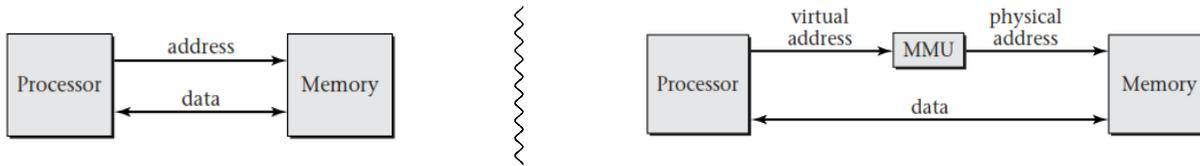


1. Notes are security and transactions:

- Often OS security exploits are due to concurrency race conditions in the OS, that only occur under rare situations. Why should appropriate parts of the operating system be implemented using atomic transactions?

2. In systems without virtual memory the processor sends *physical addresses* directly to memory. In systems with virtual memory the processor sends *virtual addresses* to a memory management unit (MMU) which translates them to *physical addresses*.

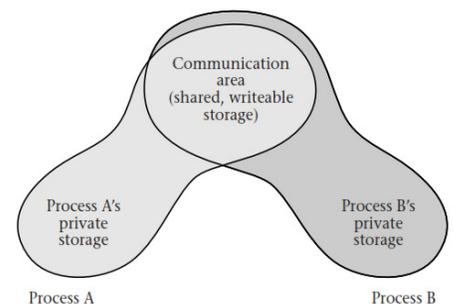
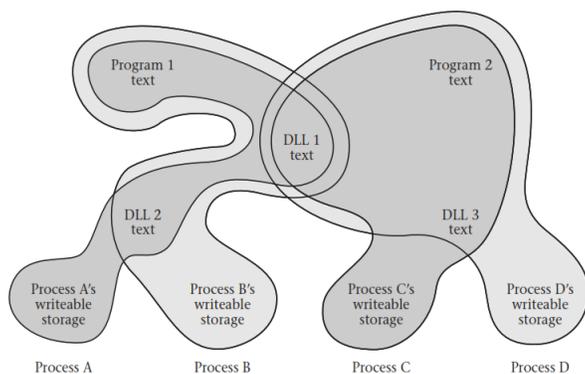


a) When you write programs, why have you not had to worry about the difference between physical vs. virtual addresses?

3. Uses for virtual memory:

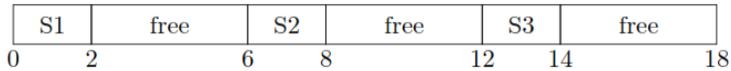
a) private storage - Why should independent computations (programs) running on the same computer have disjoint (separate) storage from each other?

b) controlled sharing - Why might the operating system want to allow processes limited sharing?



c) flexible memory allocation - processes might need varying amounts of memory. How can the OS manage memory to avoid external fragmentation?

d) sparse address spaces - if a process need gaps (free space) in its virtual address space to allow for growth (say for the right-side of data structures S1, S2, and S3).



Why would we not want to allocate physical storage for the free space?

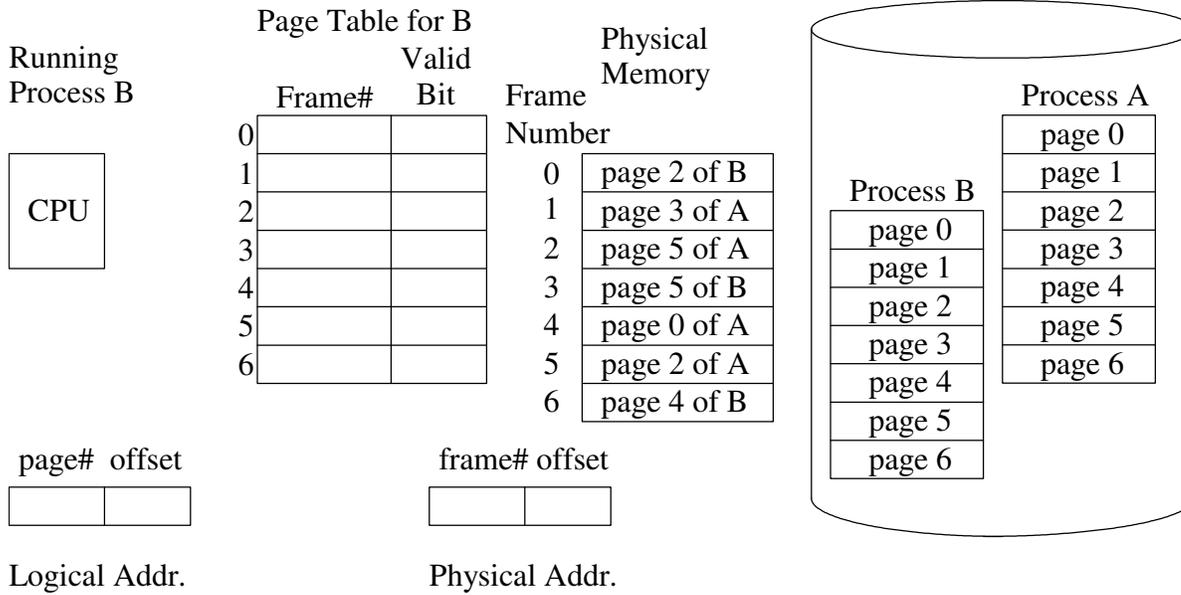
d) persistence - Why must the operating system provide some way for users to retain information even after the system is shutdown?

e) demand-driven program loading - If a program's whole virtual address space resides on disk, what advantage(s) does loading chunks of it into memory as needed?

f) efficient zero filling - Before allocating a new chunk of physical memory to a process, why would we want to fill its contents with all zeros?

g) substituting disk storage for RAM - What advantage(s) would substituting disk storage for RAM provide the OS?

4. Consider the demand paging system with 1024-byte pages.



a) Complete the above page table for **Process B**.

b) If process B is currently running and the CPU generates a logical/virtual address of 2060_{10} , then what would be the corresponding physical address?

5. How does a TLB (translation-lookaside buffer) speed the process of address translation?