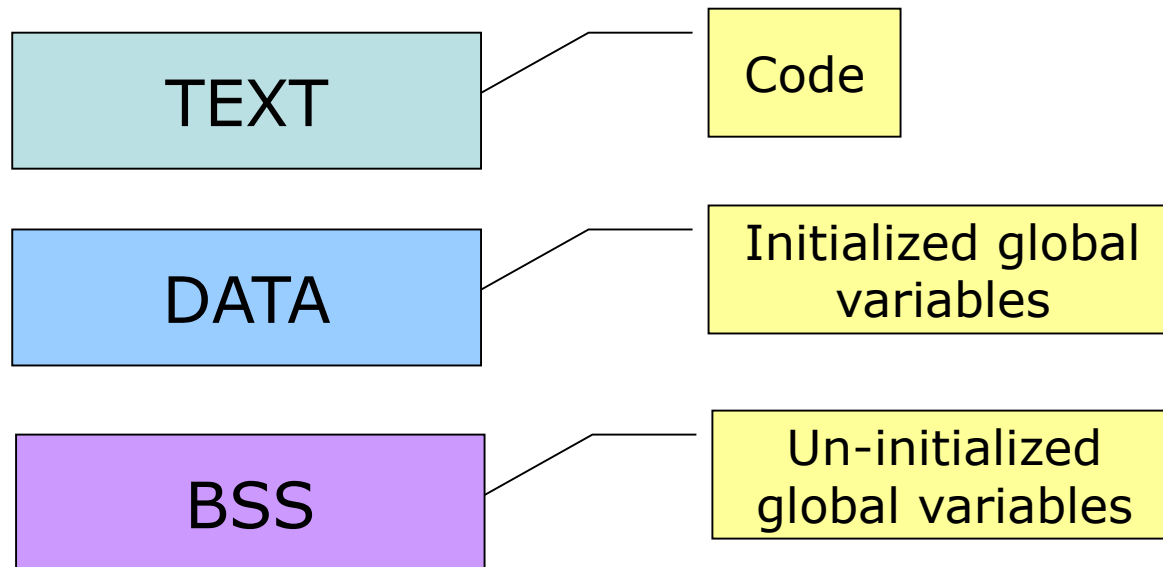# ARM Assembly Programming: Linker-Script and Crt0
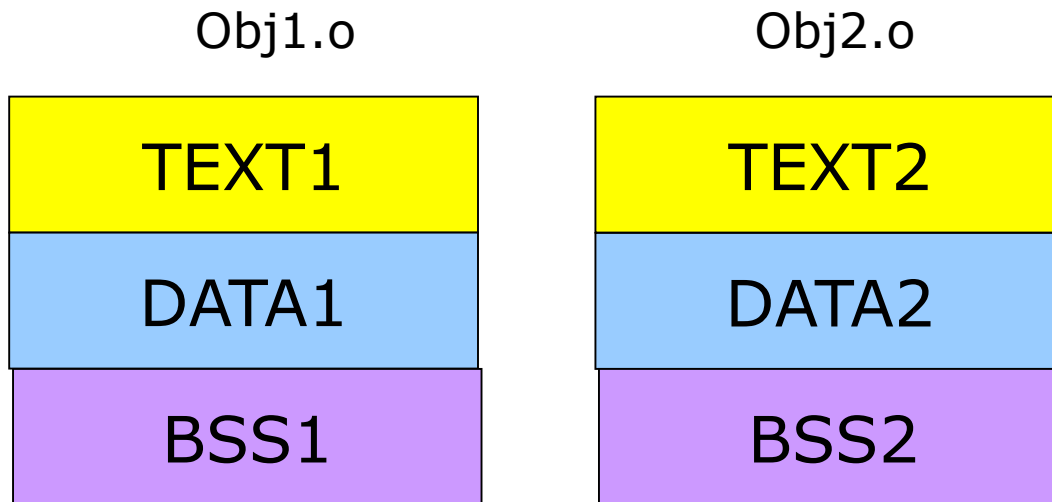
Peng-Sheng Chen

Fall, 2017

Object File Format
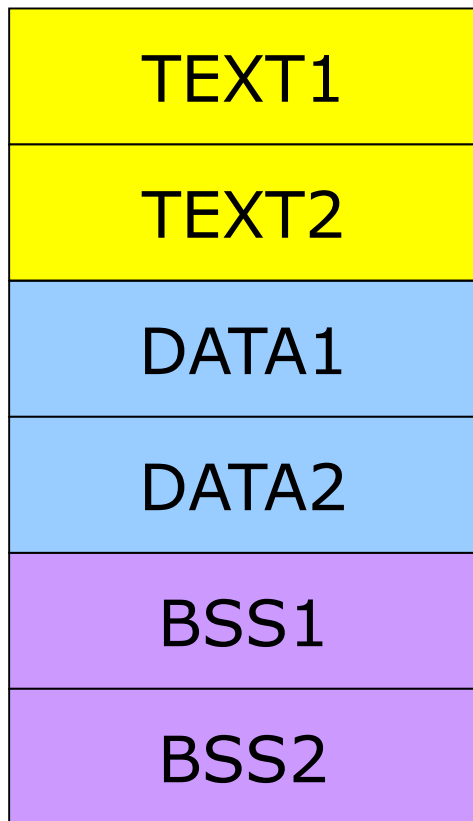
- COFF (Common Object File Format)
- ELF (Extended Linker Format)
- The segments in the object file

TEXT	— Code
DATA	— Initialized global variables
BSS	— Un-initialized global variables

Linker

Obj1.o

TEXT1
DATA1
BSS1

Obj2.o

TEXT2
DATA2
BSS2

Linker

| |
|:---:|
| TEXT1 |
| TEXT2 |
| DATA1 |
| DATA2 |
| BSS1 |
| BSS2 |

Linker script用來控制Linker的行為

Linker Script (1)

- Section
  - **Loadable**: the contents should be loaded into memory when the output file is run
  - **Allocateble**: an area in memory should be set aside, but nothing in particular should be loaded there
  - **Others**: debug information

- Every loadable or allocateble output section has two addresses
  - **VMA** (Virtual Memory Address): the address the section will have when the output file is run
  - **LMA** (Load Memory Address): the address at which the section will be loaded

Linker Script (2)

LMA

**ROM Image
(Executable Image)**
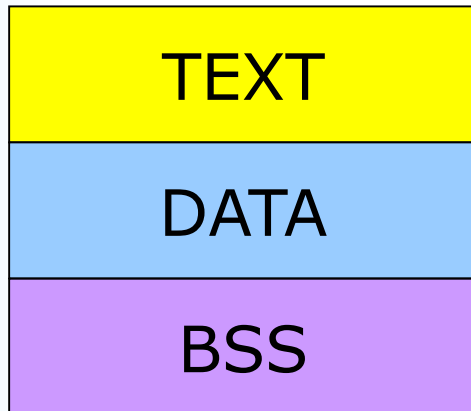
TEXT
DATA
BSS

VMA   **RAM**

0x100
TEXT

0x600
DATA
0x700
BSS

6

```
OUTPUT_ARCH(m68k)
SEARCH_DIR(.)
SECTIONS
{
        .text 0x10000000 : AT (0)
        {
                *(.text)
        } > rom

        .data 0x00000000 : AT (SIZEOF(.text))
        {
                *(.data)
        } > ram

        .bss  0x000000000 + SIZEOF(.data) :
        {
                *(.bss)
                *(COMMON)
        } > ram
}

MEMORY {
  rom : ORIGIN = 0x10000000, LENGTH = 1024K
  ram : ORIGIN = 0x00000000, LENGTH = 1024k
}
```

VMA

LMA

describe which memory regions may be used by the linker, and which memory regions it must avoid

The Executable File

crt0.o
TEXT1
TEXT2
DATA1
DATA2
BSS1
BSS2

- **crt0.o: Startup code**
  - 停用所有的中斷
  - 將初始化好的資料從ROM複製到RAM
  - 配置並初始化一個堆疊空間
  - 初始化處理器的堆疊指標
  - 建立並初始化一個配置區(heap)
  - 重新啟用中斷
  - 呼叫main function

Startup Code

- Newlib/**libgloss** provides many examples of startup codes

GNU Development Tools (1)

- newlib provides
  - C standard library
  - crt0.S
  - linker-script
- If "--prefix" is "/usr/local/arm" and "--target" is "arm-elf"
  - crt0.o => /usr/local/arm/arm-elf/lib
  - linker-script => /usr/local/arm/arm-elf/lib/ldscripts

GNU Development Tools (2)

- "arm-elf-gcc test.s"
  - implicit to link crt0.o
  - implicit to use linker-script in the directory "ldsripts"
  - You will get the following error message if you don't install newlib

  …/arm-elf/bin/ld:crt0.o: **No such file or directory**
  collect2: ld returned 1 exit status

- DEMO

Reference

- Binutils manual
(http://sources.redhat.com/binutils)