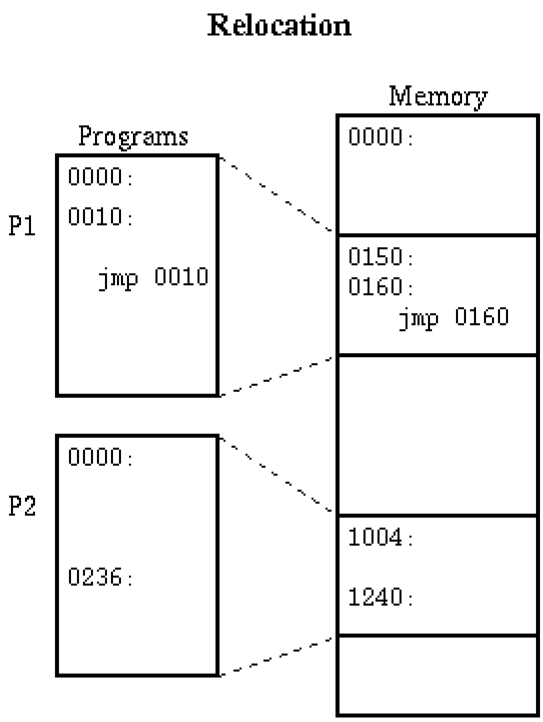
CS 537 Notes, Section #14: Sharing Main Memory

Issues:

- Want to let several processes coexist in main memory.
- No process should need to be aware of the fact that memory is shared. Each must run regardless of the number and/or locations of processes.
- Processes must not be able to corrupt each other.
- Efficiency (both of CPU and memory) should not be degraded badly by sharing. After all, the purpose of sharing is to increase overall efficiency.

Relocation: draw a simple picture of memory with some processes in it.

- Because several processes share memory, we cannot predict in advance where a process will be loaded in memory. This is similar to a compiler's inability to predict where a subroutine will be after linking.



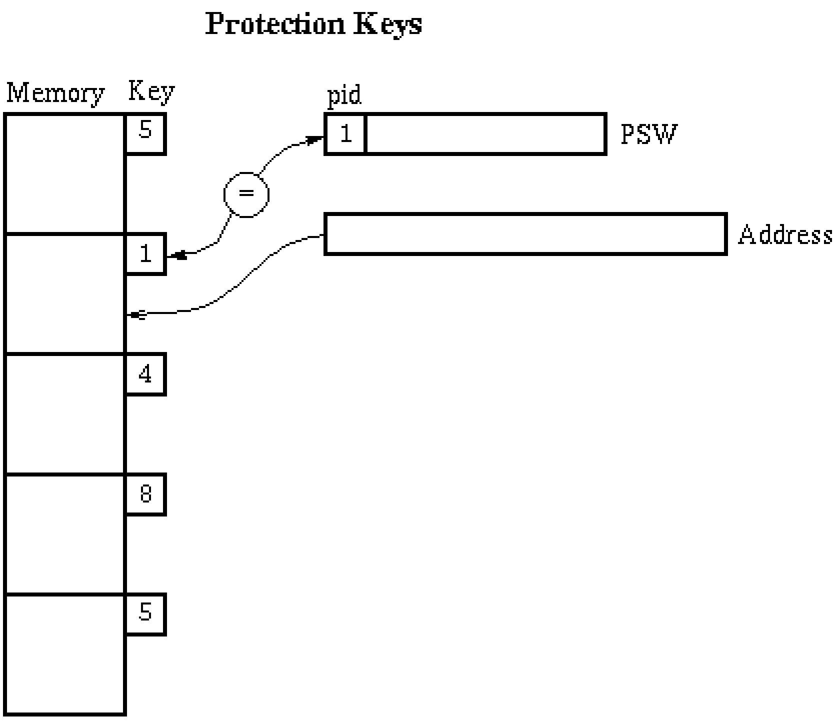
- Relocation adjusts a program to run in a different area of memory. Linker is an example of static relocation used to combine modules into programs. We now look at relocation techniques that allow several programs to share one main memory.

Static software relocation, no protection:

- Lowest memory holds OS.

- Processes are allocated memory above the OS.
- When a process is loaded, relocate it so that it can run in its allocated memory area (just like linker: linker combines several modules into one program, OS loader combines several processes to fit into one memory; only difference is that there are no cross-references between processes).
- Problem: any process can destroy any other process and/or the operating system.
- Examples: early batch monitors where only one job ran at a time and all it could do was wreck the OS, which would be rebooted by an operator. Many of today's personal computers also operate in a similar fashion.

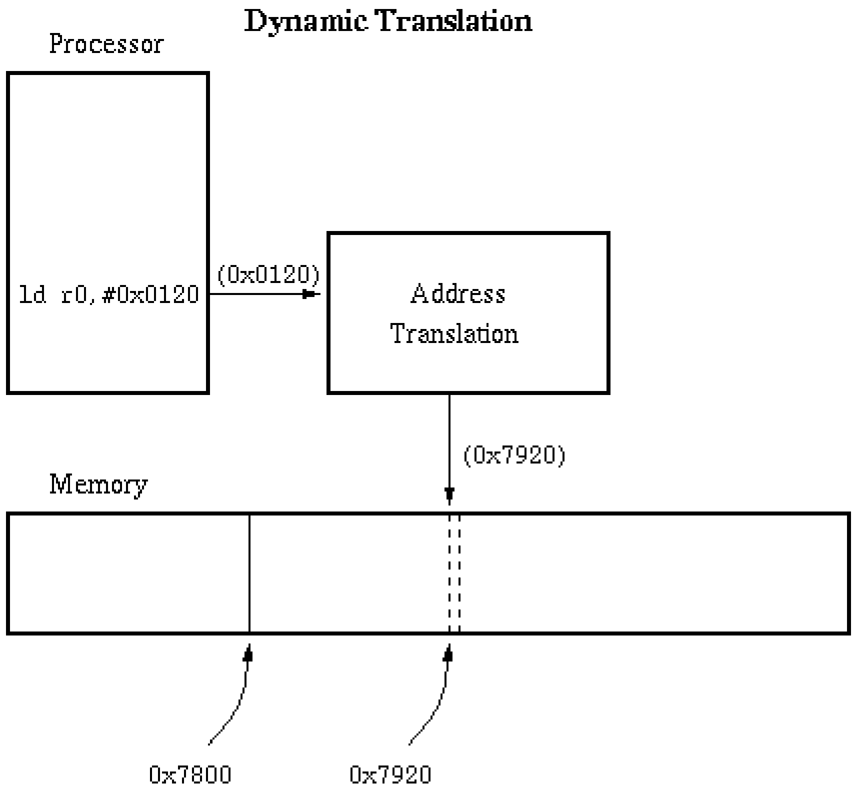
Static relocation with protection keys (IBM S/360 approach):



- Protection Key = a small integer stored with each chunk of memory. The chunks are likely to be 1k-4k bytes.
- Keep an extra hardware register to identify the current process. This is called the process id, or PID. 0 is reserved for the operating system's process id.
- On every memory reference, check the PID of the current process against the key of the memory chunk being accessed. PID 0 is allowed to touch anything, but any other mismatch results in an error trap.
- Additional control: who is allowed to set the PID? How does OS regain control once it has given it up?
- This is the scheme used for the IBM S/360 family. It is safe but inconvenient:
    - Programs have to be relocated before loading. In some systems (e.g. MPS) this requires complete relinking. Expensive.
    - Cannot share information between two processes very easily
    - Cannot swap a process out to secondary storage and bring it back to a different location

Dynamic memory relocation: instead of changing the addresses of a program before it is loaded, we change the address dynamically *during every reference*.

- Under dynamic relocation, each program-generated address (called a *logical* or *virtual* address) is translated in hardware to a *physical*, or *real* address. This happens as part of each memory reference.



- Show how dynamic relocation leads to two views of memory, called *address spaces*. With static relocation we force the views to coincide. That there can be several levels of mapping.
