Microprocessors (0630371)

Fall 2010/2011 – Lecture Notes # 9

Memory Models, Instruction Operand Notation and Data Transfer Instructions

Outline of the Lecture

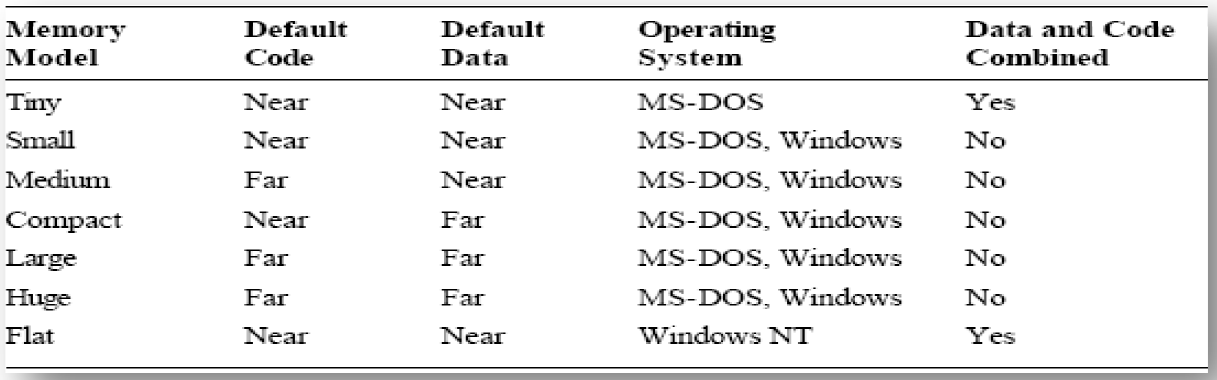
- **Memory Models.**
- **Instruction Operand Notation.**
- **Data Transfer Instructions.**

Memory Models

Memory Models that can be used in assembly language are the following:

1. **TINY MODEL (.MODEL TINY):**
   - The model uses maximum of 64K bytes for Code and Data.
2. **SMALL MODEL (.MODEL SMALL):**
   - The model uses maximum of 64K bytes for Code and 64K bytes for Data (Code<=64K and Data <=64K).
   - This model is the most widely used memory model and is sufficient for all the programs to be used in this course.
3. **MEDIUM MODEL, (.MODEL MEDIUM):**
   - The model uses maximum of 64K bytes for Data and Code can exceed 64K bytes (Code>64K and Data <=64K).
4. **COMPACT MODEL, (.MODEL COMPACT):**
   - The model uses maximum of 64K bytes for Code and Data can exceed 64K bytes (Code<=64K and Data >64K).
5. **LARGE MODEL, (.MODEL LARGE):**
   - Both Code and Data can exceed 64K bytes. However no single data set (i.e. array) can exceed 64K bytes (Code>64K and Data >64K).
6. **HUGE MODEL, (.MODEL HUGE):**
   - Both Code and Data can exceed 64K bytes. Additionally, a single data set (i.e. array) can exceed 64K bytes (Code>64K and Data >64K).
7. **FLAT MODEL, (.MODEL FLAT)**
   - Window NT Application

Attributes of Memory Models



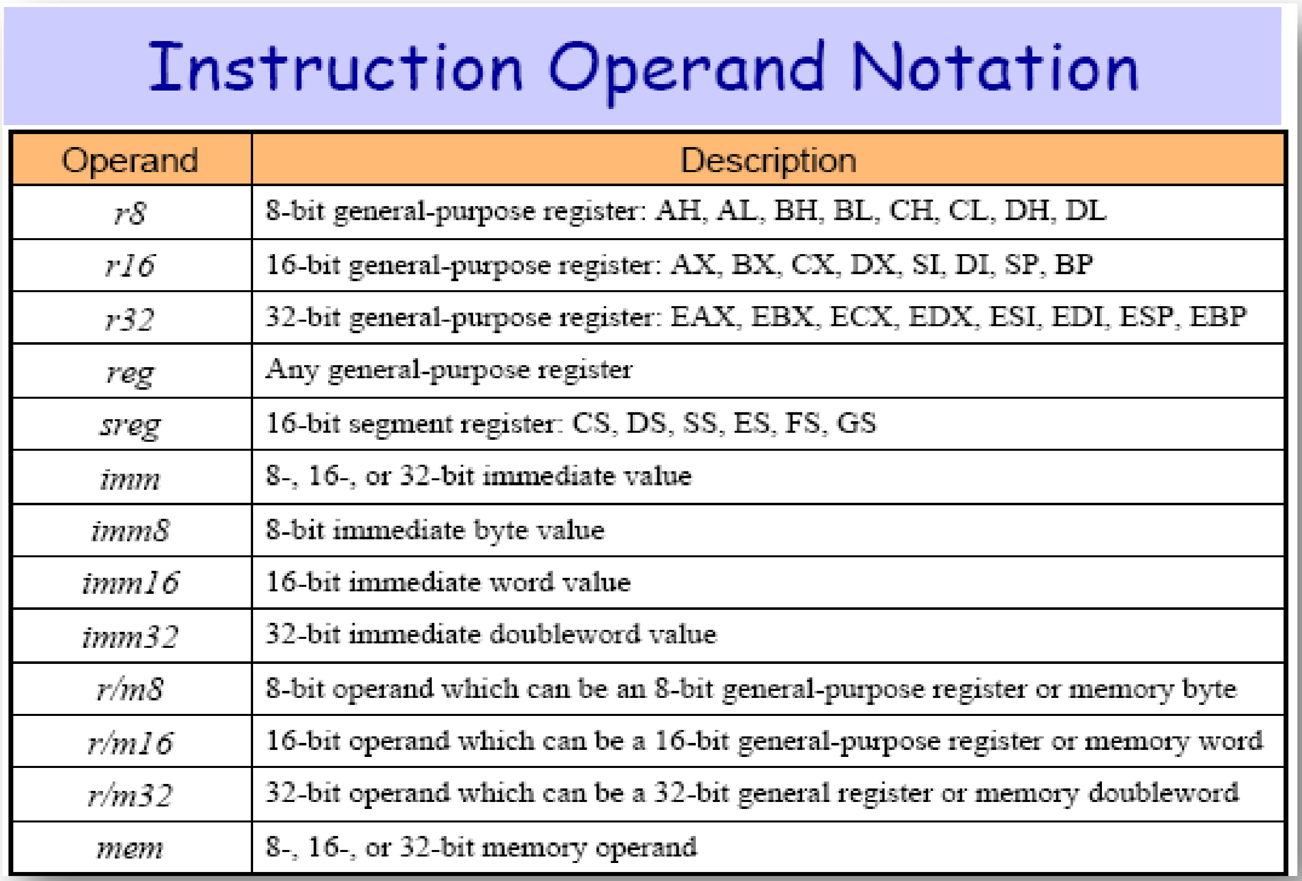
Memory Model	Default Code	Default Data	Operating System	Data and Code Combined
Tiny	Near	Near	MS-DOS	Yes
Small	Near	Near	MS-DOS, Windows	No
Medium	Far	Near	MS-DOS, Windows	No
Compact	Near	Far	MS-DOS, Windows	No
Large	Far	Far	MS-DOS, Windows	No
Huge	Far	Far	MS-DOS, Windows	No
Flat	Near	Near	Windows NT	Yes

Example

```
TITLE Add and Subtract (addsub.asm)
; This program adds and subtracts integers
.686
.MODEL flat, stdcall
.STACK
INCLUDE Irvine32.inc
.code
main PROC
    mov eax, 60000h ; EAX = 60000h
    add eax, 80000h ; EAX = EAX + 80000h
    sub eax, 20000h ; EAX = EAX - 20000h
    exit
main ENDP
END main
```

- The **.MODEL** is a directive that specifies the memory configuration for the assembly language program. For our purposes, the FLAT memory model will be used.
- The **.686** is a processor directive used before the .MODEL FLAT directive to provide access to the 32-bit instructions and registers available in the Pentium Processor.
- The **STDCALL** directive tells the assembler to use standard conventions for names and procedure calls.

Instruction Operand Notation



Instruction Operand Notation

Operand	Description
r8	8-bit general-purpose register: AH, AL, BH, BL, CH, CL, DH, DL
r16	16-bit general-purpose register: AX, BX, CX, DX, SI, DI, SP, BP
r32	32-bit general-purpose register: EAX, EBX, ECX, EDX, ESI, EDI, ESP, EBP
reg	Any general-purpose register
sreg	16-bit segment register: CS, DS, SS, ES, FS, GS
imm	8-, 16-, or 32-bit immediate value
imm8	8-bit immediate byte value
imm16	16-bit immediate word value
imm32	32-bit immediate doubleword value
r/m8	8-bit operand which can be an 8-bit general-purpose register or memory byte
r/m16	16-bit operand which can be a 16-bit general-purpose register or memory word
r/m32	32-bit operand which can be a 32-bit general register or memory doubleword
mem	8-, 16-, or 32-bit memory operand

Data Transfer Instructions

MOV Instruction

- Move source operand to destination, the syntax is

```
mov destination, source
```

- Source and destination operands can vary

```
mov reg, reg
mov mem, reg
mov reg, mem
mov mem, imm
mov reg, imm
mov r/m16, sreg
mov sreg, r/m16
```

Rules

- Both operands must be of same size
- No memory to memory moves
- No immediate to segment moves
- No segment to segment moves
- Destination cannot be CS

MOV Examples

```
.DATA
count BYTE 100
bVal BYTE 20
wVal WORD 2
dVal DWORD 5
.CODE
mov bl, count ; bl = count = 100
mov ax, wVal ; ax = wVal = 2
mov count,al ; count = al = 2
mov eax, dval ; eax = dval = 5
```

; Assembler will not accept the following moves – why?

```
mov ds, 45 ; immediate move to DS not permitted
mov esi, wVal; size mismatch
mov eip, dVal; EIP cannot be the destination
mov 25, bVal; immediate value cannot be
               ; destination
mov bVal,count; memory-to-memory move not
               ; permitted
```