REGISTERS AND REGISTER FILES

Outline

- Registers
    - User Visible Register
    - Control and Status register
- Register Files

Introduction

- CPU must have some working space (temporary storage) called registers
- Number and function vary between processor designs
- Top level of memory hierarchy

- User visible register
  - Used by the Programmer
  - To minimize the memory reference by optimizing the use of registers.

- Control and Status register
  - Used by:
    - The control unit to control the operations of the processor
    - The OS to control execution of programs.

User Visible Registers

- General Purpose
- Data
- Address
- Condition Codes

General Purpose Registers (1)

- May be true general purpose
- May be restricted-(dedicated registers-floating point or stack)
- Data
  - Accumulator
- Addressing
  - Segment pointer, Index, stack pointer

General Purpose Registers (2)

- Make them general purpose
  - Increase flexibility and programmer options
- Make them specialized
  - Smaller (faster) instructions
  - Less flexibility

How Many GP Registers?

- Between 8 - 32
- Fewer = more memory references
- More-does not reduce memory references

How big to be the GP register?

- Large enough to hold full address
- Large enough to hold full word
- Often possible to combine two data registers

Condition Code Registers

- Bits set by hardware processor as a result of some operations.
- Sets of individual bits
  - e.g. result of last operation was zero
- Can be read (implicitly) by programs
  - e.g. Jump if zero –simplifies branch taking.

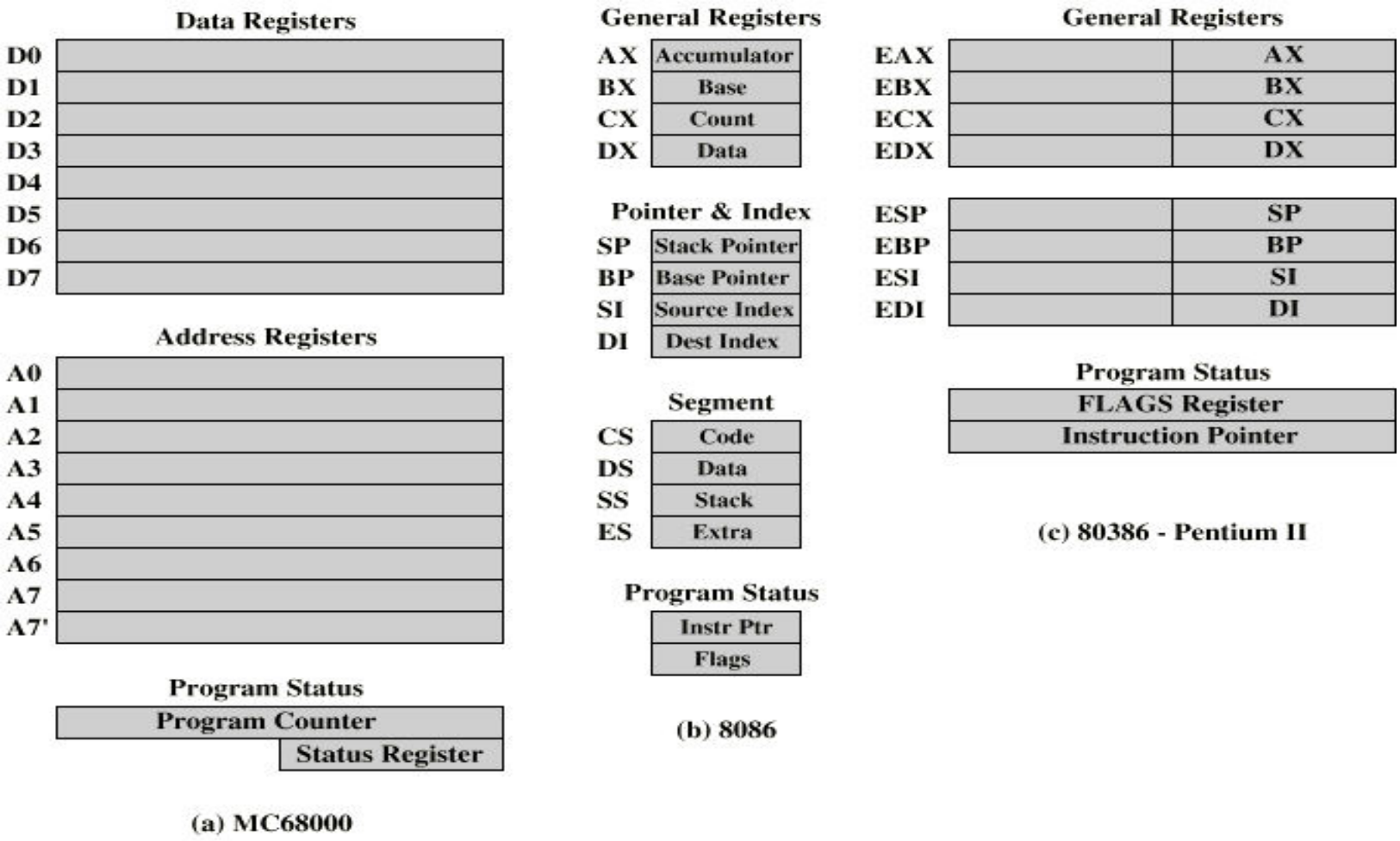
Control & Status Registers

- Not visible to the user
- May be visible in a control or operating system mode (supervisor mode)
- Registers essential to instruction execution:
  - Program Counter (PC)
  - Instruction Register (IR)-Contains the inst most recently fetched
  - Memory Address Register (MAR) – contains the addr of loc in mem
  - Memory Buffer Register (MBR) – contains a word of data to be written to mem or the word most recently read

Program Status Word(PSW)

- Registers or set of register is known as PSW
- Contains status information
- Includes Condition Codes
- Sign of last result
- Zero
- Carry
- Equal
- Overflow
- Interrupt enable/disable
- Supervisor

Example Register Organizations

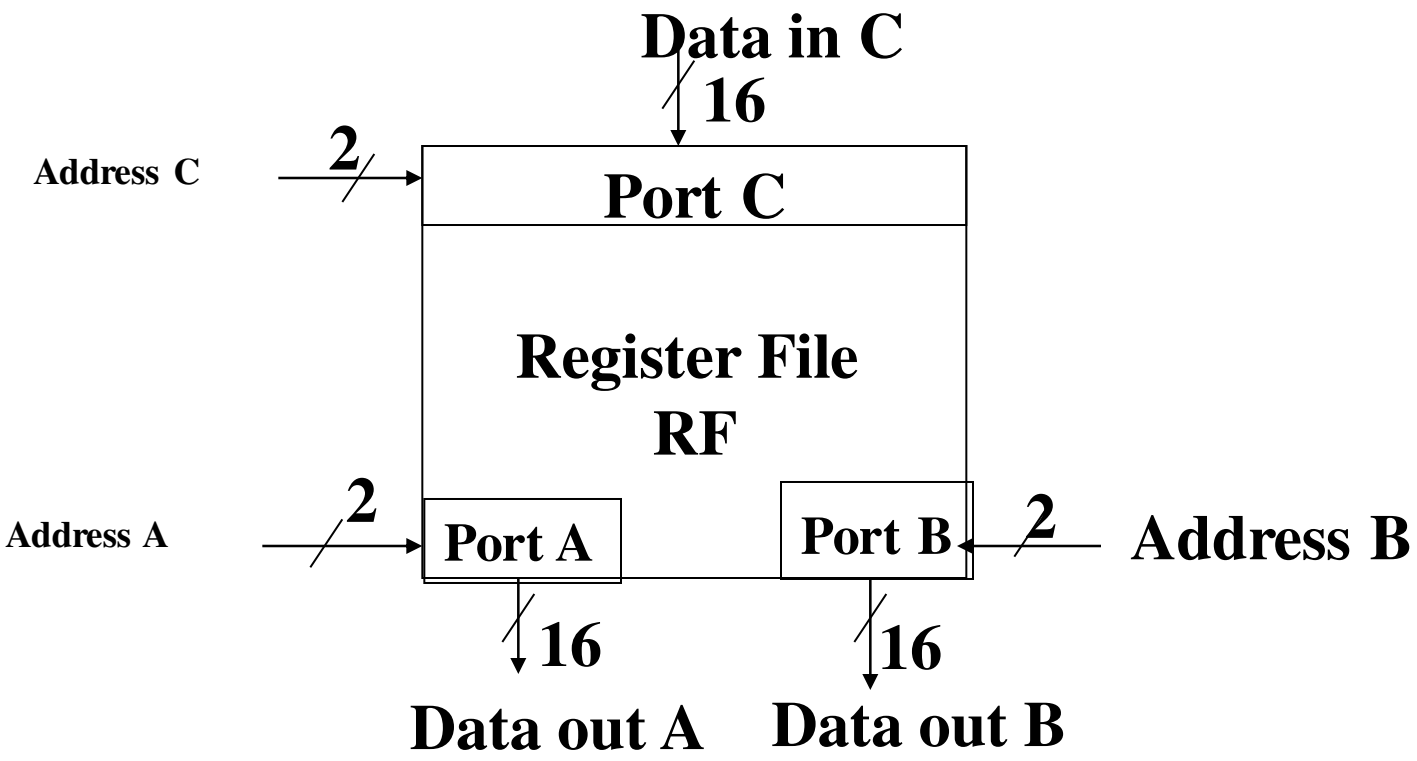


Understatement: There is no universally accepted philosophy for organizing the processor registers

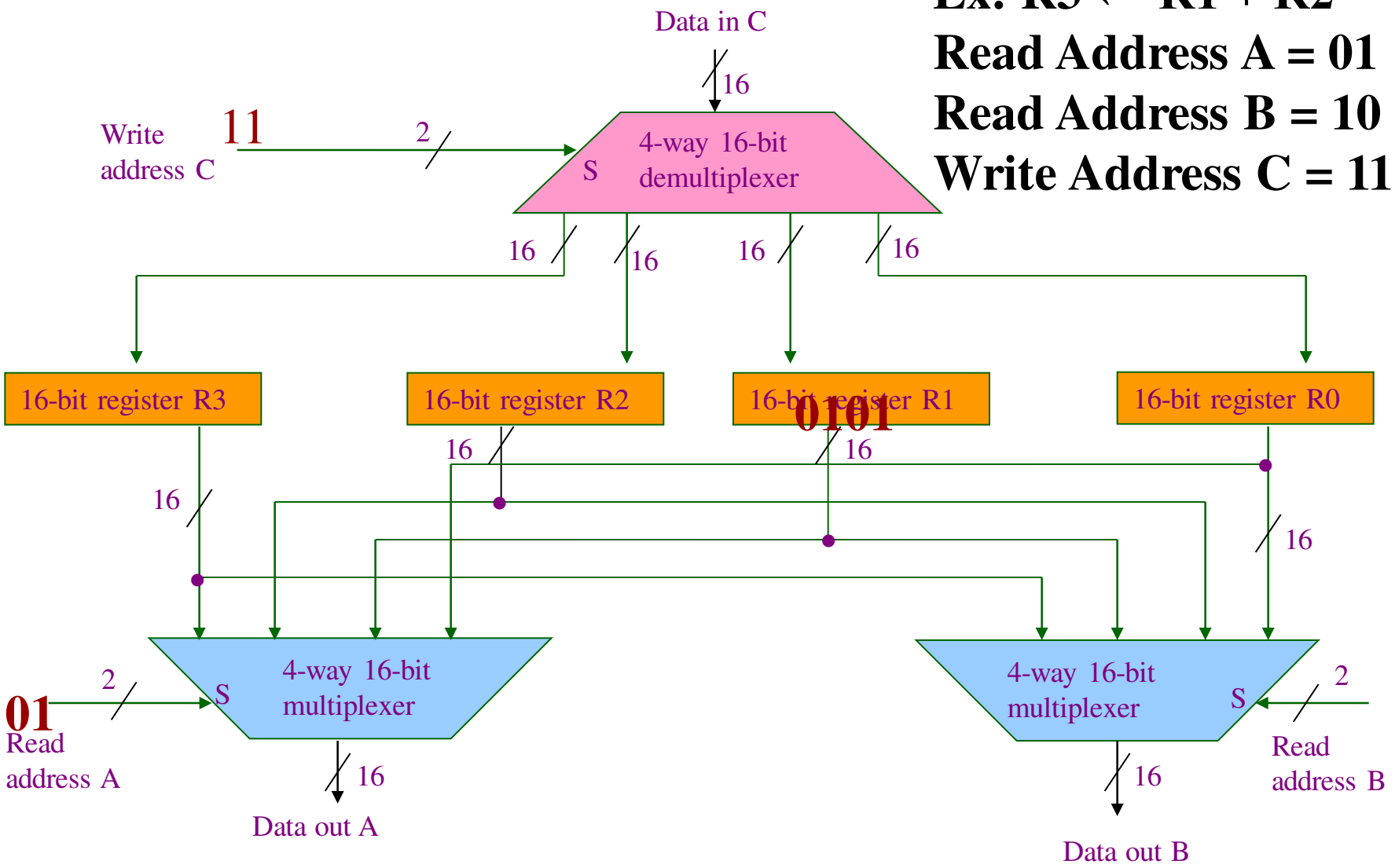
Register Files (RF)

- Set of general purpose registers.
- It functions as small RAM and implemented using fast RAM technology.
- RF needs several access ports for simultaneously reading from or writing to several different registers. Hence RF is realized as multiport RAM.
- A standard RAM has just one access port with an associated address bus and data bus.

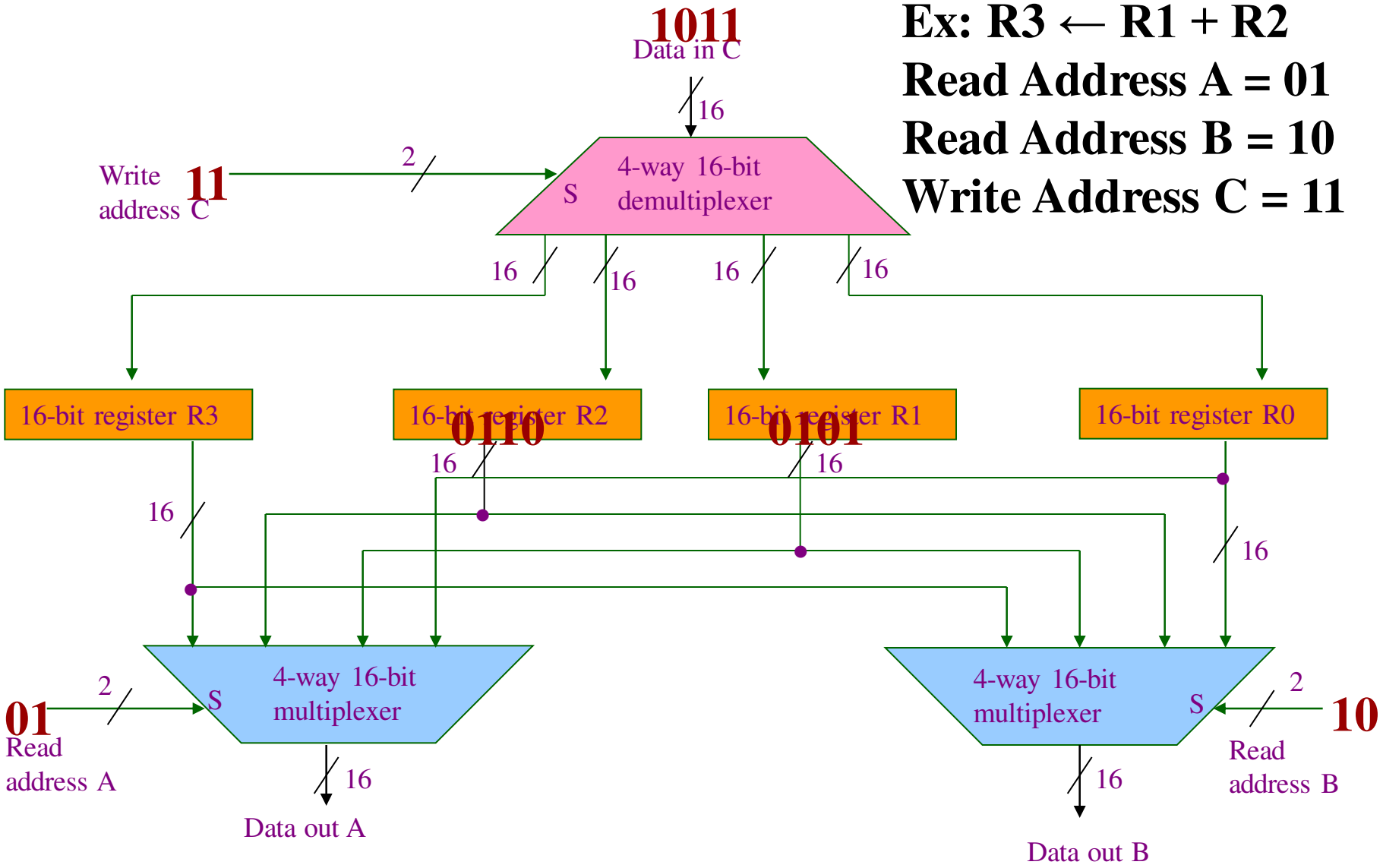
A register file with three access ports - symbol



A Register File with three access ports – logic diagram



A Register File with three access ports – logic diagram



Exercise 1:

If 8 registers are used

– How many bits are needed for read/write address?

– What is the size of the de-multiplexer and multiplexer required?

• If 4 multiplexers are used, how many parallel reads can be performed?

• Give an example with 4 parallel reads and 1 write.

• List all types of registers for the processor MC6800 and explain them briefly.

– Ref: Vincent .P. Heuring, Harry F. Jordan " Computer System design and Architecture" Pearson, 2nd Edition, 2003.

Exercise 2: Draw your design of a register file:

- Three registers, each is 2-bits wide
- Two source buses, one destination bus

- How many & what size:
  - Muxes did you use?
  - Demuxes did you use?

References

- W. Stallings, Computer organization and architecture, Prentice-Hall,2000
- J. P. Hayes, Computer system architecture, McGraw Hill