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(Really Wirth’s Law: Software is decelerating faster than hardware is accelerating)

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Physical Memory

We first consider how processes (code and data) should be laid out in memory

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This is called *physical* memory layout to distinguish it from *virtual* memory, which comes later

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- Freeing while the process is running
- Freeing at process end

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- Allocation and freeing within the kernel. The kernel has to be dynamic otherwise it would be very difficult to get started, e.g., creating processor control blocks

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Dynamic allocation for both kernel and the processes was soon introduced in OSs, but computer languages took a while to catch up with the new facility

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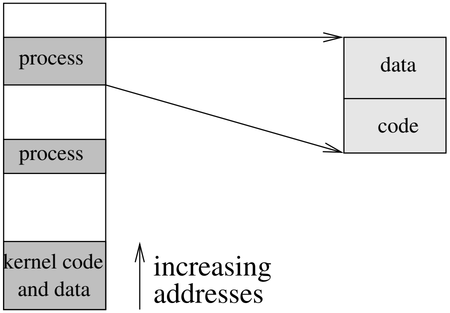
Physical Memory

Physical memory in an early computers looked something like this:



Memory Layout

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Physical Memory

Remember the kernel itself needs code and data space

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A gap above the kernel area allows for dynamic allocation of memory to itself

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Again, some early languages (FORTRAN, again) did not have a stack, and thus no recursion

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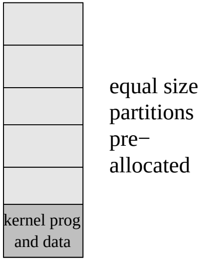

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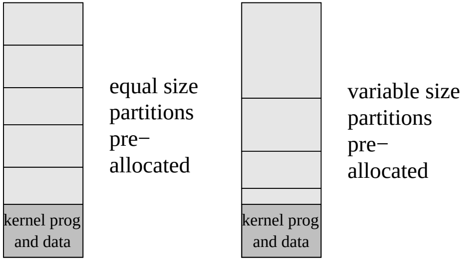
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equal size partitions pre–allocated
kernel prog and data
variable size partitions pre–allocated

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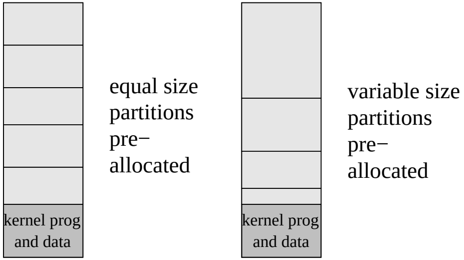
kernel prog and data
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A process is loaded into the smallest free partition it will fit into

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Variable size is not much harder to implement, but efficiency depends heavily on the choice of partition sizes as ideally they should match the expected process sizes

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IBM’s OS/360 (mid 1960s) had three partitions: one for spooling punched cards to disk; one for spooling disk to printers; and one to run jobs

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If that part of the process is needed again later, the programmer has to reload the code

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This trick of swapping memory back and forth to the disk gets a big boost later

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But when we come to virtual memory we shall see that exactly this *is* possible with modern hardware!

□