



# Virtual Memory Management involves in different Technological Platforms

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**Abstract** -- There is no doubt in today's world that we are living in the modern age of computer technology. Today's computers are faster and more reliable but despite all the advancement in computer technology experts around the world are still trying to make the systems more efficient both in their performance and in use of their hardware and software resources. One of the techniques use to improve resources efficiency or handle the limited share of resources for a specific system is *virtual Memory*. The sole purpose of this technique is to efficiently utilize the resources in order to increase the overall performance of the system itself. This paper explains the history of the virtual memory and how this technique can be used in efficient resource allocation. There are lots of techniques through which virtual memory can be implemented, this paper performs a study of how virtual memory is being manage on different operating systems whether Personal OS or mobile OS or other physical devices such as flash devices etc. In Cloud Computing techniques like Virtual Swap Memory Mechanism and ESX are used, in windows Page replacement algorithms are used and in physical devices like flash memory the concept of dirty bit is used.

## Introduction

Virtual memory is based on simulation of storage space that provides the facility of programmers to get rid from rewriting the programs which have many instructions show in fig1[14]. The name "Virtual Memory" derived from optics means that call the image which is appear on the lenses or mirror, that image behave like it is present there but in actual it not there [12]. The story of virtual memory started in 1950s from the Atlas Computer at the University of Manchester and completed in 1961[13]. The story of virtual not only based on automatic storage allocation but also based on protection of information, sharing of objects and connecting the components of program [12].

## Why virtual memory

In 1940 the computer has two-level-storage system main memory was magnetic cores (RAM); the secondary memory was magnetic drums (Disk), the storage was also expensive and not easily found [13]. To find the ways of dividing program into small blocks and the movement of blocks is one the main job of the programs and they done it well but problem started with the algorithm of multiplication of matrix and this algorithm have three nested loops the program become more complicated when programmer cannot fit the all matrices in the main memory, at this time different programmers derived different solutions like 1) divide the program and 2) the size of the program increases by a factor of two or three. For other programs that will not fit into the main memory the programmer has same solutions, but day by day the possibilities of according this problem was increase, Then in 1950s the designer of first operating system provides the automating all this storage management for reduce the burden of programmers [12].

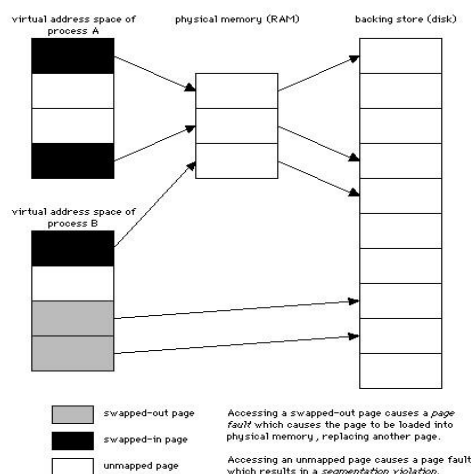


Figure.1.1 [14]

## Virtual memory in Cloud Computing

### Cloud Computing

The next thing discussed in the article is about cloud computing. Cloud computing are the services offered by different companies around the world. These companies have data centres all around the world and offer different types of application services to their users. These services are obviously offered through internet and some companies which offer these services are Amazon Web Services, Google Cloud, Alibaba Cloud, Oracle Cloud etc[1]. The main purpose behind implementing the cloud computing is that to transfer job processes and data storage resources from local machine to servers, remotely connected via user authentication protocol, to ensure authorize user access. Cloud computing framework is responsible to provide these services[2].

### Virtualization

Virtualization is the technique in computer science through which multiple OS can run on same hardware regardless of device physical configuration[3]. This technique is useful to implement different tasks associated to a specific OS[2].

### Virtual Memory

Virtual memory management is the OS ability to use hardware and software to compensate for physical resources shortage by transferring data from random access to disk storage[2].

### VM techniques used in Cloud Computing

Now cloud computing uses several techniques to perform memory utilization more efficiently. All these techniques use different set of principles to perform the given task. The one technique that uses virtual memory is focused in this paper.

#### A. Virtual Swap Memory Mechanism

One of the useful and effective method for efficient memory management is virtual swap memory mechanism (VSMM). As the name implies this technique designs a pattern through which memory pages can be swapped in or out of the memory of the system and can be stored in virtual memory for efficient use. This technique is very useful because there is not static allocation of the memory but the dynamic allocation at the run time when memory services are being used.

Swapping mechanism takes place when page fault occurs. Page fault is the event when there is no desired memory page on the main memory so swapping must happen between pages in order to get the desired memory page.

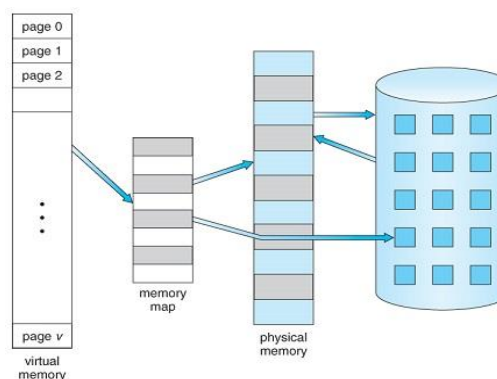


Figure 2.1 Swapping (Memory page swapping)[4]

#### B. ESX by VMware

VMware launched its technique for use of virtualization in x86 architecture. ESX memory utilization uses the idea that virtual machines can use more memory than it already presents on its physical machine host. This technique creates the possibility to use memory from the idle virtual machines to the virtual machines which need more virtual memory[2].



Figure 2.2 ESX by VMware.[5]

#### C. Transparent Page Sharing (TPS)

There is a possibility when multiple number of virtual machines are running, they might have same identical memory sets for different virtual machines. To rectify this problem the copies of the memory sets deleted, and only one-page copy is kept which can be marked as Copy-On-Write (COW). This

unique memory page can be shared between different virtual machines in order to avoid redundancy between memory pages and page sharing technique can help in achieving this.

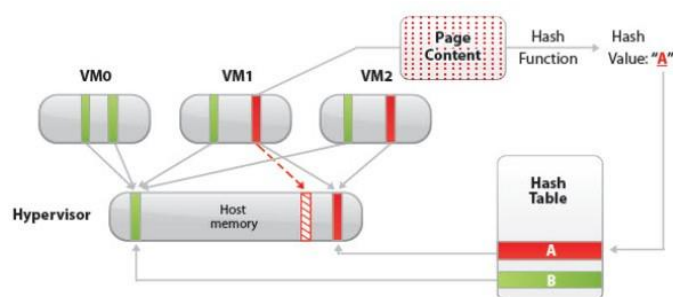


Figure 2.3 VMware-TPS[6]

#### D. Ballooning

The next technique is Ballooning. In this technique Balloon drivers are used these drivers interact with application programs to take account of their need of memory in order to make effective resource allocation for other application programs. All virtual machines are forced to demand page in order to take care of the need of host i.e. physical machine hosting all the virtual ones.[2]

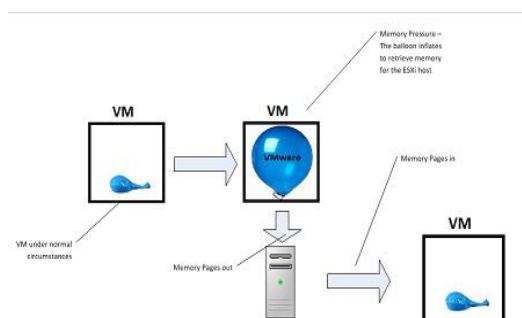


Figure 2.4 VMware-Ballooning [7]

### Virtual Memory on Window's Platform

Virtual memory management concept used in today's windows platform dates back to July 1993 when Microsoft launched their Windows NT operating system that has a support for virtual memory management. This operating system serves as

the base for the current running versions of windows operating system. Windows NT stands for (New Technology) and was launched to serve business needs of the consumer because they focussed on workstations pc and servers not personal pc.[8]

As of today, the Windows 10 version of the Microsoft is considered as the successor of the Windows NT. That's how the concept of virtual memory first used on windows platform. Comes towards the modern era virtual memory is a technique which can be implemented using both hardware and software. Exactly how virtual memory can be implemented? The basic concept is main memory of the system is faster than the secondary storage. When it comes to process execution different processes needs a contiguous block of memory size to execute. Now main memory is faster but that does not man its enough for processes to execute. So to serve this purpose some part of the secondary memory or drive acts as virtual memory with the concept of virtual address space[9]

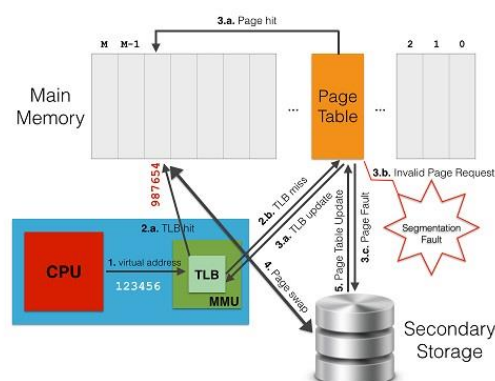


Figure 3.1 Virtual Memory in windows [9]

#### A. Page Service Response Time (PSRT)

One of the important benchmark which uses in this windows platform to evaluate how much cost effectiveness can be achieved through this virtual memory technique. When we swap pages between main memory and secondary storage for the execution of processes. Page Service Response time is the total time operating system takes to swap a desired page from secondary storage to main memory so that the process awaiting for that particular memory can be executed[4].

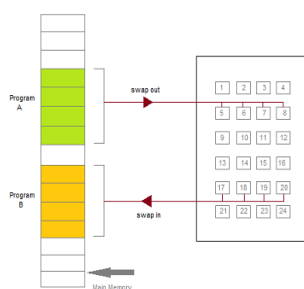


Figure 3.1 Page Replacement in windows[10].

## Virtual Memory implied on Flash Memory

So far discussed in this paper is about the secondary memory act as a virtual memory to overcome the shortage of the main memory. Now when comes to the portable devices like flash drive they came into popularity because of their portability, reliability, but at the same time flash memory impose some limitations because of their design how to deal with these kind of limitations to implement virtual memory[11].

### A. Sub Paging

Sub paging is the technique used for the implementation of virtual memory in flash memory. Because of the limited size of the flash memory the actual victim page which has to be swapped in or out first get divided into set of subpages. Moreover, each page gets associated with a dirty bit in case of page fault not all of the victim page gets swapped but only dirty subpages are written into flash memory. The concept of the dirty bit is that the subpage who has been modified recently has their dirty bit set so that the cache or operating system can use it for future purpose[11].

## Conclusion

This paper covers the involvement of virtual memory routine among different technologies such as operating systems, flash memory and cloud computing. Virtual Memory Management (VMM) is the alternative of low main memory and can compensate the low availability the RAM to execute all the ready processes.

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