Homework 1- CS6210 SPRING 2015

Arunprasanna Sundararajan Poorna
GTID: 903062365
Email: asp6@gatech.edu

1. Consider a processor that supports virtual memory. It has a virtually indexed physically tagged cache, TLB, and page table in memory. Explain what happens in such a processor from the time the CPU generates a virtual address to the point where the referenced memory contents are available to the processor.

The virtual address generated by the processor has a virtual page number and a page offset to indicate the index and offset of the physical memory. The virtual page number is translated into a physical page number by a Translation look-aside buffer, which is basically a fully associative lookup between virtual and physical page numbers. The physical page number is nothing but the tag associated with the physical memory. We now have unique indexing into the physical memory and the ability to look it up in a single cycle. TLB matching can be done in parallel with cache indexing!

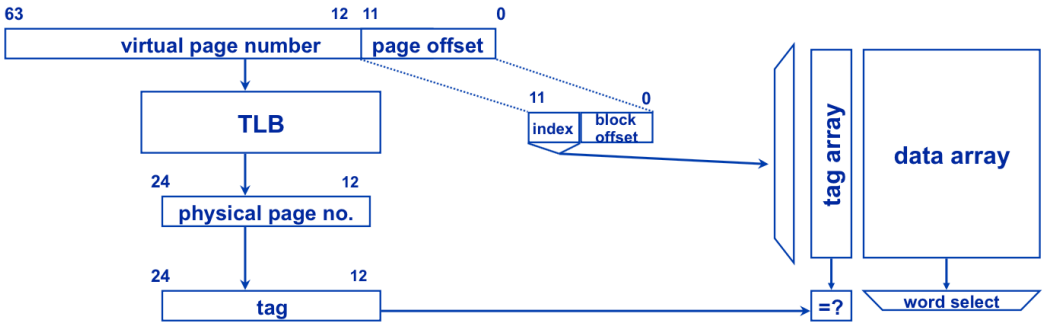

Image Source: Professor Tom Conte's lecture slides(ECE 6100).

2. Distinguish between segmentation and paging.

Paging	Segmentation
Breaking physical memory into equally sized blocks or 'pages'. Process execution happens once these pages are loaded into memory frames that are the same size.	Segmentation is division of primary memory into segments. References to segments are made through indexes for each segment and offset into the segment.
No special protection or compiling.	Separate protection mechanisms and compiling exists.
Programmer is oblivious to it.	Programmer needs to know his 'limits'.
Fragmentation of address space is internal.	Fragmentation is external, specified by the user.

The primary motive is to have more address space than available physical space.	Allows programs and data to be distinguished and thus protected or shared as required.

3. Explain all the actions from the time a process incurs a page fault to the time it resumes execution. Assume that this is the only runnable process in the entire system.

The valid bit for the particular page in the page table entry is reset to zero.
It triggers an exception which transfers control to a page fault handler in the OS.
The handler identifies the page and pages it into the disc if it has been modified.
The fault handler then pages the new page and updates the page table entry.
Control is returned to the original process, causing the failed instruction to restart.
The processor then continues execution, like a dumb animal.

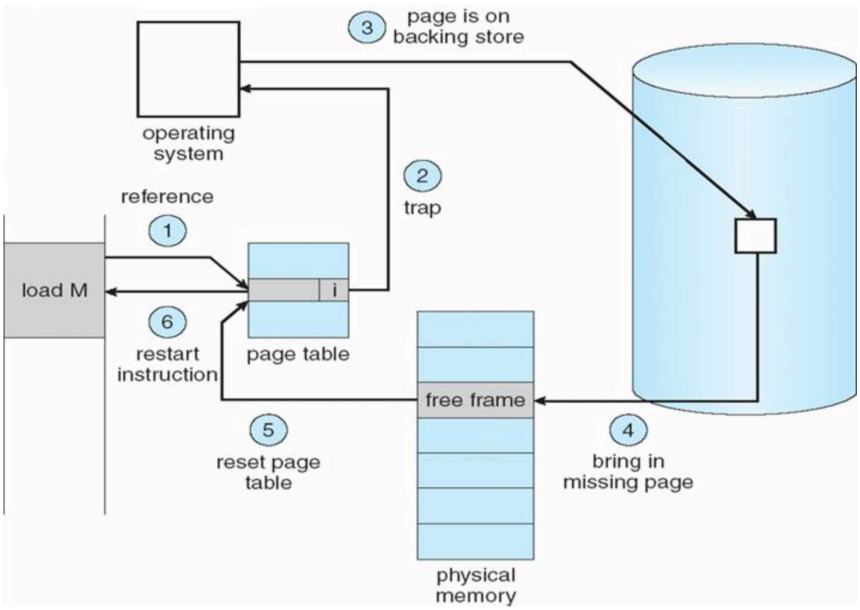

Image Source: Public repository: slidesharing.

4. Explain the following terms: working set of a process, thrashing, paging daemon, swapper, loader, and linker.

Working set of a processor refers to the memory that the current running program/algorithm is using or the memory that is accessed frequently.

When the working set is larger than the available memory, it results in thrashing due to constant page replacements. Thrashing is in other words, is constant paging due to a high page fault rate.

The paging daemon is a program that runs in the background without user interaction. Also called 'housekeeping' tasks. The paging daemon is proactive and

prepares for page eviction before the need arises. It wakes up when memory available becomes low. It cleans out dirty pages, maintains a list of eviction candidates and decides how much memory is to be allocated to file cache, Vm etc.

Swapper is responsible for moving a blocked process from main memory to disc (swap disc). This creates a queue of the suspended process and the OS may decide to admit the newly created process.

The loader loads programs from secondary memory to main memory so that it can be executed. It is called by the OS, when required.

The linker links and combines objects generated by a compiler into a program. The linker is also responsible for combination of several small modules of code into a coherent executable.

5. Explain page coloring and how it may be used in memory management by an operating system.

Page coloring is an optimization to better utilize the cache. The lesser eviction we have in the cache, the more performance we obtain. Page coloring involves caching the free pages that are contiguous from the processor's view. When physical memory is colored, different colors have different positions in the cache memory. Thus sequential pages in memory do not contend for the same cache lines. Page coloring makes virtual memory more deterministic and ideally, as deterministic as physical memory.

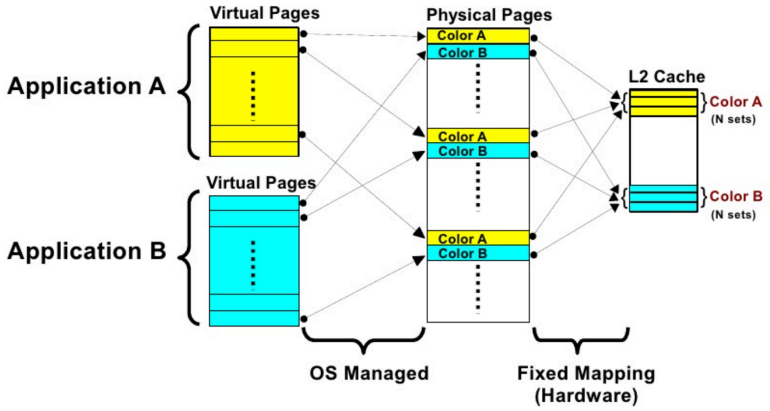

Image Source: Public repository: slidesharing.

6. Explain clearly the costs associated with a process context switch.

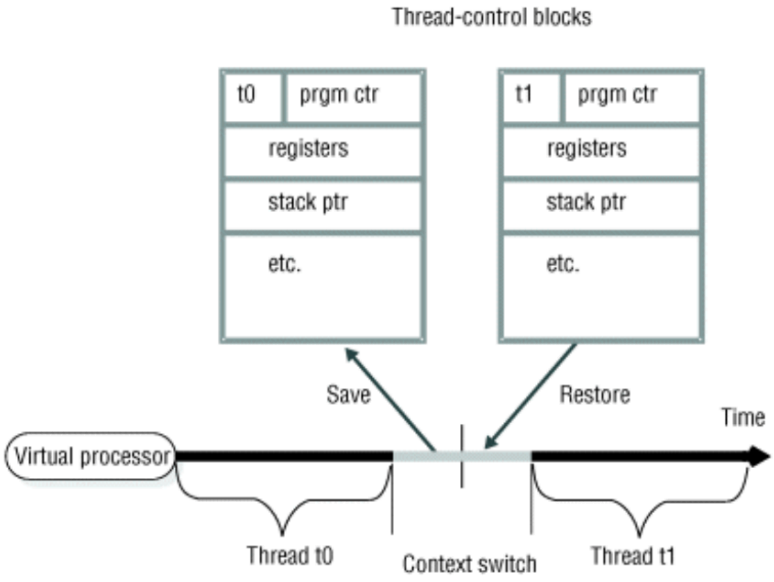

Image Source: ibm.com

Context switching is the process of storing and restoring state of a process to enable to continued execution at a later time. This is computationally expensive because:
1.Saving and loading back of registers (including the PC).
2.Saving and loading back of all the memory mappings.
3. Updating all tables.
4. Flush TLB if needed (loses all translations!).
5.Creationg of a process control block to save state of the process.

Besides, the context switch itself requires running the task scheduler, which takes up precious CPU cycles.

7. Explain the functionality of the different layers found in the network protocol stack of an operating system such as Linux.

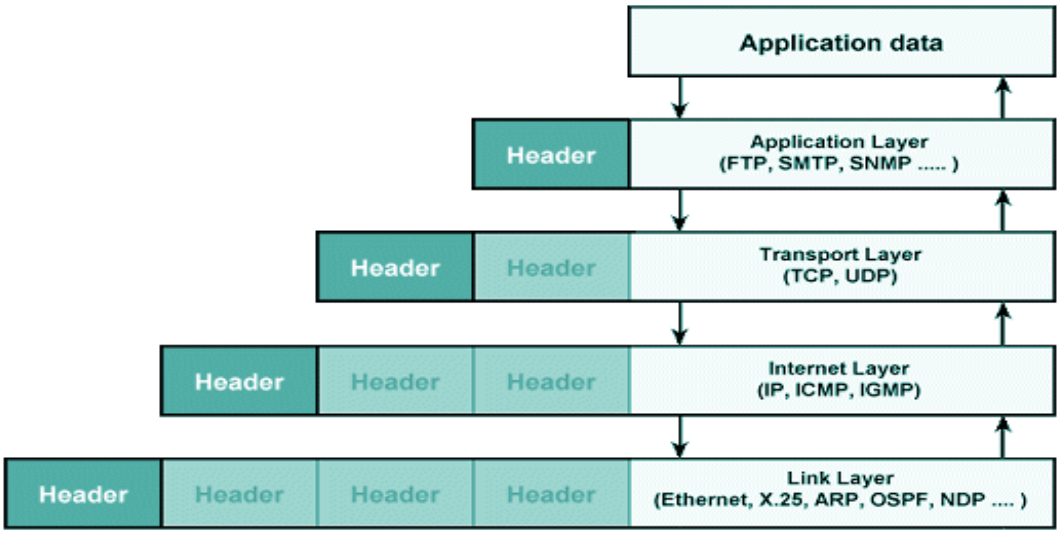

Image Source: technologyuk.net

I have discussed the TCP/IP protocol suite, since it is more relevant than the OSI model today. The different layers are:

1.Application- Responsible for appropriate formatting so that the data sent is understood by the recipient. For example use of HTTP or FTP.

2.Trasnport – Splits data into manageable chunks and adds sequence number information. It also adds appropriate port number information. Certain ports are commonly used for certain applications. Dominated by the TCP protocol(over UDP), due it's reliability and inbuilt congestion control mechanisms.

3.Network/Internet- The network layer attaches the IP address of the sender, so that the recipient will know who sent it and who to send a confirmation message to. It must also attach the IP address of the host that it is sending the data to so it doesn't get lost.

4.Link Layer- Finally the link layer attaches the MAC address of the sender and the recipient, allowing the packets to be directed to a specific network interface on the IP Address host machine.