Address binding

- Can we load a program at any location in memory?
- This depends on how instructions and data are bound to actual memory address: Address Binding
  - Absolute addressing
  - Relative/relocatable addressing

Address binding (2)

- With relocatable addressing, we can place a program anywhere in memory.
- The instructions need to be “patched” for this relocation.

Linkers and Loaders

LEON PRESSER AND JOHN R. WHITE

*University of California,**
Santa Barbara, California 93106

This is a tutorial paper on the linking and loading stages of the language transformation process First, loaders are classified and discussed Next, the linking process is treated in terms of the various times at which it may occur (i e , binding to logical space). Finally, the linking and loading functions are explained in detail through a careful examination of their implementation in the IBM System/360 Examples are presented, and a number of possible system trade-offs are pointed out.

Key words and phrases binary loaders, relocating loaders, linking loaders, linkers, compilers, assemblers, relocation, program modularity, libraries

CR categories 4 11, 4.12, 4.39

1. INTRODUCTION

A computer system includes a set of software and hardware facilities which supervises its operation, insures its coordination, and facilitates its use. Such facilities are referred to as the computer's operating system. From a functional viewpoint it is justifiable to separate from the operating system

order to obtain flexibility and better utilization of main memory, translators are required to generate *relocatable* code, that is, code that can be loaded into any section of main memory for execution Furthermore, the capability to combine subprograms into a composite program, referred to as *linking*, is of great value in modern operating sys-

Compiler, Linker, Loader

- *Compiler*: translates source code into object files.

  cc -c main.c

- *Linker (linkage editor)*: “Combines and edits modules to produce a single module that can be brought into memory”

  ld -o main main.o -lc /path/to/compiler_rt.a

- *Loader*: Stores a program into main memory.
  - Binary vs. relocating loaders.
  - Linking at loading time: “linking loaders”

Different address schemes

- **Example** progression of used addressing schemes:
  - Source code: symbolic (identifiers)
  - Object file: relative address (relocatable)
  - Executable: absolute address

Binding stages

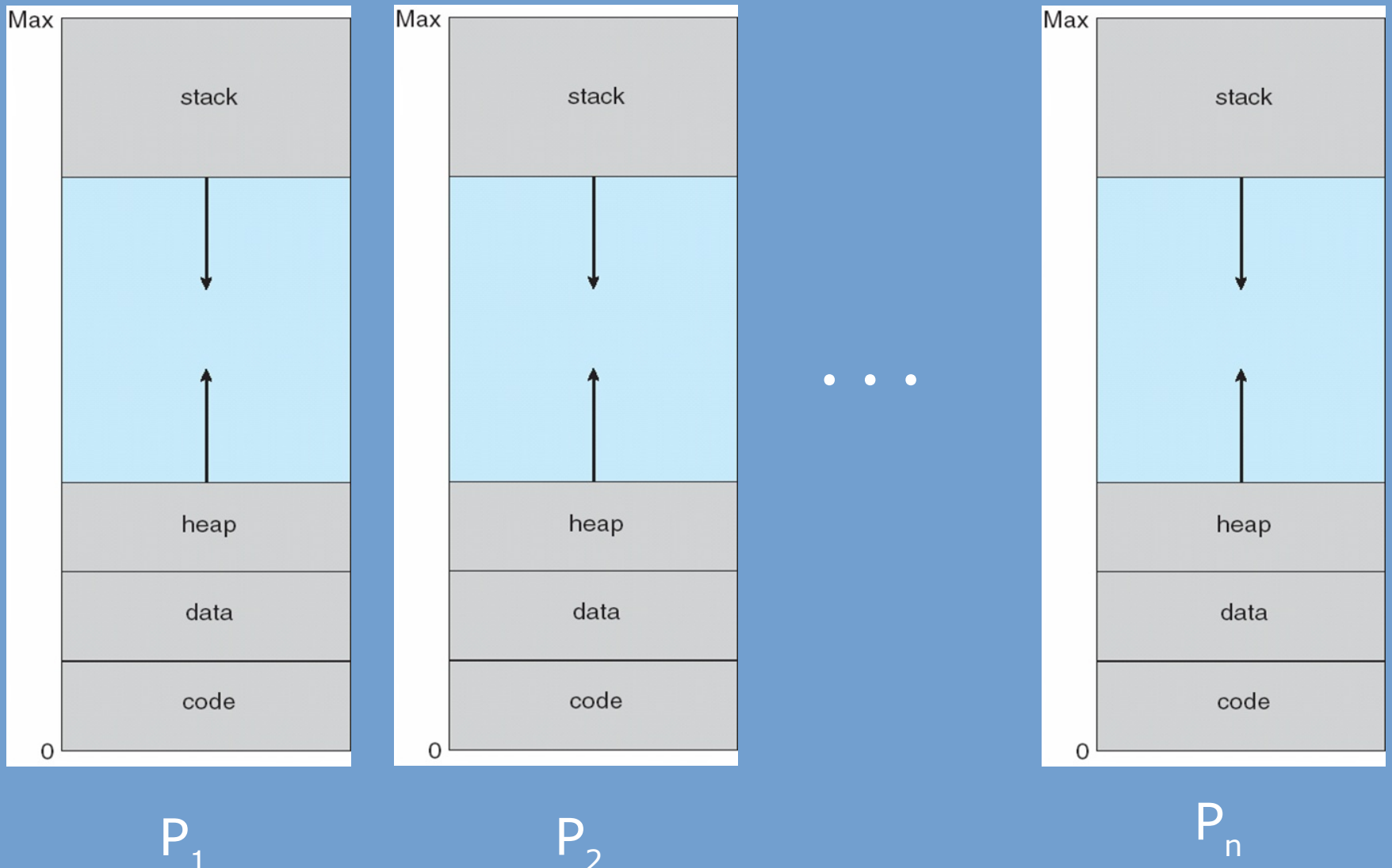
- Note that with compile-time and load-time binding a program **cannot** be relocated after it has been loaded and started.
- Execution-time binding allows bindings to be modified during the course of program execution. This is done with hardware support (MMU), the program itself is not changed again.

Chapter 9: Virtual Memory Management

Previously

- Synchronization
- Memory management techniques
  - Contiguous allocation
  - Segmentation
  - Paging
  - Address binding, hardware support

A virtual address space is created for each process:



P_1 P_2 P_n

Previously

- Synchronization
- Memory management techniques
  - Contiguous allocation
  - Segmentation
  - Paging
  - Address binding, hardware support

Hardware support

- When swapping in, try to load only these pages that will actually be used.
- When a page reference occurs, how do we know the frame is in memory?
- What happens if the frame appears not to be in memory?
  - We want to solve this without the user program knowing about this! Fully transparent to the user.

Allocating Kernel Memory

- Why handle this separately?
  - Kernel code typically allocates structures of varying sizes, want to avoid internal fragmentation.
  - Do generally not want to page out part of the kernel.
  - What if kernel needs to allocate a data structure and there is no free frame? Perform page replacement?
    - What if page replacement needs to allocate memory too?
  - Must be able to allocate contiguous physical memory regions (e.g., for page tables).
  - Must be able to map specific physical memory regions (belonging to devices) into the kernel address space.
- So, compared to user processes, kernels have additional requirements.