MEMORY

- Memory is divided in to two types.
  - Primary memory
  - Secondary memory

  Primary memory – main memory of the computer.

  It is the online memory because it is always directly available to processor.

  Primary memory can be divided in to

  1. RAM - VOLATILE MEMORY.

     DYNAMIC RAM (DRAM) USES capacitors - need refreshing of data every few millisecond

     STATIC RAM(SRAM) uses flip flops – no need of refreshing

- ROM – NON VOLATILE MEMORY.

Types of ROM

- Mask ROM – information is fabricated into the chip at the time of manufacturing.
- PROM – programmable ROM
- EPROM
- EEPROM
- EAROM
- FLASH MEMORY – new type of EEPROM that can be erased and reprogrammed using normal operating voltage.

Memory Module

The memory module is a set of RAM chips on a single plug-in circuit board.

- Physically the main memory is divided into a number of sets or banks.
- Each of these banks contain a number of chips depending on the processor type.

For example, if the computer has two 64MB memory modules installed, it has a total of 128MB of physical memory.

- The memory modules are available in the following type of memory packing.
- DIP (DUAL INLINE PACKAGE)
- SIPP (SINGLE IN-LINE PIN PACKAGE MODULE)
- SIMM (SINGLE IN-LINE MEMORY MODULES)
- DIMM (DUAL IN-LINE MEMORY MODULES)
- RIMM (RAMBUS IN-LINE MEMORY MODULES)

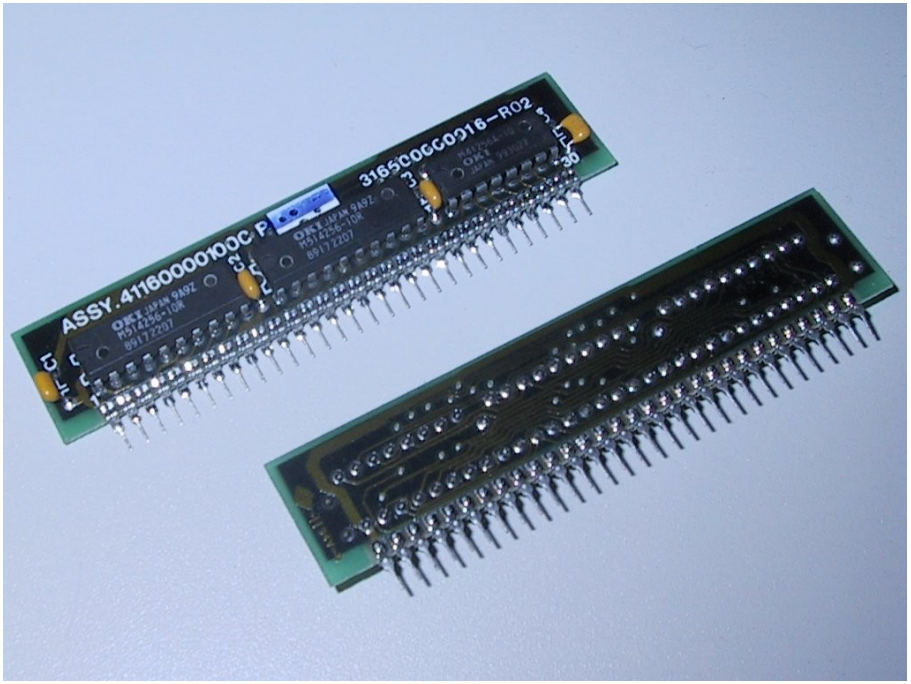
DIP

- A small flat, rectangle box with metal legs on both sides.
- 1 inch length and ½ inch width.
- Both sides contain 8 legs each to Connect to the computer circuitry or insert into the socket on the motherboard.

SIPP

- Contains pins at the bottom to connect them into the mother board memory socket.
- SIPPs are either directly soldered on onto the motherboard or installed into their socket.
- Removal and insertion of the SIPP is easier.

- On the SIPP the discrete memory chips are first soldered onto a small circuit board and then it is connected to the main board using small IC like pins.
- These pins (30pins)are either directly soldered on to the motherboard or installed into their socket.
- These memories
- were used in 80286
- and 80386



SIMM

- It is a memory module used in computers from early 1980s to late 1990s
- A number of memory chips soldered on to a small expansion board.
- The edge connector of this expansion board is plugged into a special SIMM socket on the motherboard.

SIMM

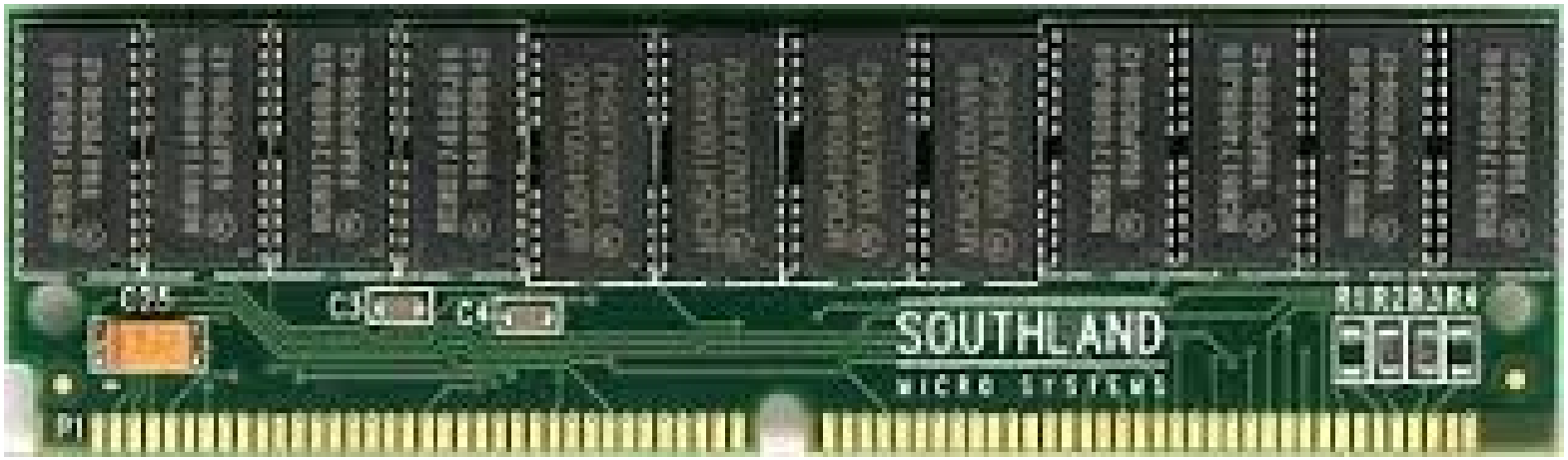
- The first variant of SIMMs has 30 pins and provides 8 bits of data. They were used in AT (286), 386, 486, Macintosh Plus, Macintosh II, Quadra, Atari STE and Wang VS systems.
- The second variant of SIMMs has 72 pins and provides 32 bits of data. These appeared first in the early 1990s in the IBM PS/2, and later in systems based on the 486, Pentium, Pentium Pro, early Pentium II.

30 – pin SIMM

- First SIMM introduced
- 3.5 inches wide and an inch tall.
- It uses one byte wide data buses.

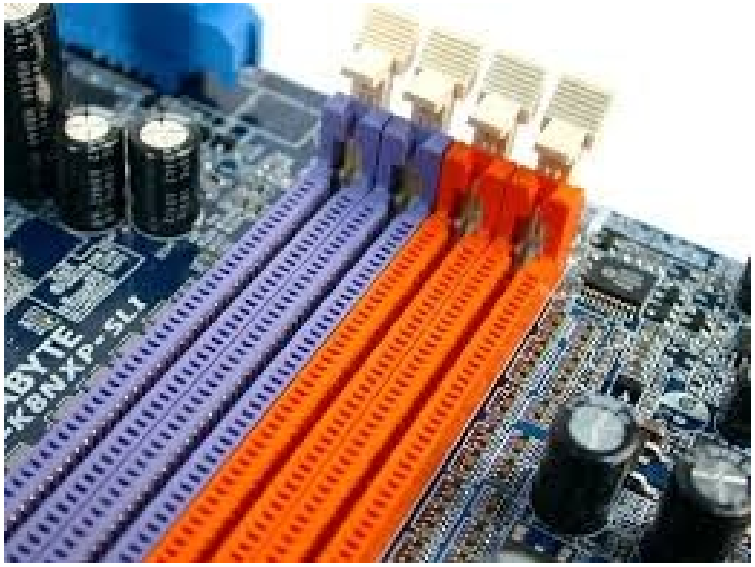
72-pin SIMM

- They are double sided – place chips on both sides of board.

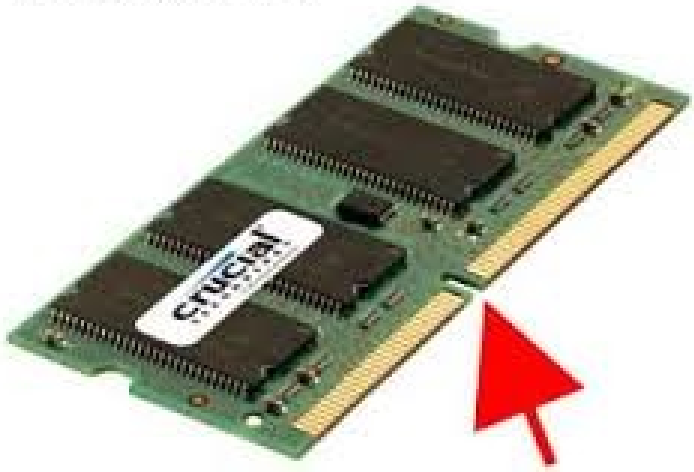


DIMM

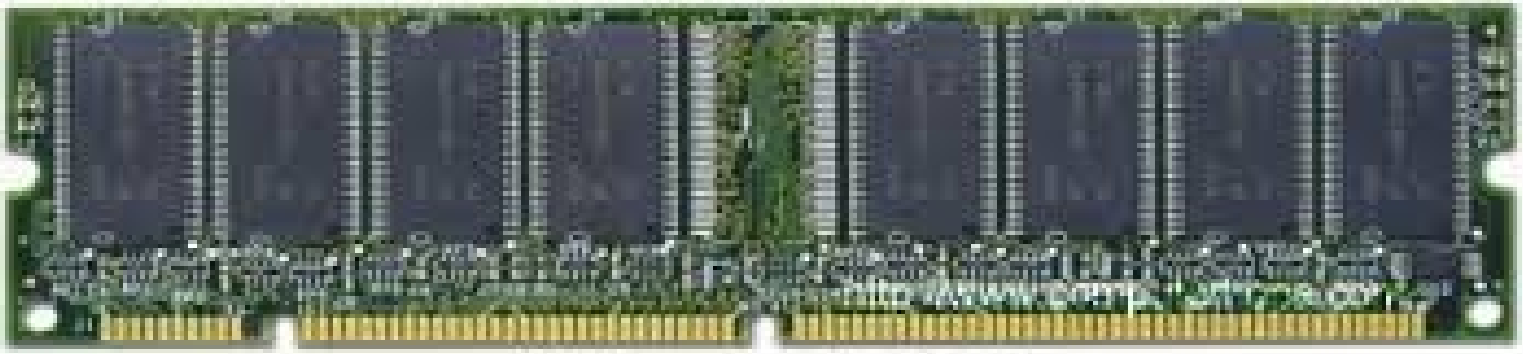
DIMM stands for Dual In-Line Memory Module,
DIMMs are natively 64 bits. This enables a single DIMM to transfer data twice as fast as a single SIMM. DIMM memory chips are dynamic random access memory (DRAM),
The DIMM is installed on a motherboard and stores each data bit in separate memory cells.



Crucial 200 pin DIMM
Notebook



512MB DIMM



http://www.computerhope.com

DIMM

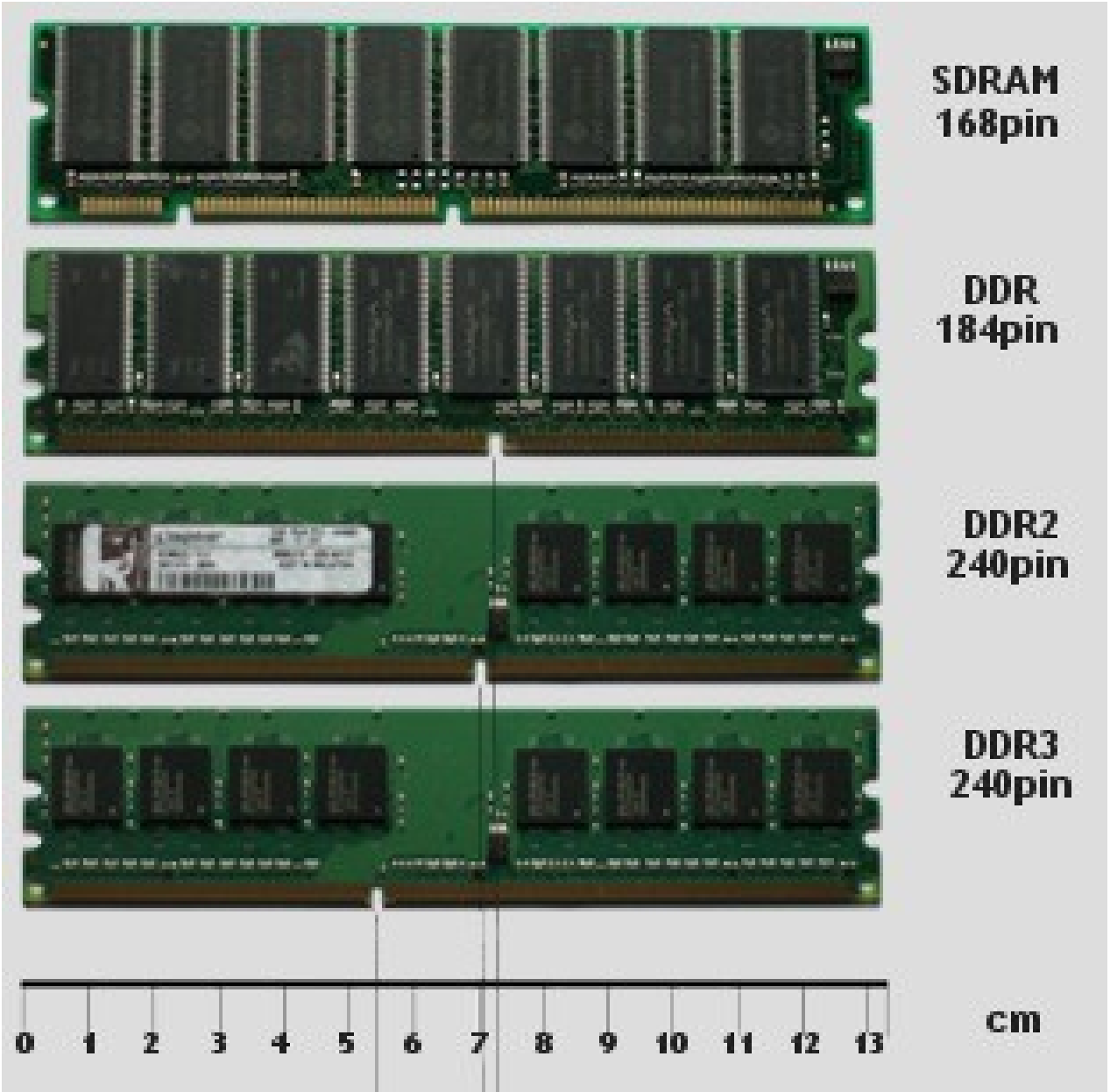
- The DIMM modules have 168 separate connections, arrayed across two sides of the DIMM module.
- Each side of the module divided into three groups.
- First group runs from pin 1 to pin 10.
- Second group from pin 11 to pin 40,
- Third group from pin 41 to pin 84
- Pin 85 is opposite pin1 and pin 84 is opposite to pin 168.
- DIMMs are 5.25 inches wide and one inch tall.

RIMM(Rambus inline)

- VERY fast memory
- Introduced for pentium 4
- RIMM- (RDRAM comes in 184 pin RIMM)
- Very costly
- Because of faster speed, it generate more heat.
- Heat spreader- aluminium casing, covers the module to protect from overheating

DDR (DOUBLE DATA RATE)

- DDR SDRAM - Double Data Rate (DDR) Synchronous Dynamic Random Access Memory (SDRAM) is a common type of memory used as RAM for most every modern processor.
- IT PROVIDES SPEED ALMOST EQUAL TO RDRAM


SDRAM
168pin
DDR
184pin
DDR2
240pin
DDR3
240pin
0 1 2 3 4 5 6 7 8 9 10 11 12 13
cm

MEMORY

Modern All About Motherboard - Lotia and Nair

Memory

- Programs / Instructions are stored in memory before execution.
- Computer takes instructions one by one and execute them.
- Data or results are also stored in computer memory after the execution.
- Memory is divided into two parts
  - Primary Memory
  - Secondary Memory

Primary Memory

- Memory on the motherboard of the computer.
- a.k.a. on-line memory, because it is always directly available to the processor.
- Further divided into
  - RAM
  - ROM

Volatile vs. Non- Volatile

- Memory which loses its contents when the power supply to this memory is switched off is **volatile memory**.

- Any information in this memory would be transferred to some permanent storage device such as floppy or CD etc.
- RAM is a volatile memory.
- Memory which does not loses its contents when the power supply to this memory is switched off is **non - volatile memory.**

Volatile vs. Non- Volatile

- Rom is a non – volatile memory.
- Computer uses ROM to keep permanent information like boot program which is required every time during booting.

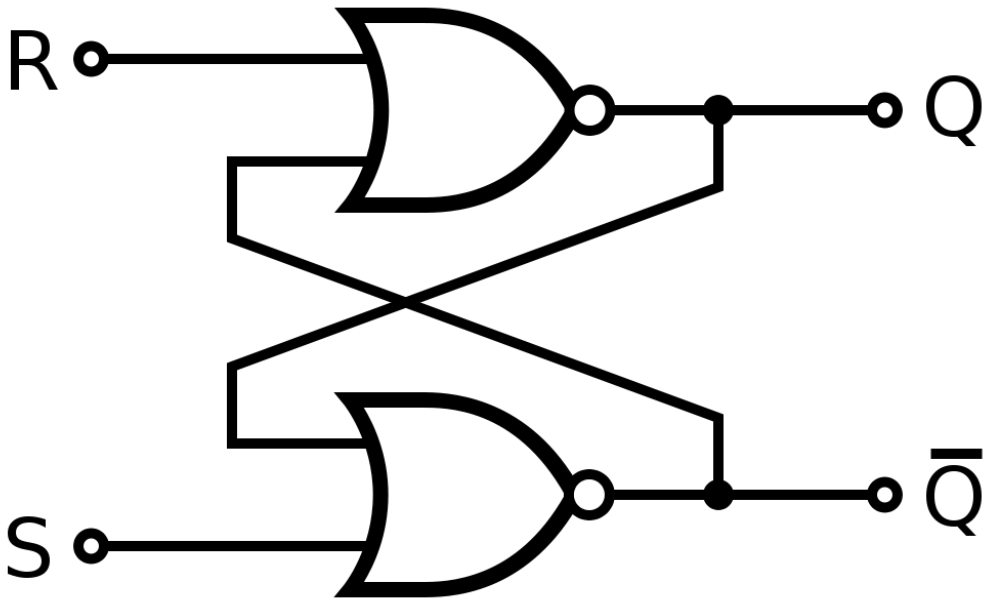
Secondary Memory

- It is actually the storage media used to store the program or the data.
- a.k.a. off-line memory, because it is not directly available to the processor.
- Because of its size, it is a.k.a. mass storage device.
- Floppy disk or hard disk.

Bits and Byte

- Bit a.k.a. Binary Digit.
- A bit is the basic unit of information in computing and digital communications.
- Number 0 or number 1 are the most basic information that one can store inside the computer.
- The two values can also be interpreted as logical values (true/false, yes/no), algebraic signs (+/−), activation states (on/off), or any other two-valued attribute_

Bits and Byte



INPUT		OUTPUT
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

S-R Flip Flop using NOR gates , used to store one bit

Bits and Byte

- By arranging many such flip- flops, a large memory can be constructed.
- Group of different bits are used to convey different information.
- Using two bits, four different combinations can be created. 00,01,10,11
- A combination of 4 bits is called a nibble and is used to store information inside a simple calculator.

Bits and Byte

- A combination of 8-bits is a.k.a. byte and which can convey $2^8 = 256$ combinations .
- Different combination of 0s and 1s of these 8 bits is used to store different information inside the computer's memory..
- 01000001 is used to store character "A"
- Combination of 1000 byte is 1 kilo byte(1KB)
- Combination of 1000 KB is 1 Mega byte(1MB)
- Combination of 1000 MB is 1 Giga byte(1GB)
- Combination of 1000 GB is 1 Tera byte(1TB)

Bits and Byte

- Combination of 1000 TB is 1 Peta byte(1PB)
- Combination of 1000 PB is 1 Exa byte(1EB)

RAM

- RAM OR RANDOM ACCESS MEMORY.
- It is the main memory used inside the computer to store program, data and results.
- It is a temporary memory computer used as a work area.
- Ram a.k.a. Read/Write memory
  - -meaning, one can read as well as write into it.
- Any part of RAM can be accessed directly.
  - -meaning, without going through all the previous parts

RAM

- Two most common RAM are.
  - Dynamic RAM (DRAM)
  - Static RAM (SRAM)

Dynamic Ram

- It is cost wise cheaper than SRAM.
- It will be preferred over SRAM for main memory.
- Uses Capacitors to store the information.
- Data stored in DRAM need to be refreshed every few millisecond by rewriting the contents of the memory.

RAM

Static Ram

- Unlike DRAM, stored information will remain as long as the power supply is provided to the SRAM chip.
- Refresh the information is not needed here.
- SRAM uses flip-flops to store the information.

ROM

- ROM a.k.a. Read Only Memory
- Memory that can be read only, one cannot write any information into it.
- Does not lose its contents even after power supply is cut off.
- Non-volatile type of memory.
- ROM is also random access memory.
- **Types of ROM are** : -
- MASK Rom, PROM, EPROM, EEPROM, EAPROM, FLASH Memory

Mask ROM

- It is the basic ROM chip.
- Information in MASK Rom is fabricated at the time of manufacturing itself.
- Mask is the master pattern used during the chip manufacturing to make various circuit elements on the chip.
- Number of chips to be manufactured should be very high, to justify the high investment required.

PROM

- A.k.a. Programmable Read Only Memory.
- Chip is made as a blank ROM during manufacturing.
- Later, Programmers uses special programs to store information into it.
- Initially when the PROM is manufactured, it contains row and address connections, i.e. all the locations contain a binary 1.
- Information is stored into PROM by burning the information into it. Information stored cannot be erased or removed.

EPROM

- A.k.a. Erasable Programmable Read Only Memory.
- Able to remove or erase the contents if user wants to change th on.

- It includes a window in the middle of a chip makes it easily distinguishable.
- Window lets the user to see the internal circuitry of the EPROM chip.

EPROM

- To erase the content- EPROM is put under a short wave ultraviolet light sou e an EPROM.

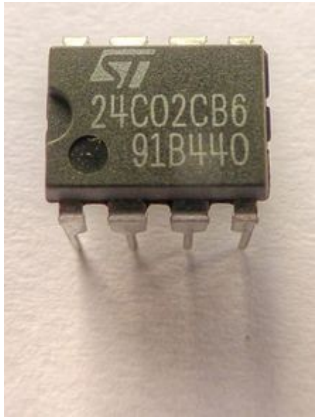
- Once the contents is removed, it can be reprogrammed or rewritten again by EPROM programmers.

EPROM

- After programming, the top window must be closed using an opaque label to protect the contents from sun rays which contains ultra violet rays(which will slowly erase the contents).
- To change or erase even one location, the entire content should be erased in EPROM chip.
- EPROM is the most commonly used ROM in computer field.

EEPROM

- A.k.a. Electrically erasable programmable read only memory.



- Contents in EEPROM are removed using a higher than normal electric voltage.
- i.e. If EEPROM uses +5V for the read operation, then by using +12V for example, the contents could be erased.

EEPROM

- Content can be deleted without removing the chip from the circuit.

Drawbacks

- EEPROM can be programmed and erased only for a limited number or times only.
- To change even one bit of information, entire content is to be first removed and then everything is to be written back with the new values.

EAROM

- A.k.a. Electrically alterable read only memory.
- By applying a high voltage to a particular bit of memory, the content of that location can be changed.
- To change the content of one location, entire content need not be erased or rewritten as in EEPROM or EPROM.
- It works just like ROM.
- Write operation is very slow compared to that of write speed in RAM memory.

EAPROM

- Useful for storing small amount of information permanently, which may requires changes from time to time where battery backup may not be available or possible.

FLASH MEMORY

- A new type of EEPROM
- Can be erased and reprogrammed using the normal operating voltage found inside the PC
- Can only erased and programmed for fixed number of times. (It can done only in blocks)
- First generation of this memory had the entire block as a single block.
- Newer generation has multiple, independent erasable blocks in sizes from 4k to 128k bytes.

Physical Memory Organization

- A memory module, commonly called RAM, memory, or a RAM chip , is a dynamic random access memory integrated circuit module mounted on a printed circuit board and designed for use in personal computers, workstations, and servers.

- Memory module is a set of number of RAM chip on a single plug-in circuit board.

Memory Module

Two types of DIMMs (dual in-line memory modules):

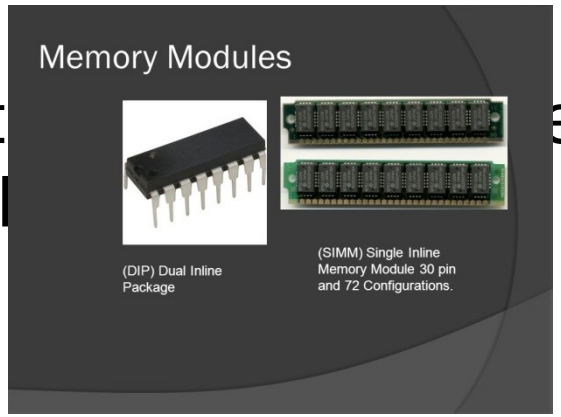
Memory Module

- A memory module, commonly called RAM, memory, or a RAM chip , is a dynamic random access memory integrated circuit module mounted on a printed circuit board and designed for use in personal computers, workstations, and servers.

- Memory module is a set of number of RAM chip on a single plug-in circuit board.

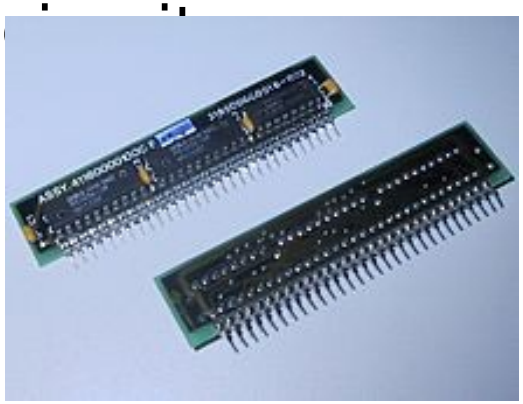
DIP – Dual Inline Package

- Small flat, rectangle metal box with 8 legs on both sides.
- 1 inch length and ½ inch wide.
- DIP in first PC could only store 64Kbits of information.
- Later with 286 processor, it could store 256Kbits of information.
- Speed and capacity of the chip is of prior importance.
- 256K X 1 bit … equire 8 chips to make 256…



SIPP – Single Inline Pin Package

- Contains pin at the bottom to connect them to the motherboard.
- Most of them are either directly soldered or inserted manually.
- Packaging makes SIPP differs from SIMM
  - On SIMM, connection to motherboard is done using edge connectors
  - On SIPP, connection to the main board is using small IC



SIMM – Single Inline Memory

- Edge connector is plugged into a special SIMM socket.
- Design allows it to be added and removed without any risks.
- Comes in different capacities
- On a 32-bit c to add 8 bit modules of 4

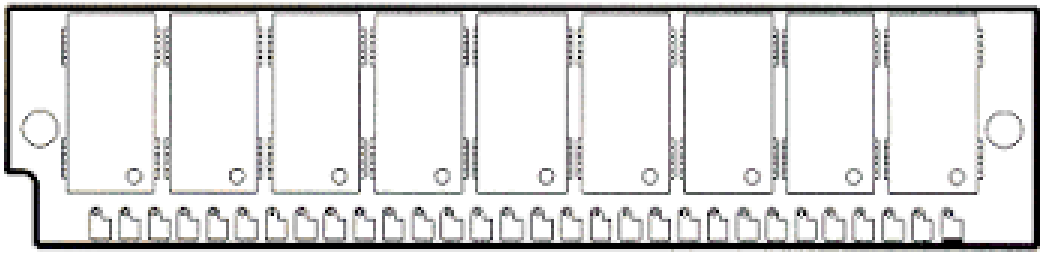
30 pin SIMM

- SIMM – Single inline memory module
- First SIMM introduced with the PC system.
- It measures about 3.5 inches wide and an inch tall.
- Uses 1 byte wide data buses.
- Require multiple SIMM to make a single memory bank for most processors.
- PCs with 16-bit processor require 2 SIMM modules.
- PCs with 32-bit processor require 4 SIMM modules.

72 pin SIMM

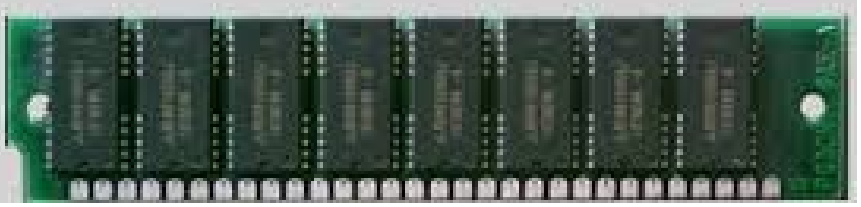
- 72 pin SIMM introduced to rectify the drawback of 30 pin SIMM.
- Uses 4 byte wide data buses.
- Incorporate several interlocks to prevent us from plugging wrong style of SIMM or sliding in at improper orientation.

30 pin SIMM

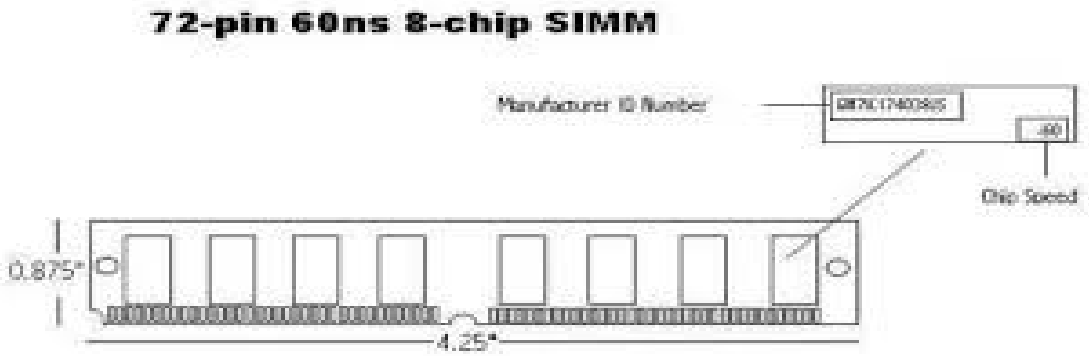


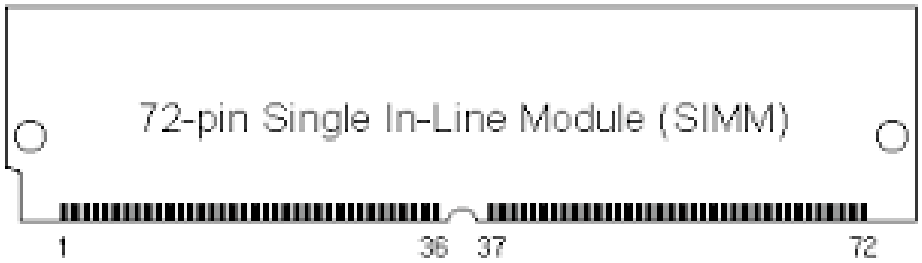
30-pin SIMM

30 pin SIMM



72 pin SIMM

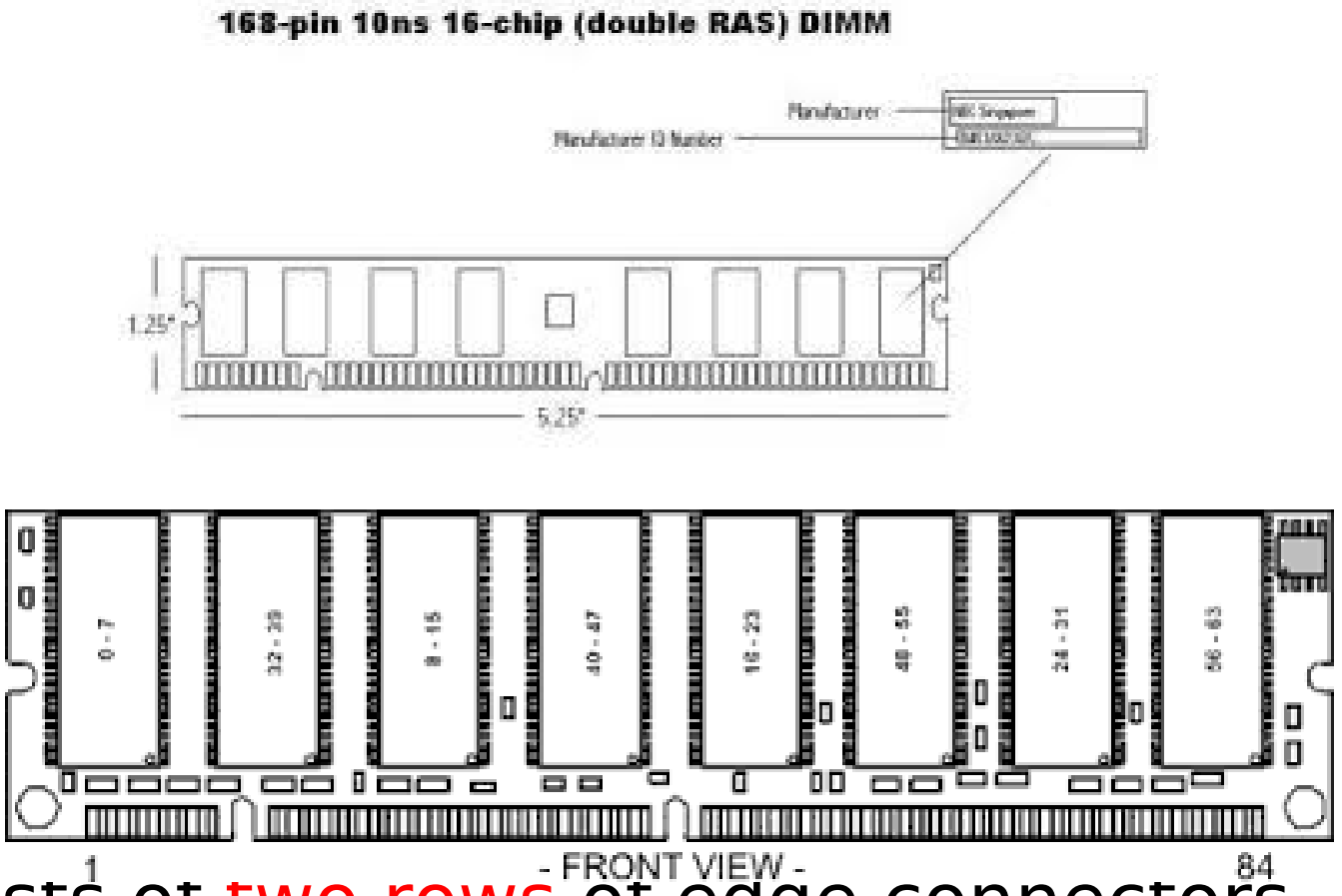

72-pin 60ns 8-chip SIMM
Manufacturer ID Number
Chip Speed
0.875"
4.25"


72-pin Single In-Line Module (SIMM)
1
36
37
72

DIMM

- Dual Inline Memory Module.
- Just as 486 processor requires four 30-pin SIMM, two 72 pin SIMM are required for PENTIUM processors.
- DIMM has 168 separate connections, arrayed across two sides of the module.

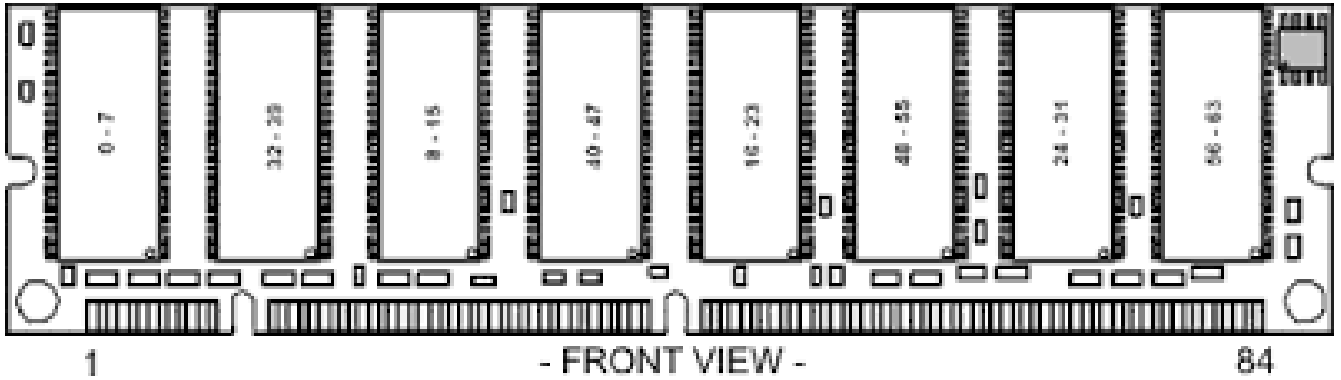
DIMM



- Consists of two rows of edge connectors, one on each side of the module, are divided into three groups with short gap between.

DIMM

- First group runs from pin 1 to pin 10, second group from pin 11 to pin 40, and the third group from pin 41 to pin 84, pin 85 is opposite to pin 1.

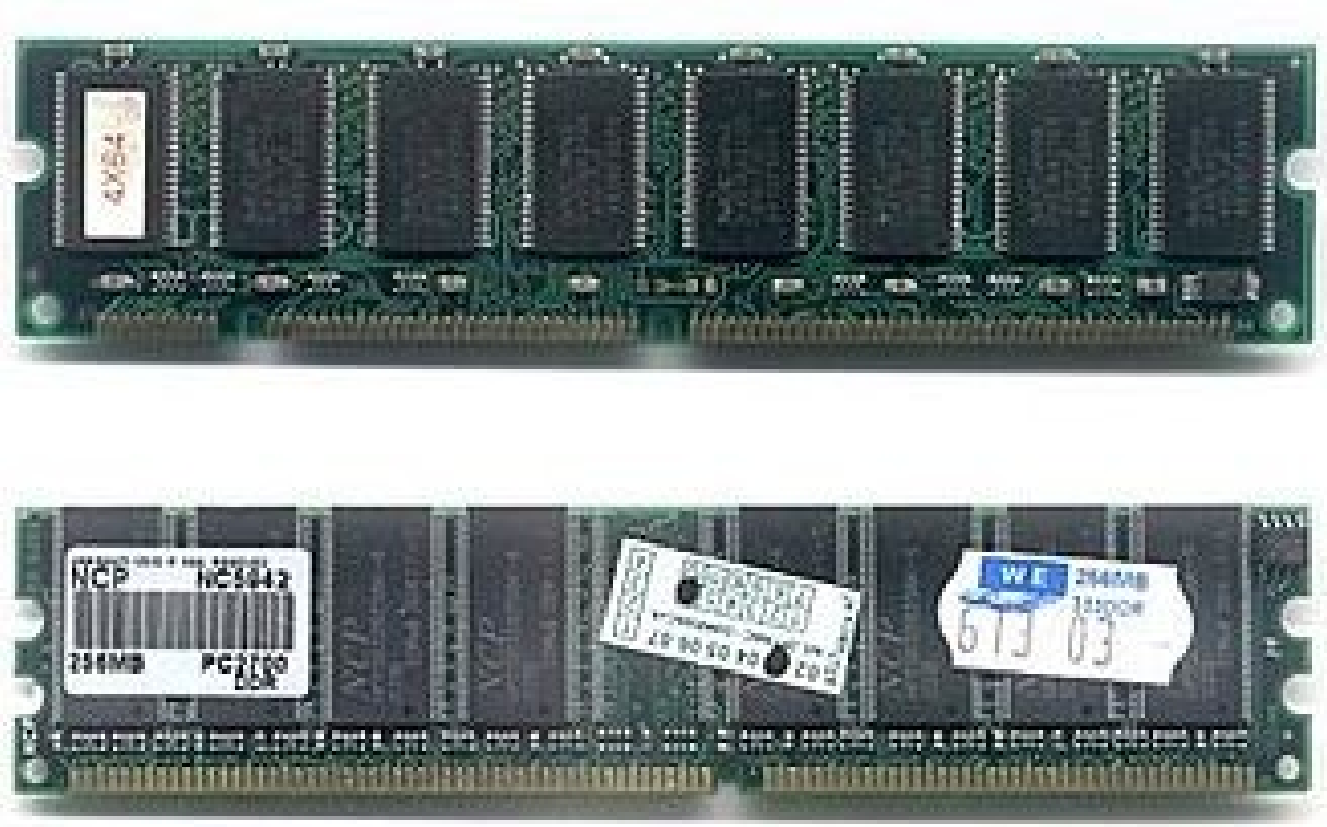


- Asymmetrical arrangement of the notches on the DIMM prevent its unintentional improper insertion into its socket.
- DIMM measures about 5.25 inches wide and typically one inch tall.

RIMM

- Rambus Inline Memory Module.
- RIMM comes in special 184-pin RIMM
- RIMM cannot be used on motherboard not designed for RAMBUS memory.
- Even though its operation speed is high, RIMM is very costly.
- Because of faster speed, it generates more heat, an aluminum casing called heat spreader, covers the module to protect the chips from overheating.

DDR DIMM



DDR DIMM

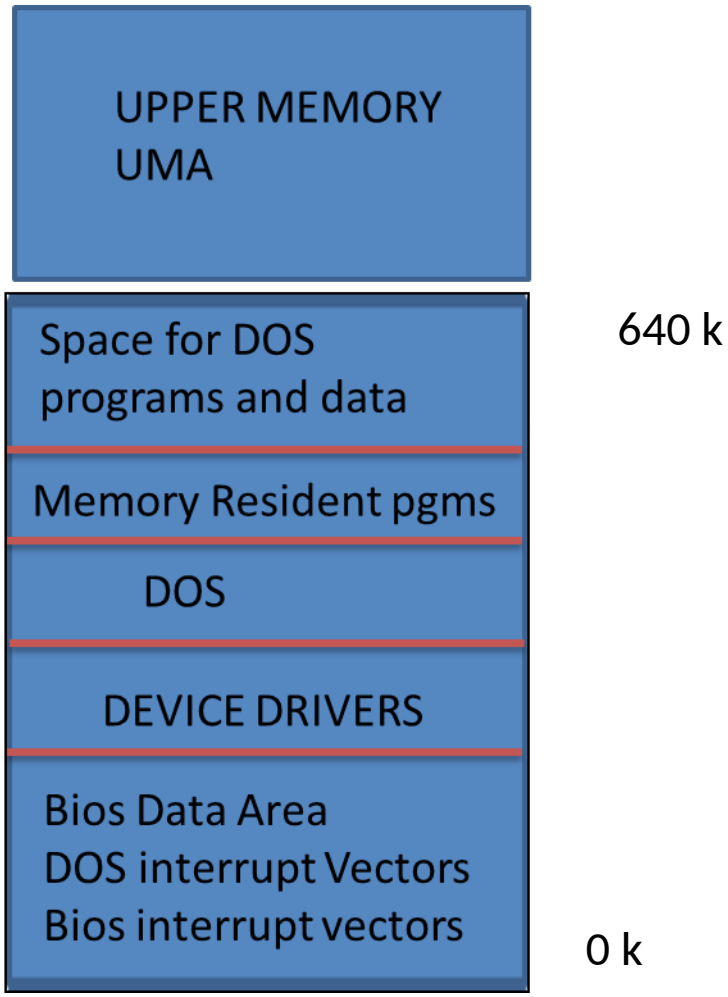
- Data Double Rate DIMM SDRAM (synchronous DRAM).
- DDR SDRAM is costlier than standard SDRAM.
- It is much cheaper than the RDRAM.
- Pentium 4 uses DDR DIMM instead of RIMM
- It uses a connector with 184 pins. Contains a single notch near the centre of the connector.

Logical Memory Organisation

How the memory chips are accessed and used by the computer system.

Conventional Memory

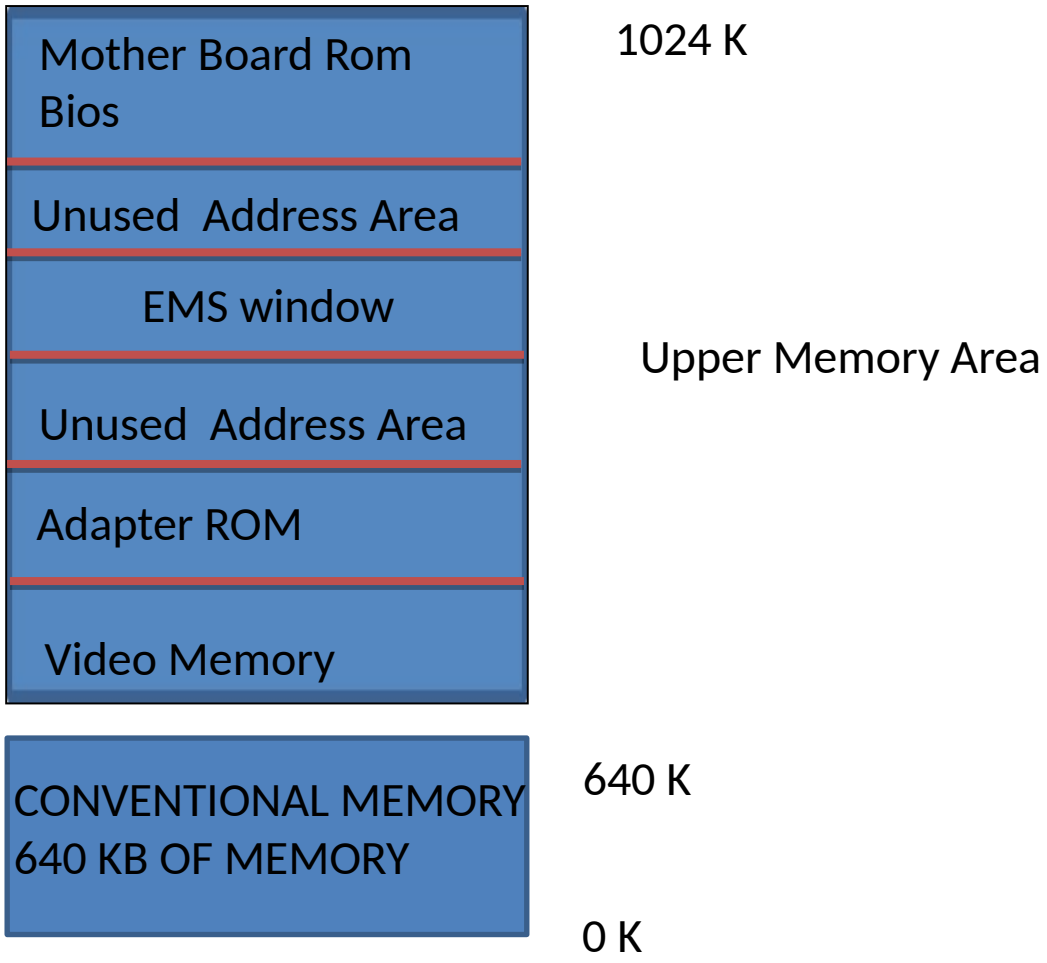
- The first PC and PC-XT systems used 8086/8088 processor as the main processor.
- These chips have 20 bit address lines.
- The maximum address that these processor could access is 2^{20} Bytes or 1MB.
- In this 1MB , 640 KB of memory is set as the RAM memory area.
- This 640 KB which is used by the DOS and other programs is called Conventional Memory, Dos Memory or Base memory.


UPPER MEMORY
UMA
Space for DOS
programs and data
Memory Resident pgms
DOS
DEVICE DRIVERS
Bios Data Area
DOS interrupt Vectors
Bios interrupt vectors
640 k
0 k

Upper Memory Area (UMA)
High Dos Memory Area

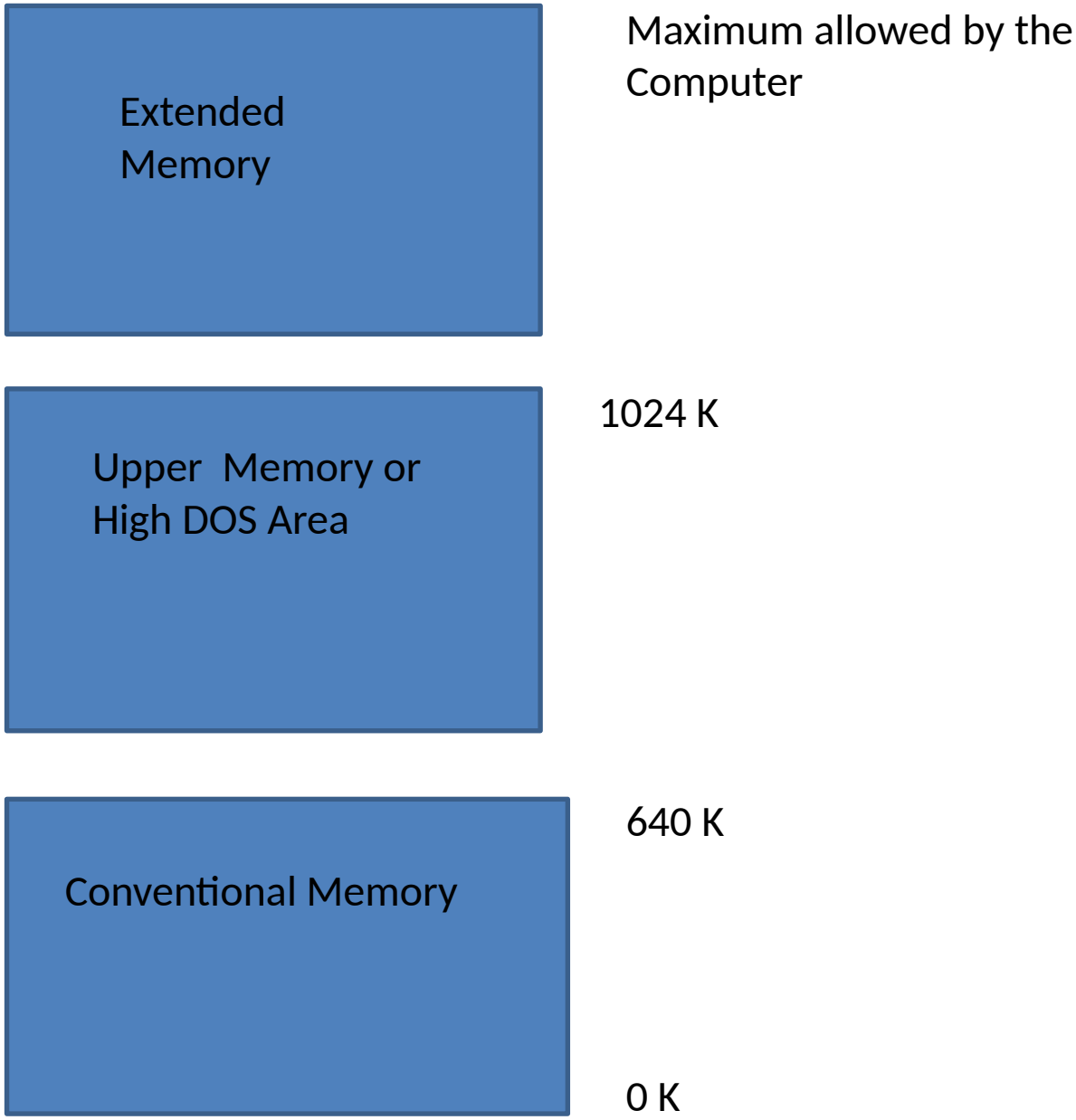
- The memory area between the 640KB and the 1MB is called the UPPER MEMORY AREA.
- There are many empty memory locations in this area that is not used by 8bit processor.
- On machines with memory mapping capability, (386 or higher processor) can map these empty locations to some real memory area and use them for storing small driver or memory resident programs.

- This memory is available in small chunks of different sized memory, so big pgms can not be stored here.



Extended (XMS) Memory

- XMS is memory beyond the 1MB limit – any memory available after the 1MB.
- 8086/8088 cannot address memory beyond 1MB.
- 286 processors have up to 16MB of XMS.
- 486 processors have up to 4 gigabyte of XMS.
- Not useful for DOS users. Used as Disk cache.
- Windows OS allow multiple DOS pgms to run in the extended memory. Each pgm working in its own 640KB memory area.


Extended Memory
Maximum allowed by the Computer
Upper Memory or High DOS Area
1024 K
Conventional Memory
640 K
0 K

Extended Memory Specification

- Standard developed jointly by Microsoft, Intel, Lotus and AST research in 1987.
- This specification works with all the processors that can address extended memory.
- This specification allows the real mode DOS pgms to use a special area in xms called High Memory Area or HMA.
- To provide the XMS capability, a xms driver called HIMEM.SYS is used.
- This driver co-ordinates the complete working of XMS.

VIRTUAL CONTROL PROGRAM INTERFACE (VCPI)

- Another xms manager specification.
- Developed by Phar lap software.
- Mainly developed to make the DOS pgms in the virtual 86 mode without any conflicts.
- Uses software interrupt 67h for the virtual 86 pgms to communicate with each other.

Dos protected mode interface

- DPMI is the latest xms memory manager standard by microsoft in 1990.
- First introduced with windows 3.0

High memory area (HMA)

- Is a 64KB of memory at the beginning of the xms.
- Starts at 1024KB and goes upto 1088 KB
- From 5.0 version onwards dos can use this memory as a part of conventional memory.
- The use of HMA is controlled and co-ordinated by the HIMEM.SYS XMS manager.
- This area can be used by device drivers and memory resident pgms.

Expanded Memory (EMS)

- EMS is a specification which defines a method to access system memory above 1MB of RAM on PC-XT and AT computers.
- This memory is accessed via 16KB window within the first 1MB. It is accessed in 16KB pages.
- The EMS is not part of the main memory, it is a separate memory installed into the system which can be accessed in a fixed sized pages using a method called **bank switching.**

- In this method a small window in the main memory is used to view the content of EMS.
- This window is located in the memory location between 640KB and 1024 KB.
- The EMS memory is arranged in blocks of 16KB each.
- To access this memory , 1 block of the EMS is copied into the window in the main memory an after the processing it is copied back into the EMS memory.
- This type of memory is limited to 286 based processors, because DOS cannot address memory beyond 640 KB.
- To solve this pblm, LIM EMS specification has developed. (lotus, intel , microsoft)

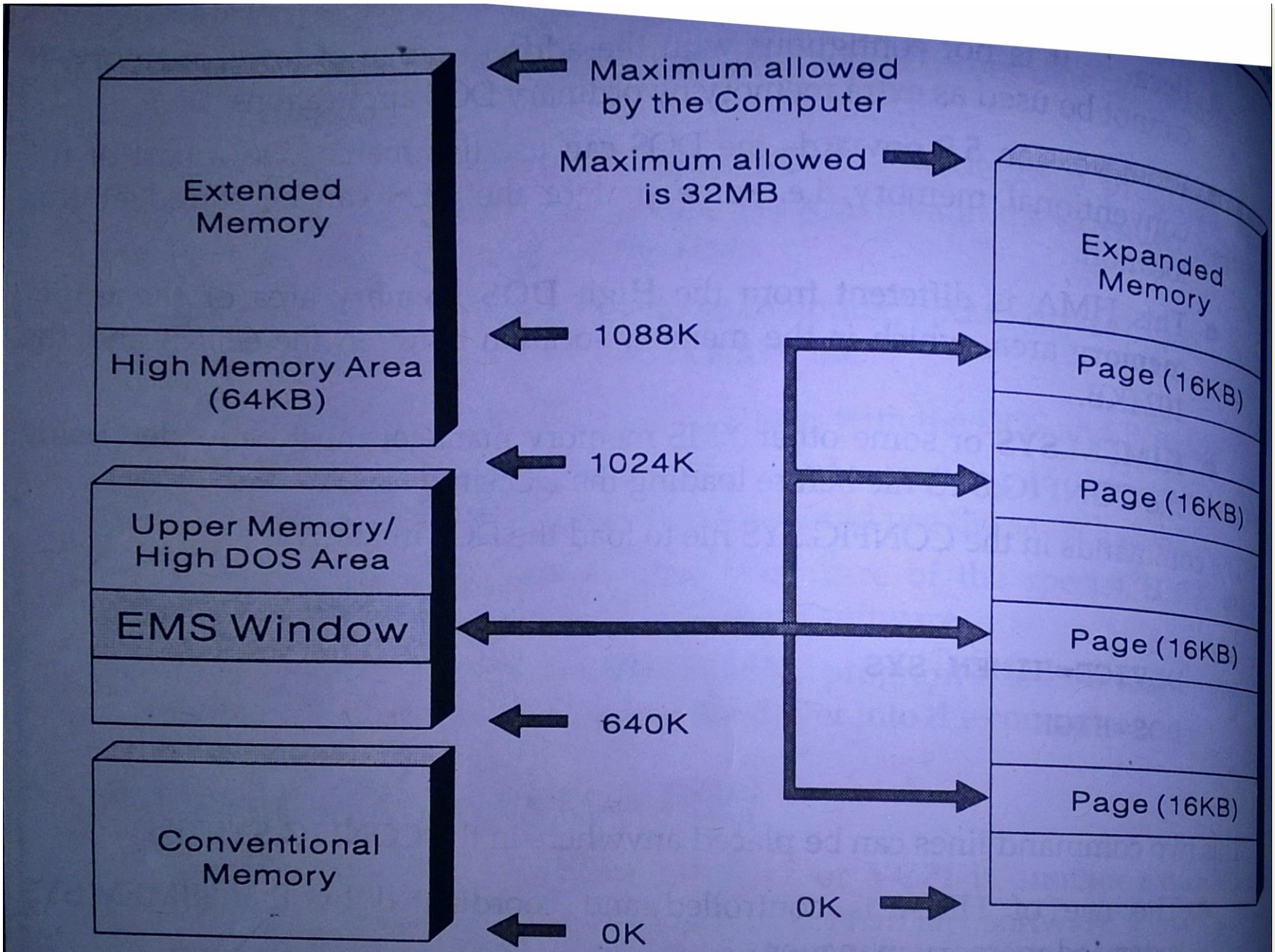


Fig. Expanded Memory.