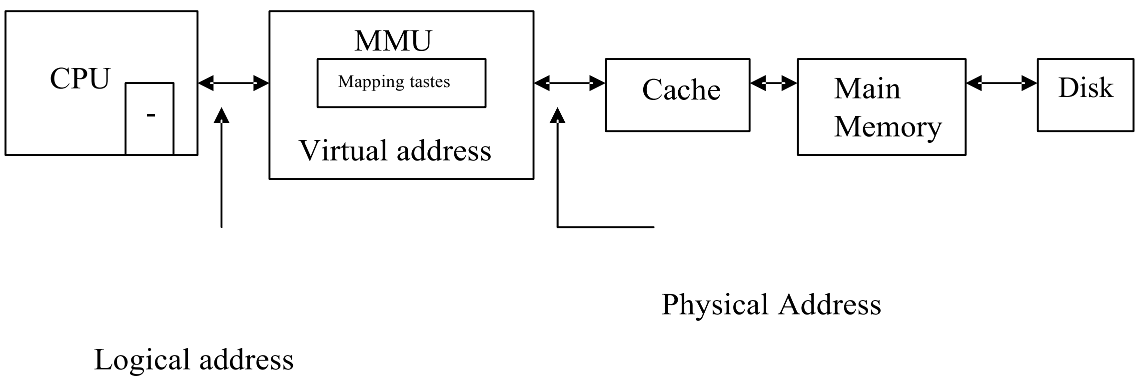
Virtual Memory

Virtual memory is the technique of using secondary storage such as disks to enter the apparent size of accessible memory beyond its actual physical size. Virtual memory is implemented by employing a memory-management unit (MMU) to translate every logical address reference into a physical address reference as shown in fig 1. The MMU is imposed between the CPU and the physical memory where it performs these translations under the control of the operating system. Each memory reference is sued by the CPU is translated from the logical address space to the physical address space. Mapping tables guide the translation, again under the control of the operating system.



Virtual memory usually demand paging, which means that a Page is moved from disk into main memory only when the processor accesses a word on that page. Virtual memory pages always have a place on the disk once they are created, but are copied to main memory only on a miss or page fault.

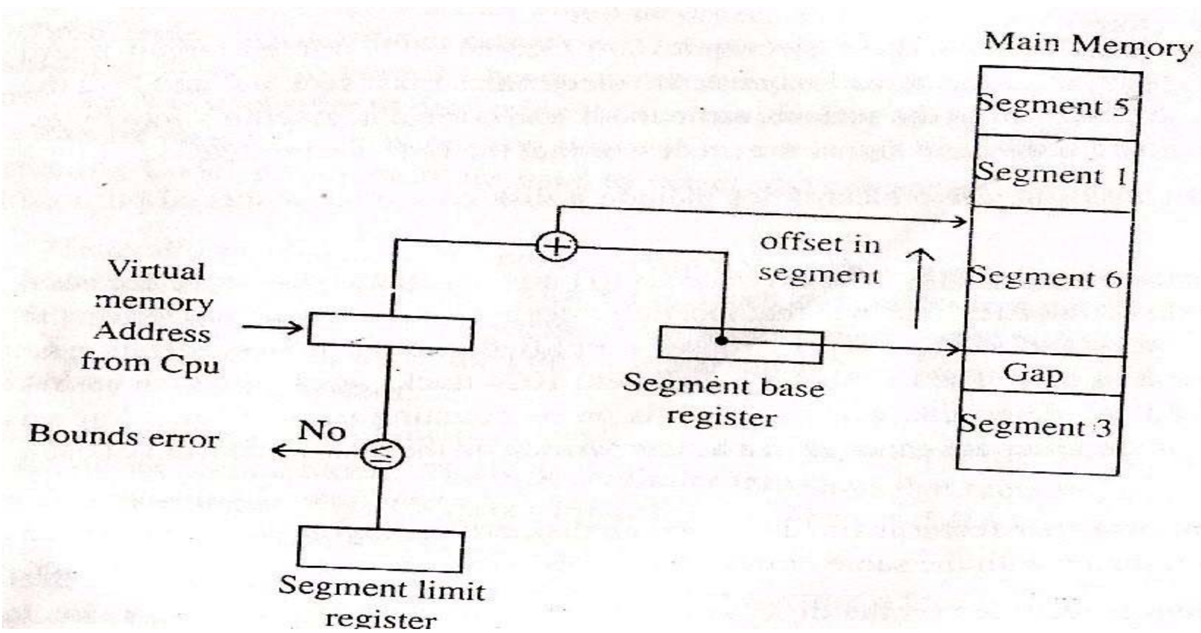
Advantages of Virtual memory:-

1. **Simplified addressing:-** Each program unit can be compiled into its own memory space, beginning at address O and extending far beyond the limits of physical memory. Programs and data structures do not require address relocation

at load time, nor must they be broken into fragments merely to accommodate memory limitations.

2. **Cost effective use of memory: -** Less expensive disk storage can replace more expensive RAM memory, since the entire program does not need to occupy physical memory at one time.
3. **Access control: -** Since each memory reference must be translated, it can be simultaneously checked for read, write and execute privileges. This allows hardward level control of access to system resources and also prevents and also prevents buggy programs or intruders from causing damage to the resources of other users or the system.

a) Memory management by segmentation:- Segmentation allows memory to be divided into segments of varying sizes depending upon requirements. Fig 2. Shows a main memory containing five segments identified by segment numbers. Each segment beings at a virtual address 0, regardless of where it is located in physical memory.



Each virtual address arriving from the CPU is added to the contents of the segment base register in the MMU to form the physical address. The virtual address may also optionally be compared to a segment limit register to trap reference beyond a specified limit.

b) Memory management by paging:- Fig 3 shows a simplified mechanism for virtual address translation in a paged MMU. The process begins in a manner similar to the segmentation process. The virtual address composed of a high order page number and a low order word number is applied to MMU. The virtual page number is limit checked to be certain that the page is within the page table, and if it is, it is added to the page table base to yield the page table entry. The page table entry contains several control fields in addition to the page field. The control fields may include access control bits, a presence bit, a dirty bit and one or more use bits, typically the access control field will include bits specifying read, write and perhaps execute permission. The presence bit indicates whether the page is currently in main memory. The use bit is set upon a read or write to the specified page, as an indication to the replaced algorithm in case a page must be replaced.

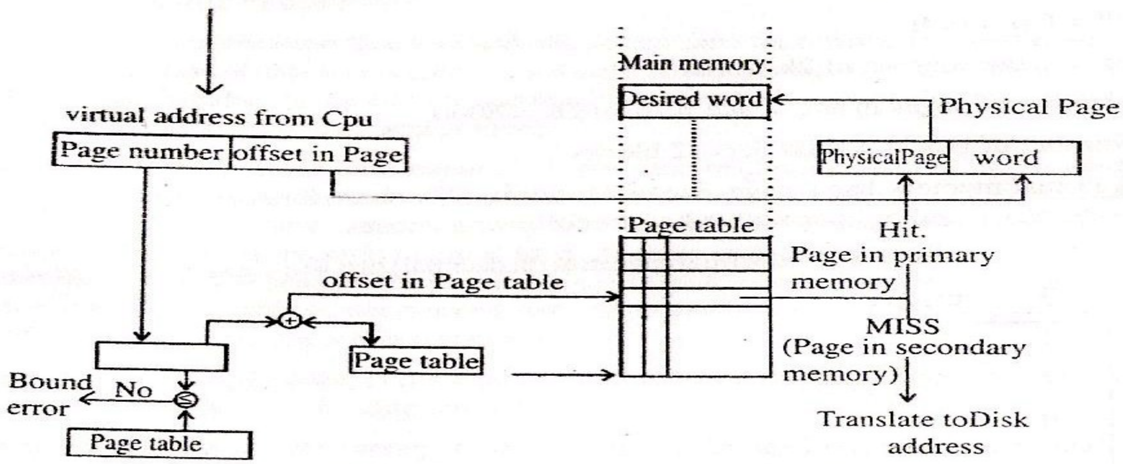


Fig. 12. Virtuel address translation in a paged MMU.

If the presence bit indicates a hit, then the page field of the page table entry will contain the physical page number. If the presence bit is a miss, which is page fault, then the page field of the page table entry which contains an address is secondary memory where the page is stored. This miss condition also generates an interrupt. The interrupt service routine will initiate the page fetch from secondary memory and with also suspended the requesting process until the page has been bought into main memory. If the CPU operation is a write hit, then the dirty bit is set. If the CPU operation is a write miss, then the MMU with begin a write allocate process.