Microprocessors (0630371)

Fall 2010/2011 – Lecture Notes # 8

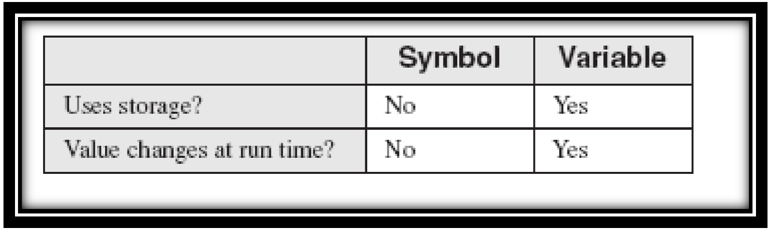
Symbolic Constants and Real-Address Mode Programming

Outline of the Lecture

- **Symbolic Constants**
    - **Equal-Sign Directive**
    - **Calculating the Sizes of Arrays and Strings.**
    - **EQU Directive**
    - **TEXTEQU Directive**
- **Real-Address Mode Programming**

Symbolic Constants

- A symbolic constant (or symbol definition) is created by associating an identifier (a symbol) with an integer expression or some text.
- Symbols cannot change at run time.
- Unlike a variable definition, a symbolic constant does no use any storage.



	Symbol	Variable
Uses storage?	No	Yes
Value changes at run time?	No	Yes

Equal-Sign Directive

```
name = expression
```

- **name** is called a symbolic constant
- **expression** is a 32-bit integer (expression or constant)
- Good programming style to use symbols.
    - **Example 1 (Keyboard Definitions)**

```
Esc_key = 27
mov al, Esc_key  ;good style
```

Rather than

```
mov al,27 ; poor style
```

- **Example 2 (Using the DUP Operator)**

The counter used by DUP should be a symbolic constant

```
Count = 5
array DWORD COUNT DUP(0)
```

- May be **redefined**.

A symbol defined with _ can be redefined within the same program.

```
COUNT = 5
mov al,COUNT ; AL = 5
COUNT = 10
mov al,COUNT ; AL = 10
COUNT = 100
mov al,COUNT ; AL = 100
```

Calculating the Size of a Byte Array.

- Uses a constant named **ListSize** to declare the size of list:

```
list BYTE 10,20,30,40
ListSize = 4
```

- A better way to handle this situation would be to let the assembler automatically calculate **ListSize**
- The **$** operator (**current location counter**) returns the offset associated with the current program statement

```
list BYTE 10,20,30,40
ListSize = ($ - list)
```

- **ListSize** must follow immediately after **list**.

```
list BYTE 10,20,30,40
var2 BYTE 20 DUP(?)
ListSize = ($ - list)    ;incorrect
```

Calculating the Size of a Word Array

- **current location counter: $**
    - subtract address of list
    - difference is the number of bytes
    - divide by 2 (the size of a word)

```
list WORD 1000h,2000h,3000h,4000h
ListSize = ($ - list) / 2
```

Calculating the Size of a Doubleword Array

- **current location counter: $**
    - subtract address of list
    - difference is the number of bytes
    - divide by 4 (the size of a doubleword)

```
list DWORD 1,2,3,4
ListSize = ($ - list) / 4
```

Calculating the Size of a string

- Rather than calculating the length of a string manually, let the assembler do it:

```
myString BYTE "This is a long string, containing"
         BYTE "any number of characters"
myString_len = ($ −.myString)
```

EQU Directive

- The EQU directive associates a symbolic name with an integer expression or some arbitrary text.
- There are three formats:

```
name EQU expression
name EQU symbol
name EQU <text>
```

- **expression** must be a valid integer expression
- **symbol** is an existing symbol name, already defined with = or EQU.
- **text** is any text may appear within the brackets <. . .>

- EQU can be useful when defining a value that does not evaluate to an integer:

```
PI EQU <3.1416>
```

- associate a symbol with a character string

```
pressKey EQU <"Press any key to continue...",0>
.data
prompt BYTE pressKey
```

- associate a symbol with an expression

```
matrix1 EQU 10 * 10
matrix2 EQU <10 * 10>
.data
M1 WORD matrix1
M2 WORD matrix2
```

- Cannot be redefined

TEXTEQU Directive

- Define a symbol as either an integer or text expression Called a **text macro**
- There are three different formats

```
name TEXTEQU <text>
name TEXTEQU textmacro
name TEXTEQU %constExpr
```

- **Example 1**

```
continueMsg TEXTEQU <"Do you wish to continue (Y/N)?">
.data
prompt1 BYTE continueMsg
```

- **Example 2**

```
continueMsg TEXTEQU <"Do you wish to continue (Y/N)?">
rowSize = 5
.data
prompt1 BYTE continueMsg
count TEXTEQU %(rowSize * 2)  ;
move TEXTEQU <mov>
setupAL TEXTEQU <move al,count>
.code
setupAL        ; generates: "mov al,10"
```

- **TEXTEQU** Can be **redefined**.

The following program illustrates the definition of symbolic constants:

```
TITLE Symbolic Constants (File: Constants.asm)
; Demonstration of EQU and = directives
.686
.MODEL flat, stdcall
.STACK
INCLUDE Irvine32.inc
.data
Rows EQU 3
Cols EQU 3
Elements EQU Rows * Cols
CR EQU 10
LF EQU 13
PromptText   EQU   <"Press   any   key   to   continue
...",CR,LF,0>
matrix WORD Elements DUP(0)
prompt BYTE PromptText
COUNT = 10h
COUNT = 100h
COUNT = 1000h
COUNT = SIZEOF matrix
.code
main PROC
exit
main ENDP
END main
```

Real-Address Mode Programming

Generate 16-bit MS-DOS Programs

- Advantages
  - enables calling of MS-DOS and BIOS functions
  - no memory access restrictions
- Disadvantages
  - must be aware of both segments and offsets
  - cannot call Win32 functions (Windows 95 onward)
  - limited to 640K program memory
- Requirements
  - INCLUDE Irvine16.inc
  - Two additional instructions are inserted at the beginning of the startup procedure (main) Initialize DS to the data segment using predefined MASM constant **@data**::

```
mov ax,@data
mov ds,ax
```

Add and Subtract, 16-Bit Version

```
TITLE Add and Subtract, Version 2      (AddSub2.asm)
INCLUDE Irvine16.inc
.data
val1 DWORD 10000h
val2 DWORD 40000h
val3 DWORD 20000h
finalVal DWORD ?
.code
main PROC
mov ax,@data   ; initialize DS
mov ds,ax
mov eax,val1   ; get first value
add eax,val2   ; add second value
sub eax,val3   ; subtract third value
mov finalVal,eax    ; store the result
call DumpRegs  ; display registers
exit
main ENDP
END main
```

Programming Exercise 1

The following exercise can be done in protected mode or real-address mode.

Subtracting Three Integers

Using the **AddSub.asm** program as a reference, write a program that subtracts three integers using only 16-bit registers. Insert a call **DumpRegs** statement to display the register values.