King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Computer Engineering Department
COE 301: Computer Architecture

LAB 05: Arrays and Files

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Agenda

- Static Allocation: Declaration and Initialization
- Dynamic Allocation using System Call
- Memory Organization
- Address Calculation of 1-D and 2-D arrays
- Files: Open, Read, Write, Close
- Live Examples
- Tasks

Static Allocation

- Allocates one variable or an array of variables in the static area of data segment.
- Array size is determined at assemble time.
- Data Types: byte (1 Byte), half-word (2 Bytes), word (4 Bytes)
- Declaration and Initialization at the same time Example

```
.data
secretbyte: .byte 0xAB
secrethalf: .half 0xABCD
secretword: .word 0x89ABCDEF
```

```
.data
secretbytes: .byte 0xAB:10
secrethalfs: .half 0:15
secretwords: .word 1:20
```

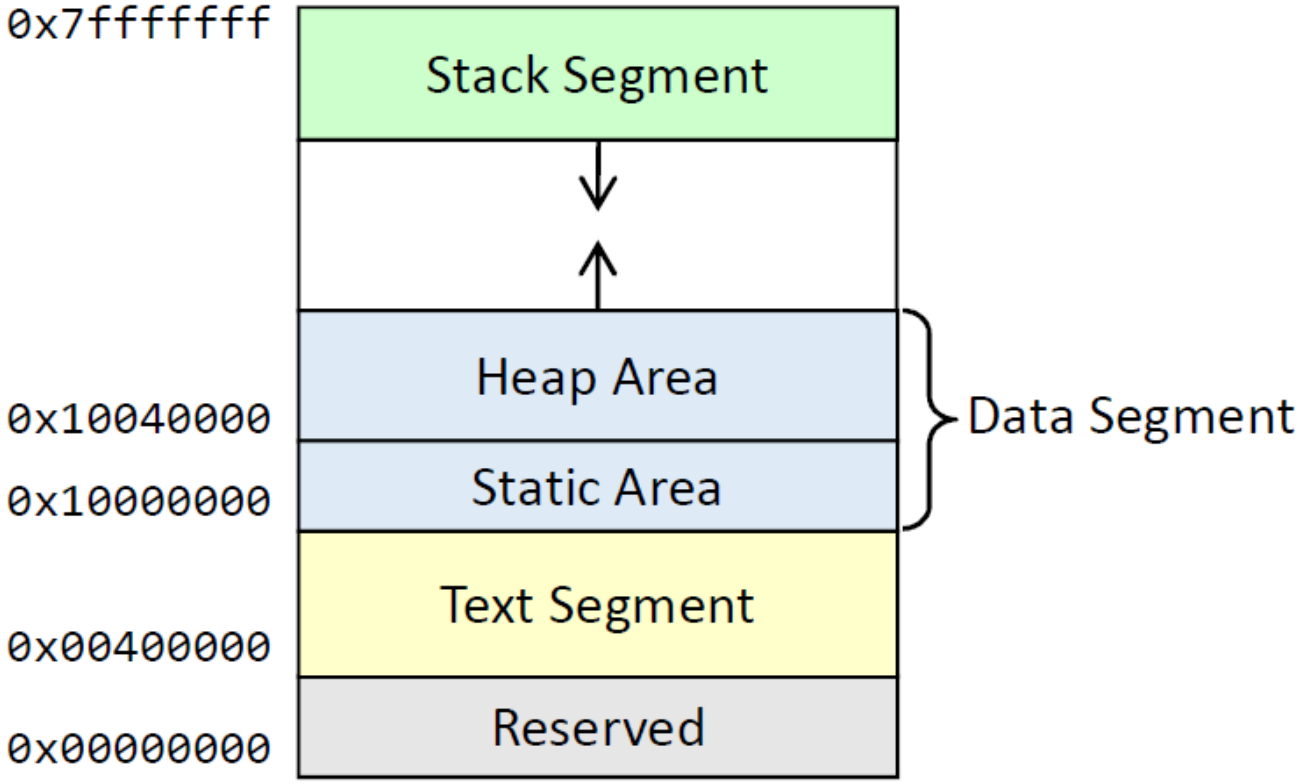
- Declaration only Example

```
.data
secretarr: .space 100
```

Dynamic Allocation

- Allocates one or more bytes at run time in the dynamic area (heap) of the data segment.
- Some programs require different array sizes based on some inputs.
- Use system call ($v0 = 9) and number of bytes to allocate in $a0.
- The base address will be returned in $v0, this base address needs to be saved.

Memory Organization



Address Calculation

- 1-D Array Address Calculation
  - arr1D: .type 0:20
  - For example int arr1D[20];
  - Address of arr1D[i] =

    base_address(arr1D) + (i * element_size)
- 2-D Array Address Calculation
  - arr2D: .type 0:20
  - For example int arr2D[4][5]
  - Address of arr2D[i][j] =

    base_address(arr2D) + (i * col_size * element_size) + (j * element_size)

Files

- They provide an easy method to test applications that require many input and output values.
- For a file to be used, it needs to be opened first.
- System Call **13** is used to open a file with the following options:
  - **$a0** address of null-terminated string containing the file name.
    - Path can be relative to the location of MARS.jar file or an absolute path.
  - **$a1** = 0 for read-only.
  - **$a1** = 1 for write-only with truncate and create.
  - **$a1** = 9 for write-only with create and append.
- It returns in **$v0** a positive file descriptor if it can open the file or negative if error.
- File descriptor **NEEDS** to be saved for other system calls.

Files (continued)

- System Call **14** is used to read file contents with the following options
  - **$a0** file descriptor
  - **$a1** = address of input buffer
  - **$a2** = maximum number of characters to read
- It returns in **$v0** positive number of characters read, zero if end of file or negative if error
- System Call **15** is used to write contents to file with the following options:
  - **$a0** = file descriptor
  - **$a1** = address of output buffer
  - **$a2** = number of characters to write
- It returns in **$v0** positive number of characters written or negative if error
- System Call **16** is used to close file with **$a0** containing the file descriptor.

Live Examples