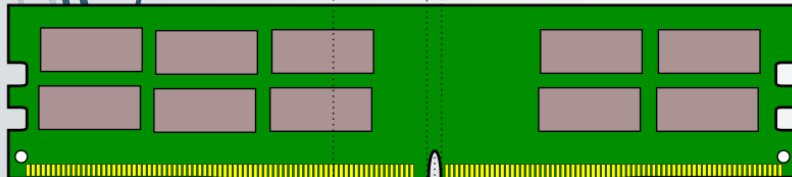
DDR 2



DDR 3



DDR 4



1. Check the Interface on your main/mother board first.
2. Match the Bus speed frequency.
Tips:
 - I. Check processor's FSB (Front Side Bus)
 - II. Buy a main board that matches processor's FSB
 - III. Buy RAM whose Bus speed is more than main board's minimum bus speed.
 - IV. It is best to buy a RAM whose Bus speed is equal to the maximum bus speed of main board.

RAM Buying Guide – Good to Know

3. Check the no. of memory channel your processor supports. Say for example your processor supports dual channel, then buy a main board that has dual memory channel. After that, instead of buying one RAM module, buy two and enjoy double the rate of memory transfer speed.

4. And of course cut your coat according to your cloth. I mean spend money on RAM according to your budget and need.

**Let's check some main
board memory channels**

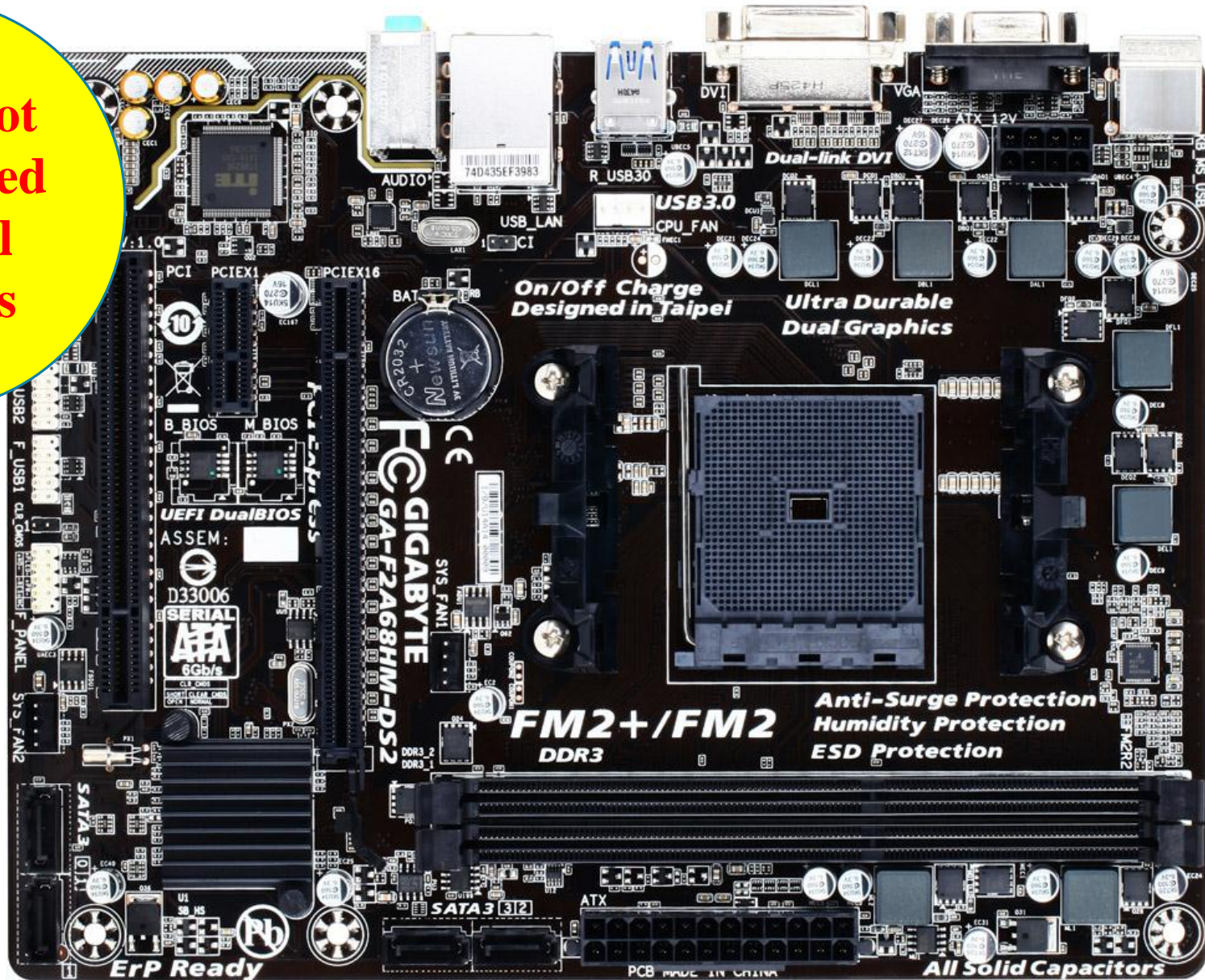
RAM Buying Guide – Good to Know

**4 slots,
color coded
dual
channels**



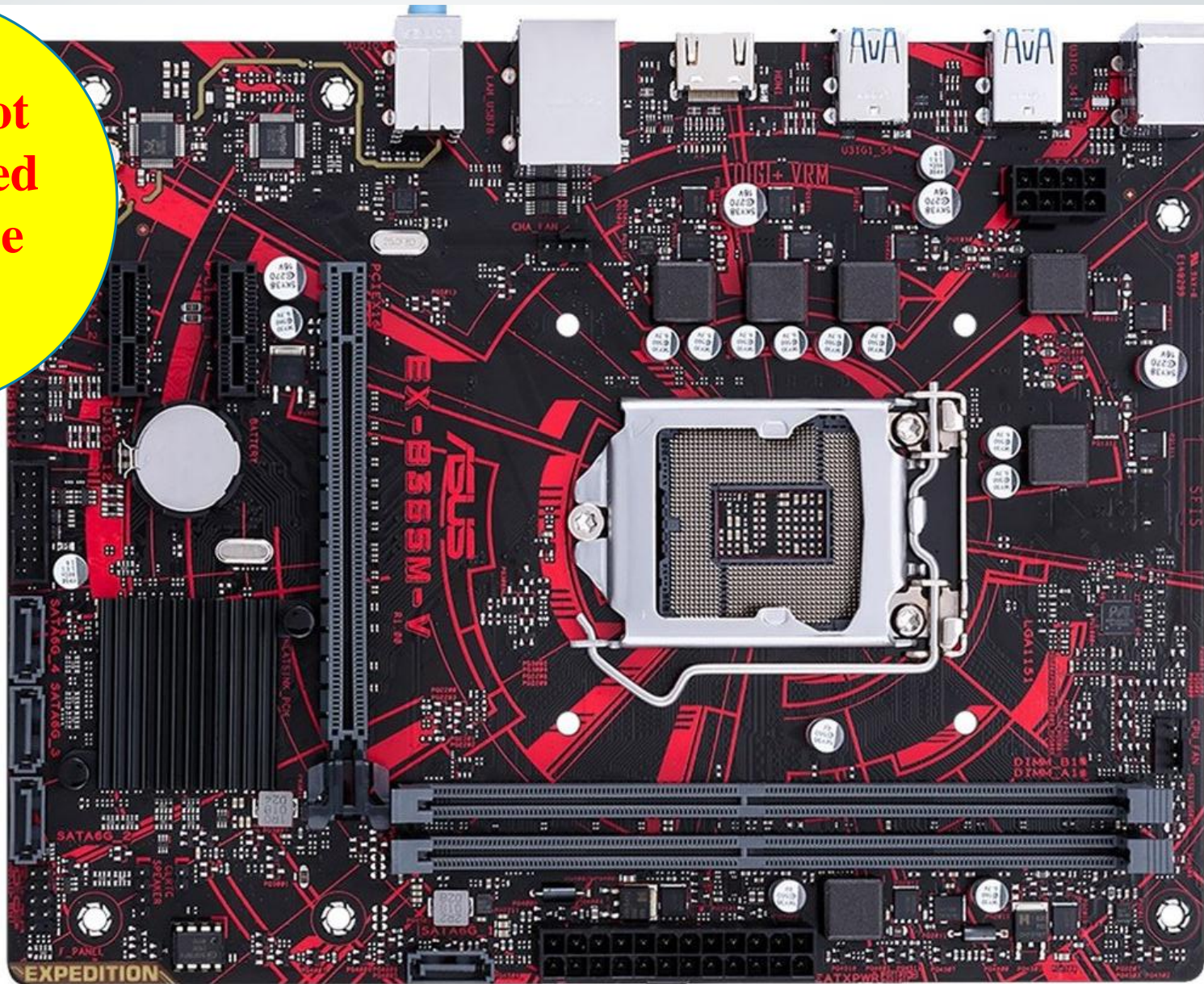
RAM Buying Guide – Good to Know

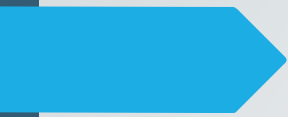
2 slots, not
color coded
but dual
channels



RAM Buying Guide – Good to Know

2 slots, not
color coded
and single
channel





Stay Home, Stay Safe
Always put on a mask
when you are in public!

