High-Level Language Interface

Chapter 13

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High-Level Language Interface

- Why program in mixed-mode?
  - Focus on C and assembly
- Overview of compiling mixed-mode programs
- Calling assembly procedures from C
  - Parameter passing
  - Returning values
  - Preserving registers
  - Publics and externals
  - Examples
- Calling C functions from assembly
- Simplified calling mechanisms
  - The ARG directive
  - Avoiding explicit specification of underscores
  - Extended CALL instruction
- Inline assembly code

Why Program in Mixed-Mode?

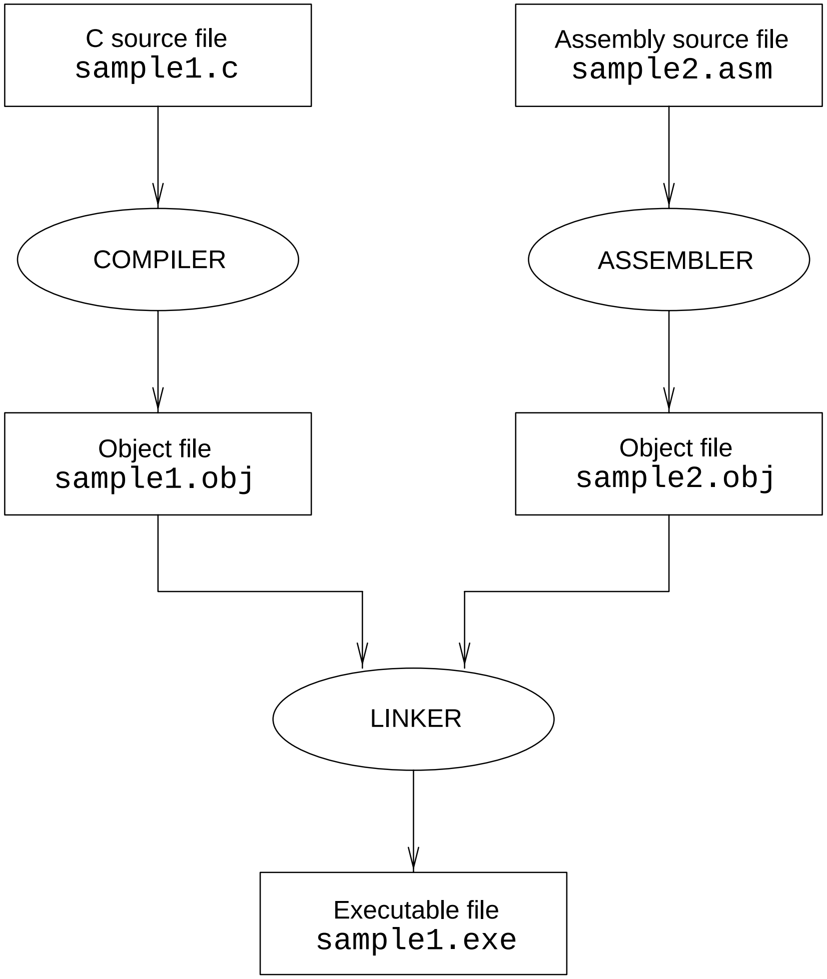
- Pros and cons of assembly language programming
    - ∗ Advantages:
        - » Access to hardware
        - » Time-efficiency
        - » Space-efficiency
    - ∗ Problems:
        - » Low productivity
        - » High maintenance cost
        - » Lack of portability
- As a result, some programs are written in mixed-modem (e.g., system software)

Compiling Mixed-Mode Programs

- We use C and assembly mixed-mode programming
- Our emphasis is on the principles
- Can be generalized to any type of mixed-mode programming

- To compile

```
bcc sample1.c sample.asm
```



Calling Assembly Procedures from C

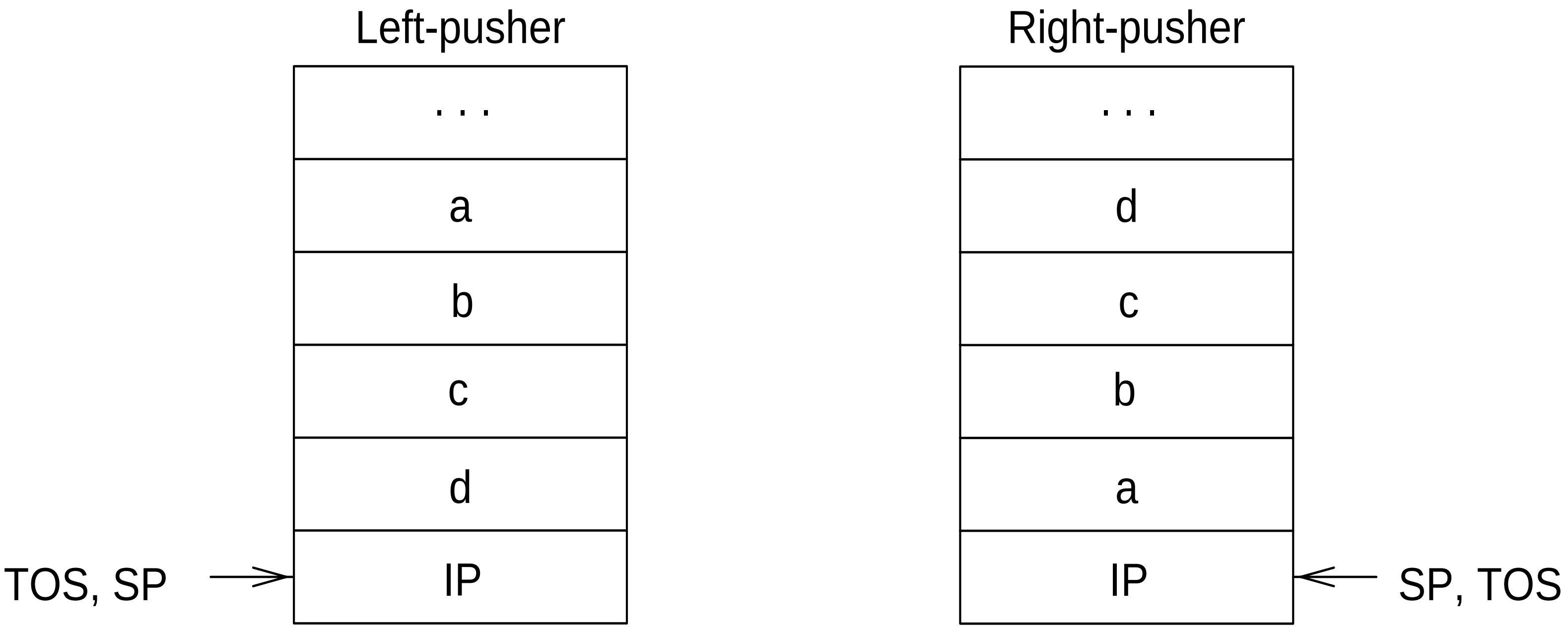
Parameter Passing

- Stack is used for parameter passing
- Two ways of pushing arguments onto the stack
    - ∗ Left-to-right
        - » Most languages including Basic, Fortran, Pascal use this method
        - » These languages are called *left-pusher* languages
    - ∗ Right-to-left
        - » C uses this method
        - » These languages are called *right-pusher* languages

Calling Assembly Procedures from C (cont’d)

Example:

`sum(a,b,c,d)`



Left-pusher

. . .

a

b

c

d

IP

TOS, SP

Right-pusher

. . .

d

c

b

a

IP

SP, TOS

Calling Assembly Procedures from C (cont'd)

Returning Values

- Registers are used to return values

Return value type	Register used
char, short, int (signed/unsigned)	AX
long (signed/unsigned)	DX:AX
near pointer far pointer	AX DX:AX

Calling Assembly Procedures from C (cont'd)

Preserving Registers

- The following registers must be preserved

  BP, SP, CS, DS, SS

- In addition, if register variables are enabled,

  SI and DI

  should also be preserved.

- Since we never know whether register variables are enabled or not, it is a good practice to preserve

  BP, SP, CS, DS, SS, SI and DI

Calling Assembly Procedures from C (cont'd)

Publics and External

- Mixed-mode programming involves at least two program modules
  - » One C module and one assembly module
- We have to declare those functions and procedures that are not defined in the same module as external
  - » **`extern`** in c
  - » **`extrn`** in assembly
- Those procedures that are accessed by another modules as public

Calling Assembly Procedures from C (cont'd)

Underscores

- In C, all external labels start with an underscore
  - » C and C++ compilers automatically append the required underscore on all external functions and variables
- You must make sure that all assembly references to C functions and variables begin with underscores
- Also, you should begin all assembly functions and variables that are made public and referenced by C code with underscores

Calling C Functions from Assembly

- Stack is used to pass parameters (as in our previous discussion)
- Similar mechanism is used to pass parameters and to return values
- Since C makes the calling procedure responsible for clearing the stack of the parameters, make sure to clear the parameters after the **`call`** instruction as in

```
        add     SP,4
```

on line 45 in the example program

Simplified Calling Mechanisms

The ARG Directive

- By using ARG directive, we can let the assembler calculate the offset values of the parameters on the stack
- Arguments in ARG directive are listed in the same order as in the C call
  - ∗ All arguments should be listed in a single line
  - ∗ If necessary, use ‘\’ to extend the ARG line beyond 80 characters
  - ∗ If type is not specified, TASM assumes WORD for 16-bit models, DWORD for 32-bit models

Simplified Calling Mechanisms (cont'd)

Avoiding explicit specification of underscores

- We can let the assembler prefix the required underscore on all external functions and variables
- We need to let the assembler know that we are using C language
  - » We do this by using

    `PUBLIC C`

    instead of **`PUBLIC`** (see line 10 in the example program)
- We can use a similar method for **`EXTRN`** as well (i.e., **`EXTRN C`**)
  - » see line 8 in the example program

Simplified Calling Mechanisms (cont'd)

Extended CALL Instruction

- This instruction relieves us from pushing the arguments onto the stack before a procedure call
  - » Assembler will insert the necessary push instructions
- The syntax is

```
CALL  destination [language[,arg1]…]
```

`language` is C, CPP, Pascal, Fortran, etc.

- Extended CALL does three things:
  - » Pushes the arguments in the correct order (right or left pushing based on the language specified)
  - » Prefixes an underscore if required (as in C)
  - » Clears the stack of the arguments if needed (as in C)

Inline Assembly Code

- Assembly language statements are embedded into the C code
  - » Separate assembly module is not necessary
- Assembly statements are identified by placing the keyword **`asm`**

```
asm  xor  AX,AX;  mov  AL,DH
```

- We can use braces to compound several assembly statements

```
asm  {
       xor  AX,AX
       mov  AL,DH
     }
```

Inline Assembly Code (cont'd)

Example

Get date interrupt service

- ∗ Uses interrupt 21H service
- ∗ Details:

    Input:

        AH = 2AH

    Returns:

        AL = day of the week (0=Sun, 1=Mon,…)
        CX = year (1980 - 2099)
        DH = month (1=Jan, 2=Feb, …)
        DL = day of the month (1-31)

Inline Assembly Code (cont'd)

Compiling inline Assembly Programs

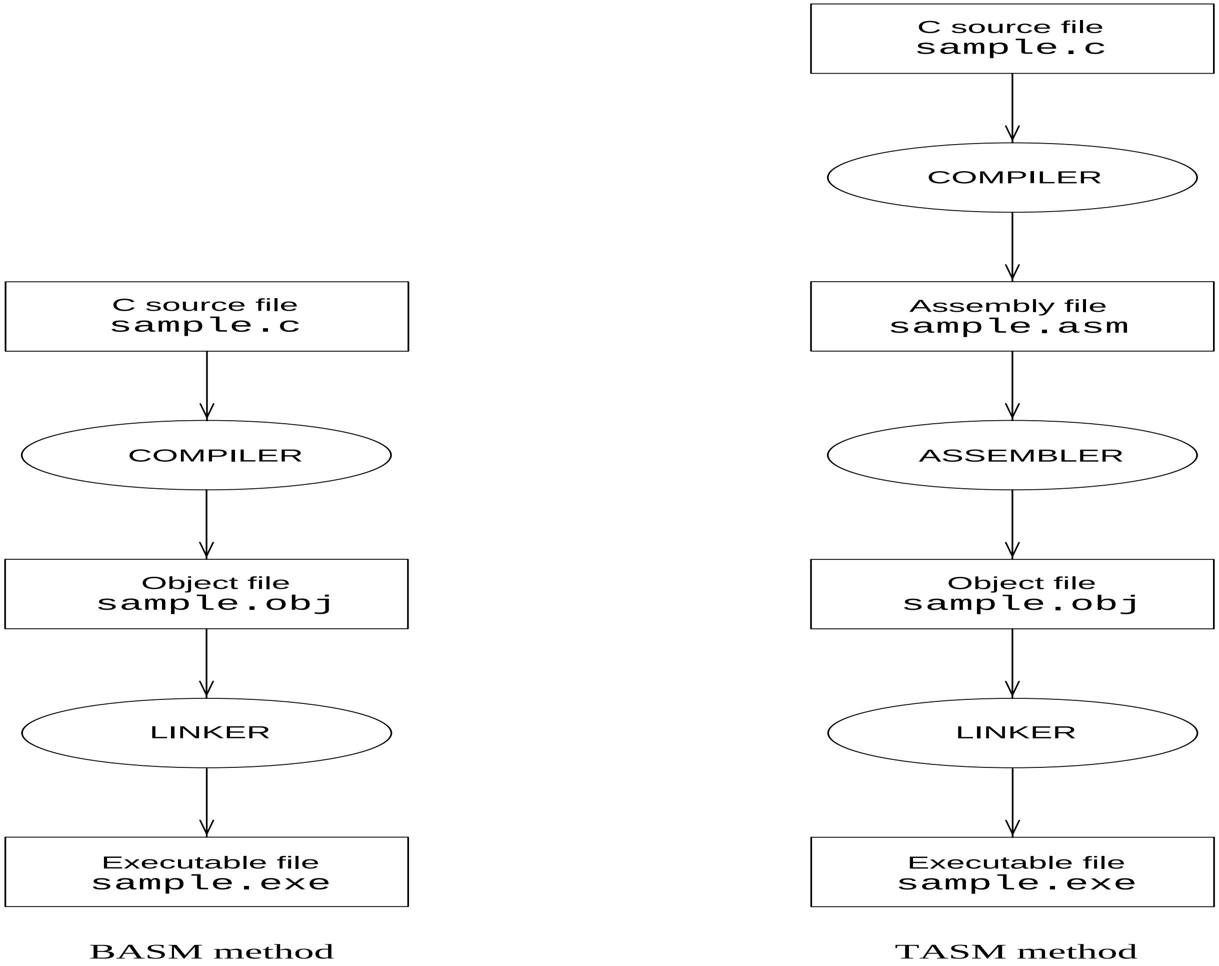
Two ways:

- ∗ TASM method
  - » Convert C code into assembly language and then invoke TASM to produce .OBJ file
  - » Can use **`-B`** compiler option to generate assembly file
  - » Alternatively, can include

    ```
    #pragma    inline
    ```

    at the beginning of the C file to instruct the compiler to use the **`-B`** option
- ∗ BASM method
  - » Uses the built-in assembler (BASM) to assemble **`asm`** statements
  - » Restricted to 16-bit instructions (i.e., cannot use 486 or Pentium instructions)

Inline Assembly Code (cont'd)


C source file
sample.c
COMPILER
Object file
sample.obj
LINKER
Executable file
sample.exe
BASM method
C source file
sample.c
COMPILER
Assembly file
sample.asm
ASSEMBLER
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