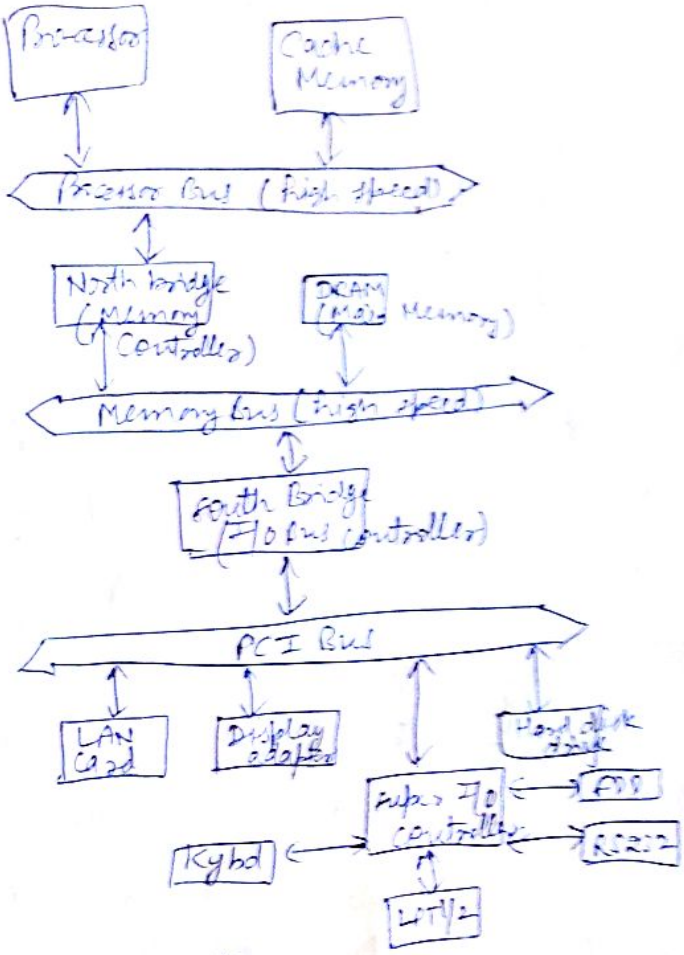
I/O Buses:-

Multi-bus design approach :→ Because of the wide range of speeds of components used in PCs and to eliminate bus bottleneck, multibus design



Multibus design in PCs.

approach has been implemented in PCs. Because some components such as CPU and cache Memory run much faster than ROM or floppy disk. Multibus design consists of three types of buses in PCs

(1) Processor Bus + cache Bus. [high speed]
(2) Memory Bus
(3) Expansion Bus [slow speed]

(i) **Processor Bus** is the communication pathway b/w the CPU and the chipset. the North bridge part of chipset or Memory controller chipset maintains the direct communication with the processor through the processor bus, which is also called as (Processor Bus) or front side Bus (FSB). it is highest-speed bus in the system and consists of data, address and control bus.

it runs at 66 MHz, 100 MHz, 133 MHz, 200 MHz, 400 MHz, 533 MHz, 800 MHz. it is 8 bytes (64-bits) wide.

(2) Cache Bus:- it is a dedicated bus for accessing the system cache. Called as Backside bus.

(3) Memory Bus:- it is second level system Bus. it connects the memory subsystem to the chipset and the Processor.

- it is used to transfer information between the CPU and the main memory (RAM) in the system.
- Memory bus is actually a part of the processor bus itself. But usually, it is implemented separately by the North Bridge of a chipset (that is responsible for transferring information b/w the Processor bus and the Memory bus.

I/O Bus or expansion slots :- I/O bus or expansion slots enables the computer to communicate with the peripherals devices.

Expansion slots are required because (1) additional devices like sound card, video adapter, SCSI host adapter can be added to the system. However, these devices may not be built into the motherboard chipset. (2) They may be configured as additional chips installed on the board. They use the I/O bus to communicate with the CPU.

(3) The I/O bus helps the user to add devices to a computer system in order to expand its capabilities.

(4) Expansion slots provides special signals to synchronize the working of add-on-cards with the rest of computer.

* Types of Expansion slots or I/O buses on the motherboard

(1) (i) ISA (Industry Standard Architecture 8-bit Bus) or PC Bus.
(ii) 16-bit ISA bus

(2) MCA bus - (Microchannel Architecture)

(3) EISA (Extended ISA 32-bit bus)

(4) Local Bus
- (1) VESA Local bus
- (2) PCI bus
- (3) PCI Express
- (4) Accelerated graphic port bus.

(i) <u>ISA Bus</u>:→ Industry standard Architecture originated in 1980's by IBM.

The original IBM PC that was introduced in 1981 includes the <u>8-bit</u> subset of the ISA bus.

→ In 1984 IBM introduced PC-AT, that is the first full 16-bit implementation of the ISA bus.

<u>8-bit ISA</u>:- (1) it ran at 4.77 MHz in PC and XT.

<u>16-bit ISA</u>:- it is newer version is a 16-bit bus. it ran at 6 MHz and then 8 MHz in PC and AT.

→ Later on 8.33 MHz was decided as a maximum standard speed for 8/16 bit versions of the ISA bus for backward compatibility.

→ Some computers have a capability to run the ISA bus faster than 8.33 MHz. But some of the adapter cards may not properly operate at high speeds.

→ Generally, the ISA data transfers need two to eight cycles.

Hence the maximum data rate of ISA bus is

$$\frac{8.33\,MHz \times 2\,bytes\,(16\text{-bit})}{2\text{ cycles per transfer}} = 8.33\,MBps.$$

Thus, the Bandwidth of the 8-bit ISA bus would be $\frac{8.33}{2} = 4.17$ MBps.

ISA is the oldest of all these and today's computers still have a ISA bus interface in the form of ISA slot on the main board.

ISA has 8-bit and 16-bit standards along with 32-bit version (EISA) all operates at 8 MHz approximately.

(i) 8-bit ISA Bus (1) capable of providing
(i) 8 data lines
(2) 20 address lines
(3) 6 interrupt lines
and (4) 3 DMA channels

(2) I/O data transfer rate approximately requires 2 to 8 clock cycles.

(3) Runs at 4.77 MHz.

(4) an adapter card with 62 contacts on its bottom edge, plugs into a slot on the motherboard that has 62 matching contacts.

(5) the 8 data lines and 20 address lines enables the slot to handle 1MB of memory.

Limitations of 8-bit ISA bus :→

(i) low data transfer rate
(2) Complex expansion board installation
(3) Very limited IRQ
(4) very limited DMA channel.

(2) 16-Bit ISA Bus :→ In 1984, IBM introduced PC-AT with the 286 processor, which is the 16-bit implementation of the ISA bus. 16-bit ISA bus has an additional connector attached behind the 8-bit connector.

(1) it has additional data bits D_8-D_{15} and
(2) it provides additional interrupt request signals.
(3) and More DMA request signals.

Limitation of 16-bit ISA :→

(1) The system board has access to IRQ lines, DMA channels and I/O addresses creates problems when expansion boards are used.

(2) ISA bus does not have any central registry from where the system resources can be assigned to expansion boards

(3) EISA (Extended ISA): has a 32-bit data bus but still operates at 8 MHz. EISA was developed in september 1988 by IBM as a response to the introduction of the MCA bus to handle its licensing.

(1) it is used for 80386 and 80486 processor.

(2) it is rarely used -- mainly as a disk controller or video graphic adapter.

(3) It supports higher data transfer rate for bus masters and DMA devices.

(4) It supports automatic translation of bus cycles b/w the EISA and ISA slaves and masters

(5) it supports automatic configuration of system and expansion boards.

(4) Local bus :→ The ISA, MCA and EISA buses are relatively of slow-speed. The I/O buses that were developed after these buses uses the concept of local bus.

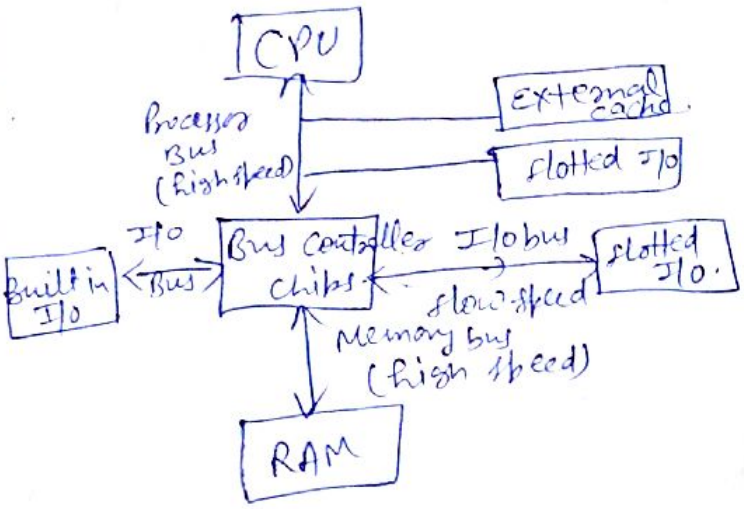
- There are three main local buses found in the PC systems are

  (1) VESA Local Bus (VL Bus)

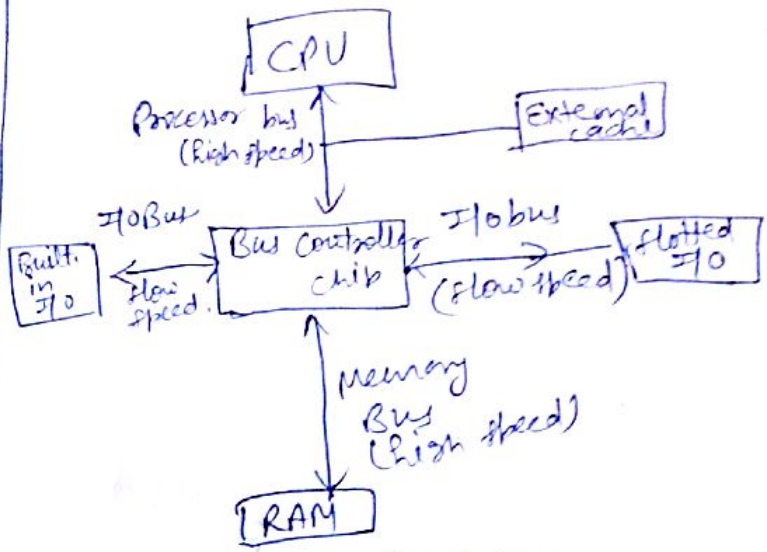
  (2) PCI

  (3) AGP.

- why local bus is required:
  - speed limitation of the ISA, MCA and EISA arises the need of local bus.
  - slow bus speed was a problem in the applications that require speed like video and disk controllers.
  - also I/O bus is capable of transferring data at the rate of 8 MHz. whereas the processor bus is capable of transferring data at the rate of 66MHz – 450MHz or faster.



Local Bus



without local bus.

To over the problems of EISA, ISA a remedy to this problem was decided to move the slotted I/O block to an area where it could access the faster of the processor bus like the external cache as shown above

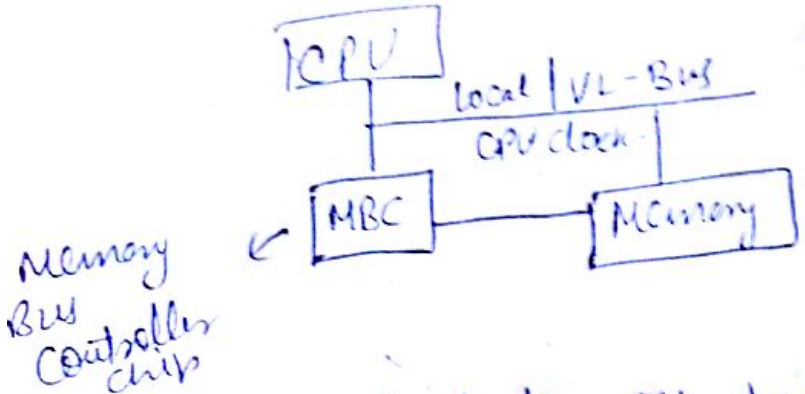
(1) VESA Bus :- was first designed in 1992 as an extension to ISA bus VESA stands for video Electronics standards Association (VESA)

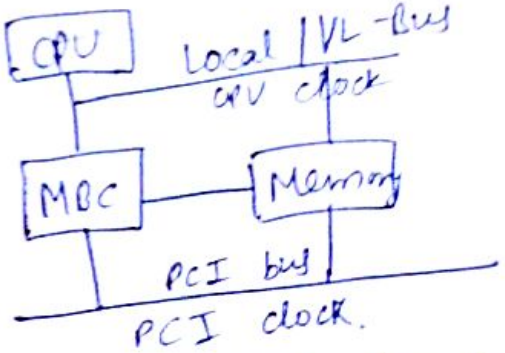
- Initially it was used for video cards To improve the video performance.
- VL-bus or VESA local bus is a 32-bit bus. it is a direct extension of 486 processor / Memory bus.
- it can move data 32 bits at a times enabling data to flow between the CPU and a compatible video sub-system.
- Maximum data rate of VL-bus is 133 Mbps.

(2) PCI (Peripheral component interconnect) :- local bus is a high performance bus for interconnecting chips, expansion boards and processor / memory subsystems. it was originally designed

by intel in the early 1990s.

- PCI is a high-bandwidth, processor-independent bus that can function as peripheral bus.
- Unlike some earlier standard buses, the PCI bus is designed to be easily interfaced with different microprocessor families, main memory, and a very wide range of I/O devices.





→ In contrast to VL-bus which directly taps into the processor bus, the PCI architecture has been designed by inserting another bus b/w the CPU and the low speed I/O bus by means of bridges.