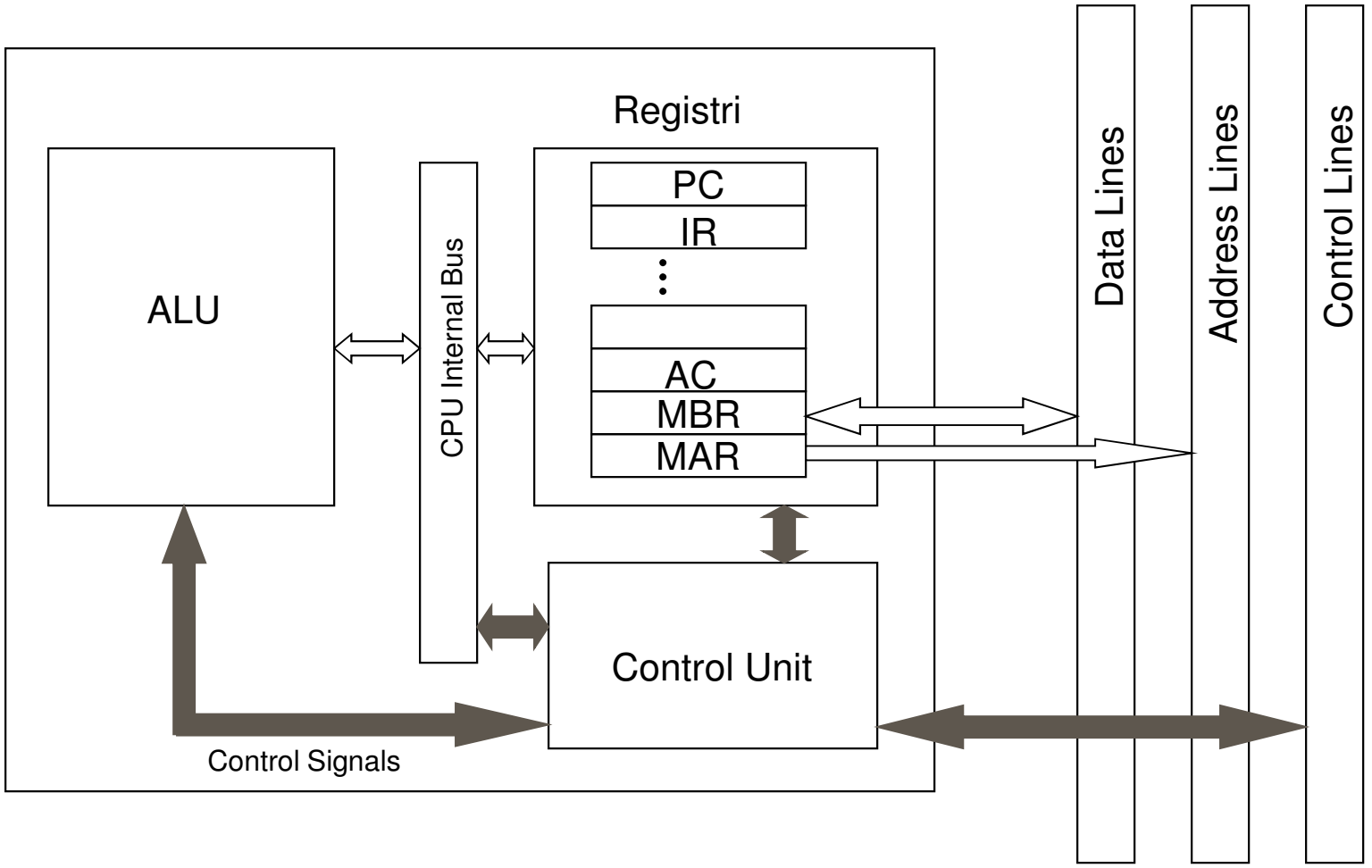
William Stallings
Computer Organization and Architecture

Chapter 12
CPU Structure and Function

CPU Functions

- CPU must:
  - Fetch instructions
  - Decode instructions
  - Fetch operands
  - Execute instructions / Process data
  - Store data
  - Check (and possibly serve) interrupts

CPU Components



Kind of Registers

- User visible and modifiable
  - General Purpose
  - Data (e.g. accumulator)
  - Address (e.g. base addressing, index addressing)
- Control registers (not visible to user)
  - Program Counter (PC)
  - Instruction Decoding Register (IR)
  - Memory Address Register (MAR)
  - Memory Buffer Register (MBR)
- State register (visible to user but not directly modifiable)
  - Program Status Word (PSW)

Kind of General Purpose Registers

- May be used in a general way or be restricted to contains only data or only addresses
- Advantages of general purpose registers
  - Increase flexibility and programmer options
  - Increase instruction size & complexity
- Advantages of specialized (data/address) registers
  - Smaller (faster) instructions
  - Less flexibility

How Many General Purposes Registers?

- Between 8 - 32
- Fewer = more memory references
- More does not reduce memory references and takes up processor real estate

How many bits per register?

- Large enough to hold full address value
- Large enough to hold full data value
- Often possible to combine two data registers to obtain a single register with a double length

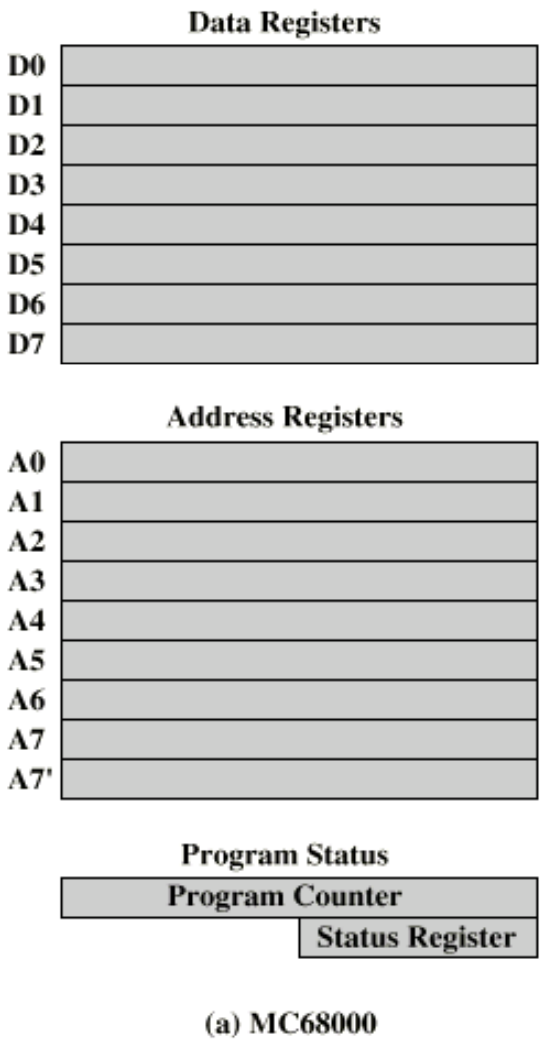
State Registers

- Sets of individual bits
  - e.g. store if result of last operation was zero or not
- Can be read (implicitly) by programs
  - e.g. Jump if zero
- Can not (usually) be set by programs
- There is always a Program Status Word (see later)
- Possibly (for operating system purposes):
  - Interrupt vectors
  - Memory page table (virtual memory)
  - Process control blocks (multitasking)

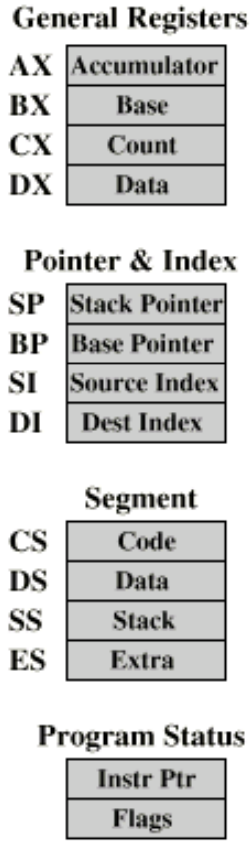
Program Status Word

- A set of bits, including condition code bits, giving the status of the program
  - Sign of last result
  - Zero
  - Carry
  - Equal
  - Overflow
  - Interrupt enable/disable
  - Supervisor mode (allow to execute privileged instructions)
    - Used by operating system (not available to user programs)

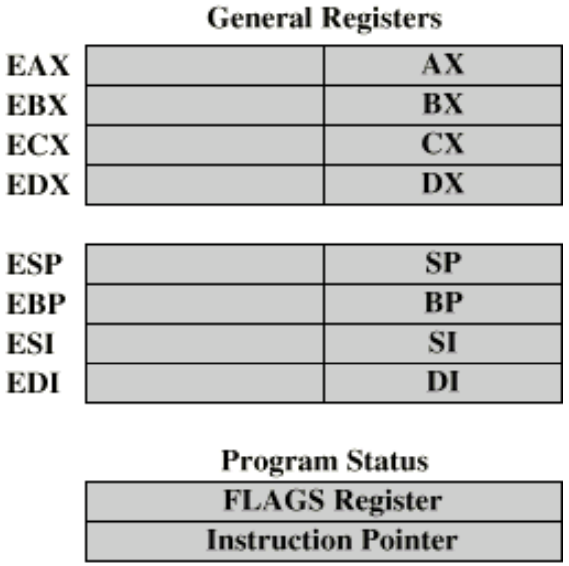
Example Register Organizations



(a) MC68000



(b) 8086



(c) 80386 - Pentium II