x86 HW3

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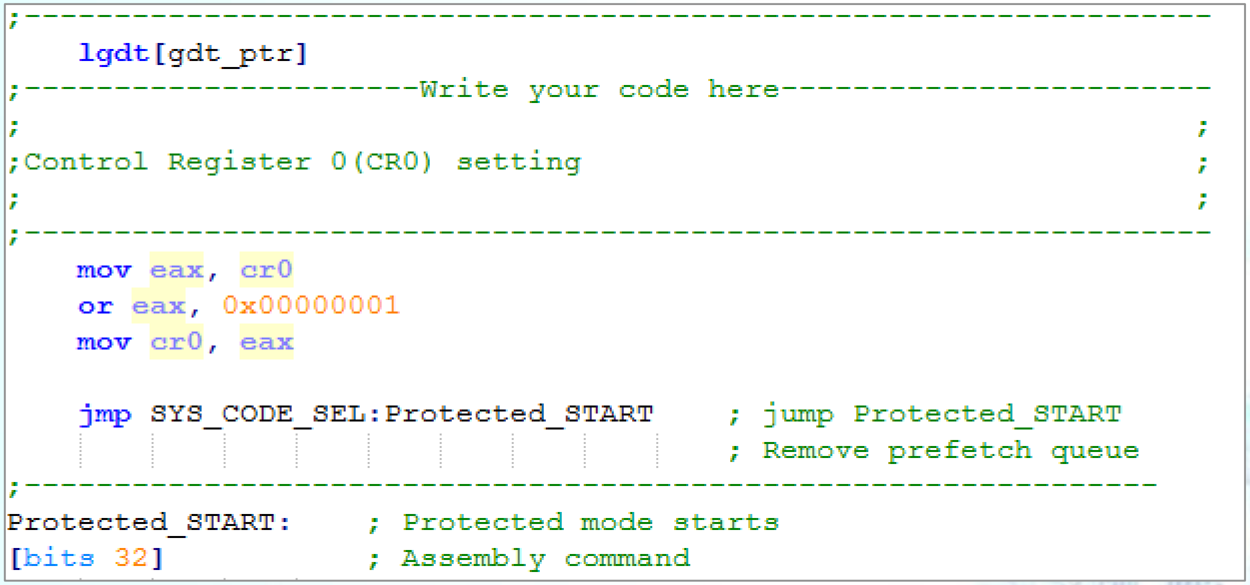
Contents

- Describe about 2nd Homework

- 3rd Homework

Describe about 2nd Homework

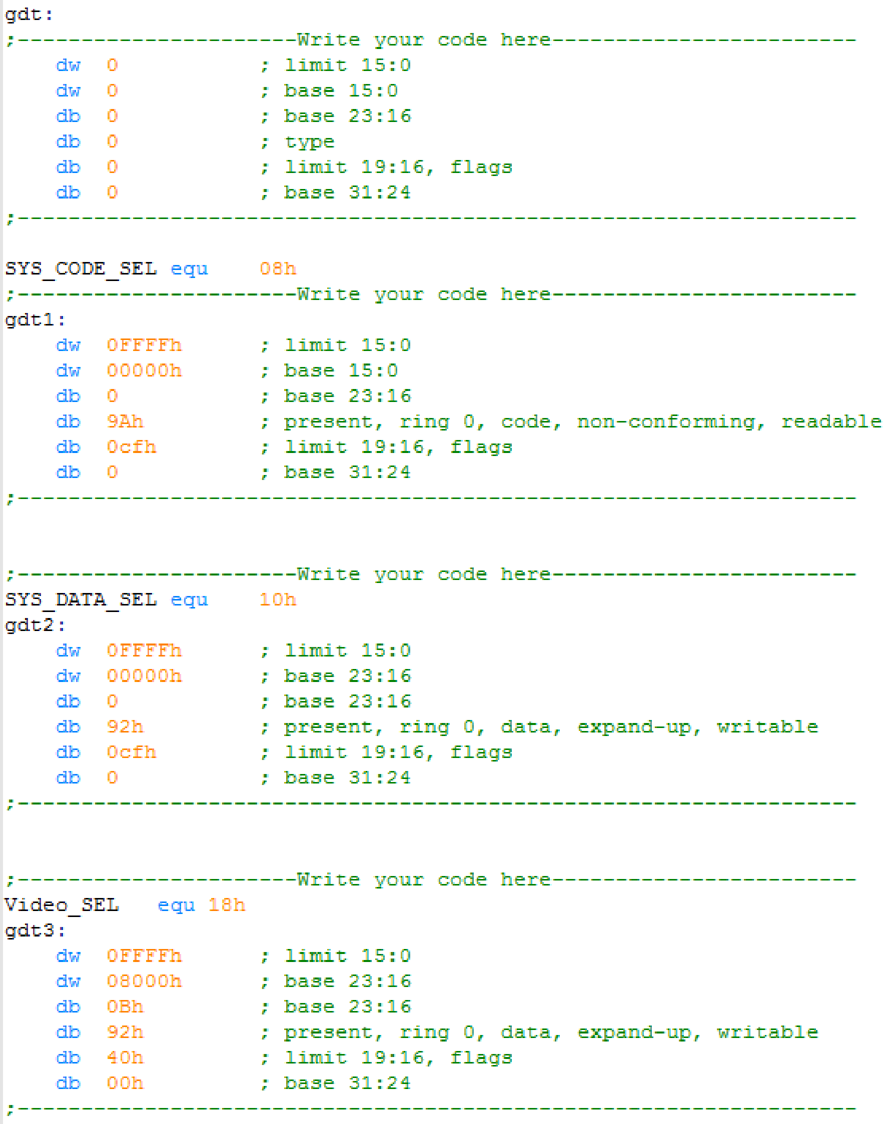
- Switch to Protected mode from Real mode
  - Load the address of GDT to GDTR
    - Using lgdt instruction
  - Control Register 0(CR0) setting
    - Protected Enable(PE) bit is set
  - jmp SYS_CODE_SEL:Protected_START
    - Jump to Protected_START



```
;-----------------------------------------------------------------
    lgdt[gdt_ptr]
;---------------------Write your code here------------------------
;                                                               ;
;Control Register 0(CR0) setting                                ;
;                                                               ;
;-----------------------------------------------------------------
    mov eax, cr0
    or eax, 0x00000001
    mov cr0, eax

    jmp SYS_CODE_SEL:Protected_START    ; jump Protected_START
                                        ; Remove prefetch queue
;--------------------------------------------------------------
Protected_START:    ; Protected mode starts
[bits 32]           ; Assembly command
```

Describe about 2nd Homework

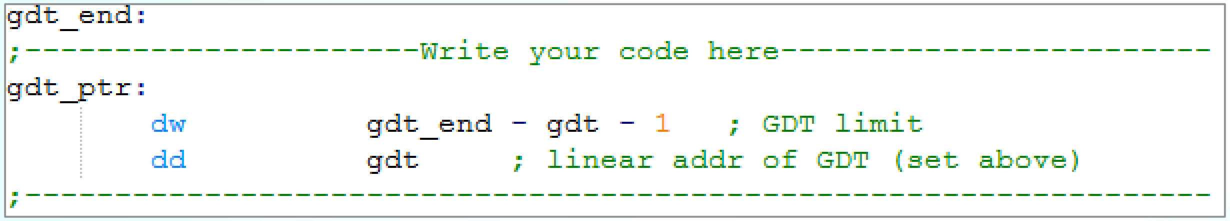
Global Descriptor Table & Selector



```
gdt:
;----------------------Write your code here------------------------
    dw  0           ; limit 15:0
    dw  0           ; base 15:0
    db  0           ; base 23:16
    db  0           ; type
    db  0           ; limit 19:16, flags
    db  0           ; base 31:24
;------------------------------------------------------------------

SYS_CODE_SEL equ    08h
;----------------------Write your code here------------------------
gdt1:
    dw  0FFFFh      ; limit 15:0
    dw  00000h      ; base 15:0
    db  0           ; base 23:16
    db  9Ah         ; present, ring 0, code, non-conforming, readable
    db  0cfh        ; limit 19:16, flags
    db  0           ; base 31:24
;------------------------------------------------------------------


;----------------------Write your code here------------------------
SYS_DATA_SEL equ    10h
gdt2:
    dw  0FFFFh      ; limit 15:0
    dw  00000h      ; base 23:16
    db  0           ; base 23:16
    db  92h         ; present, ring 0, data, expand-up, writable
    db  0cfh        ; limit 19:16, flags
    db  0           ; base 31:24
;------------------------------------------------------------------


;----------------------Write your code here------------------------
Video_SEL   equ 18h
gdt3:
    dw  0FFFFh      ; limit 15:0
    dw  08000h      ; base 23:16
    db  0Bh         ; base 23:16
    db  92h         ; present, ring 0, data, expand-up, writable
    db  40h         ; limit 19:16, flags
    db  00h         ; base 31:24
;------------------------------------------------------------------
```

Describe about 2nd Homework

- Limit and base address of GDT
  - dw gdt_end – gdt – 1
    - Limit address computation and storage of GDT
  - dd gdt
    - Base address stored in the GDT



```
gdt_end:
;---------------------Write your code here-----------------------
gdt_ptr:
        dw          gdt_end - gdt - 1    ; GDT limit
        dd          gdt     ; linear addr of GDT (set above)
;------------------------------------------------------------------
```

3rd Homework

3rd Homework Describe

- Make three LDT
  - Make descriptors in GDT
  - Load ldt
- Control transfer using LDT
  - Far jump
  - Far call / return
  - Call gate descriptor
- Print strings
  - Print on vmware

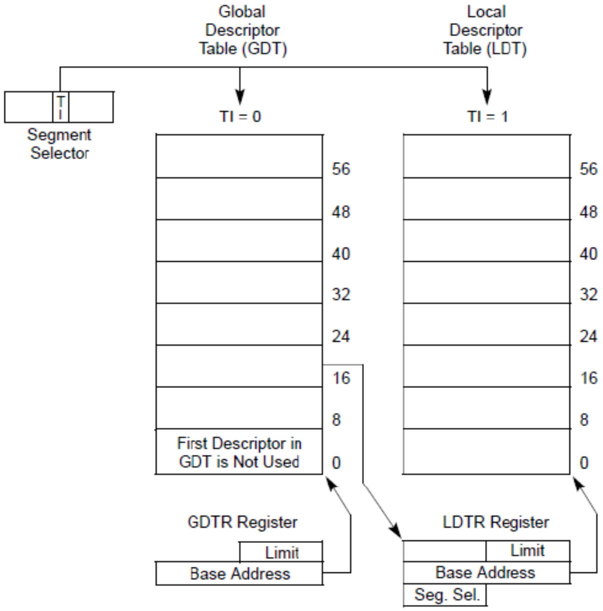
Global Descriptor Table

Global Descriptor Table

Index	Segment Selector	TYPE
0	-	NULL Descriptor
1	SYS_CODE_SEL_0	Code Segment Descriptor
2	SYS_DATA_SEL	Data Segment Descriptor
3	VIDEO_SEL	Data Segment Descriptor
4		
5		
6	SYS_CODE_SEL_1	Code Segment Descriptor
7		

Local Descriptor Table

- Memory addressing using LDT
  - Make LDTR 1 descriptor in GDT
    - Base address : base address of LDT 1
    - Limit : limit value of LDT 1
    - Type : System Descriptor, LDT
    - Other Information
      - In IA-32mode
      - Descriptor Privilege Level is 0
      - Present in Memory
      - Limit is interpreted in byte units
      - Not available for use by system software



Local Descriptor Table

- Memory addressing using LDT (Con’t)
  - Make LDTR 2 descriptor in GDT
    - Base address : base address of LDT 2
    - Limit : limit value of LDT 2
    - Type : System Descriptor, LDT
    - Other Information
      - In IA-32mode
      - Descriptor Privilege Level is 0
      - Present in Memory
      - Limit is interpreted in byte units
      - Not available for use by system software

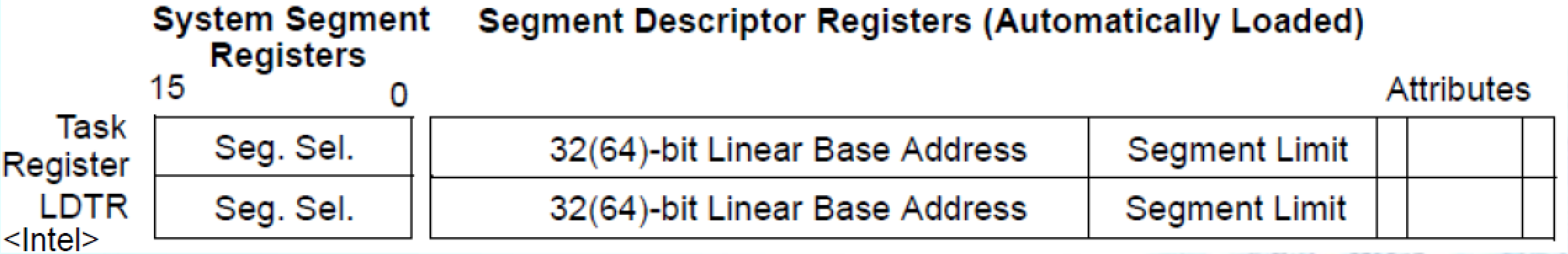
Local Descriptor Table

- Memory addressing using LDT (Con’t)
  - Make LDTR 3 descriptor in GDT
    - Base address : base address of LDT 3
    - Limit : limit value of LDT 3
    - Type : System Descriptor, LDT
    - Other Information
      - In IA-32mode
      - Descriptor Privilege Level is 0
      - Present in Memory
      - Limit is interpreted in byte units
      - Not available for use by system software

Local Descriptor Table

Local Descriptor Table Register

- LDT is accessed with its segment selector
- The LDTR register holds
  - 16-bit segment selector
  - Base address and segment limit
  - Descriptor attributes for LDT
- Load LDT
  - LLDT instruction
  - Load a segment selector of LDTR descriptor
    - The base, limit, attributes from LDT are automatically loaded in the LDTR



	System Segment Registers 15 0	Segment Descriptor Registers (Automatically Loaded)		Attributes
Task Register	Seg. Sel.	32(64)-bit Linear Base Address	Segment Limit	
LDTR	Seg. Sel.	32(64)-bit Linear Base Address	Segment Limit	

<Intel>

Local Descriptor Table

Global Descriptor Table

Index	Segment Selector	TYPE
0	-	NULL Descriptor
1	SYS_CODE_SEL_0	Code Segment Descriptor
2	SYS_DATA_SEL	Data Segment Descriptor
3	VIDEO_SEL	Data Segment Descriptor
4	LDTR1	System Descriptor
5	LDTR2	System Descriptor
6	SYS_CODE_SEL_1	Code Segment Descriptor
7	LDTR3	System Descriptor

Local Descriptor Table

Local Descriptor Table 1

Index	Segment Selector	TYPE
0	LDT1_CODE_SEL_0	Code Segment Descriptor
1	LDT1_CODE_SEL_1	Code Segment Descriptor
2	LDT1_DATA_SEL_0	Data Segment Descriptor

Local Descriptor Table 2

Index	Segment Selector	TYPE
0	LDT2_DATA_SEL_0	Data Segment Descriptor
1	LDT2_CODE_SEL_0	Code Segment Descriptor
2	LDT2_Call_Gate	Call Gate Descriptor
3	LDT2_CODE_SEL_1	Code Segment Descriptor

Local Descriptor Table 3

Index	Segment Selector	TYPE
0	LDT3_CODE_SEL_0	Data Segment Descriptor
1	LDT3_DATA_SEL_0	Code Segment Descriptor

Local Descriptor Table

Code Segment Descriptor

- Base Address : 0x00000000 / Limit : 0xFFFFF
- Type : non-conforming, execute/read, not accessed
- Other Information
  - In IA-32 mode and 32-bit code segments
  - Descriptor Privilege Level is 0
  - Present in Memory
  - Limit is interpreted in 4-Kbyte units
  - Not available for use by system software

Data Segment Descriptor

- Base Address : 0x00000000 / Limit : 0xFFFFF
- Type : expand up, read/write, not accessed
- Other Information
  - In IA-32 mode and 32-bit data segments
  - Descriptor Privilege Level is 0
  - Present in Memory
  - Limit is interpreted in 4-Kbyte units
  - Not available for use by system software

JUMP Instruction

- Jump Instruction
  - Far jump
    - Destination is in a different code segment
  - Instructions
    - jmp CS:offset
  - A logical address consisting of
    - A 16-bit segment selector
      - Base address
    - A 32-bit offset
      - EIP ← offset
  - A far jump to a code segment at the same privilege level
    - CS ← the new code segment selector and its descriptor
    - EIP ← the offset from the instruction

CALL and RET Instruction

- CALL Instruction
  - Far call
    - Destination is in a different code segment
  - Instructions
    - call CS:offset
  - A logical address consisting of
    - A 16-bit segment selector
      - Base address
    - A 32-bit offset
      - EIP ← offset
  - A far call to a code segment at the same privilege level
    - CS ← the new code segment selector and its descriptor
    - EIP ← the offset from the instruction

- RET Instruction
  - retf (far return)

CALL and RET Instruction

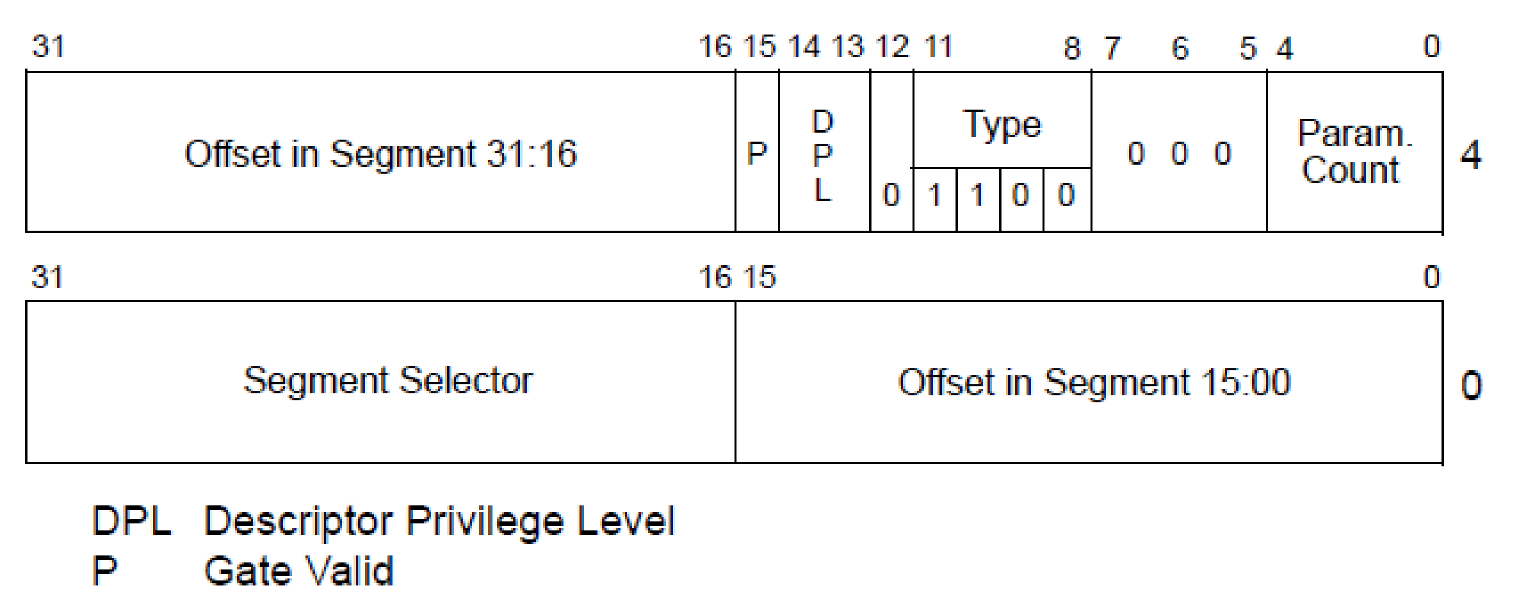
- When executing a far call
  - Push CS register on the stack
  - Push EIP register on the stack
  - Begin execution of the called procedure

- When executing a far return
  - Pop EIP register(top of stack value)
  - Pop CS register(top of stack value)
  - Resumes execution of the calling procedure

Call Gate Descriptor

- **A call-gate descriptor**
  - **May reside in the GDT or in an LDT**
  - **Not int the interrupt descriptor table (IDT)**

    - **Other Information**
      - **Descriptor Privilege Level is 0**
      - **Param. Count value is 0**
      - **Gate valid value is 1**



31 … 16	15	14 13	12	11 … 8	7 6 5	4 … 0	
Offset in Segment 31:16	P	DPL	0	Type 1 1 0 0	0 0 0	Param. Count	4

31 … 16	15 … 0	
Segment Selector	Offset in Segment 15:00	0

DPL Descriptor Privilege Level
P Gate Valid

3rd Homework

- Transfer control (move other code segment)
  - Jump
    - Protected_START → LDT1_Start
      - Using LDT1_CODE_SEL_0 in LDT 1
    - LDT1_Start→ LDT2_Start
      - Using LDT2_CODE_SEL_1 in LDT 2
    - LDT2_Start→ LDT3_Start
      - Using LDT3_CODE_SEL_0 in LDT 3
    - LDT3_Start→ GDT_Return
      - Using SYS_CODE_SEL_1 in GDT

3rd Homework

- Transfer control (move other code segment)
  - Call / RET
    - LDT1_Start → LDT1_Next
      - Using LDT1_CODE_SEL_1 in LDT 1
    - LDT1_Next→ LDT1_Start
      - Using far return instruction
    - LDT2_Start → LDT2_Next
      - Using Call-gate descriptor
    - LDT2_Next→ LDT2_Start
      - Using far return instruction

3rd Homework

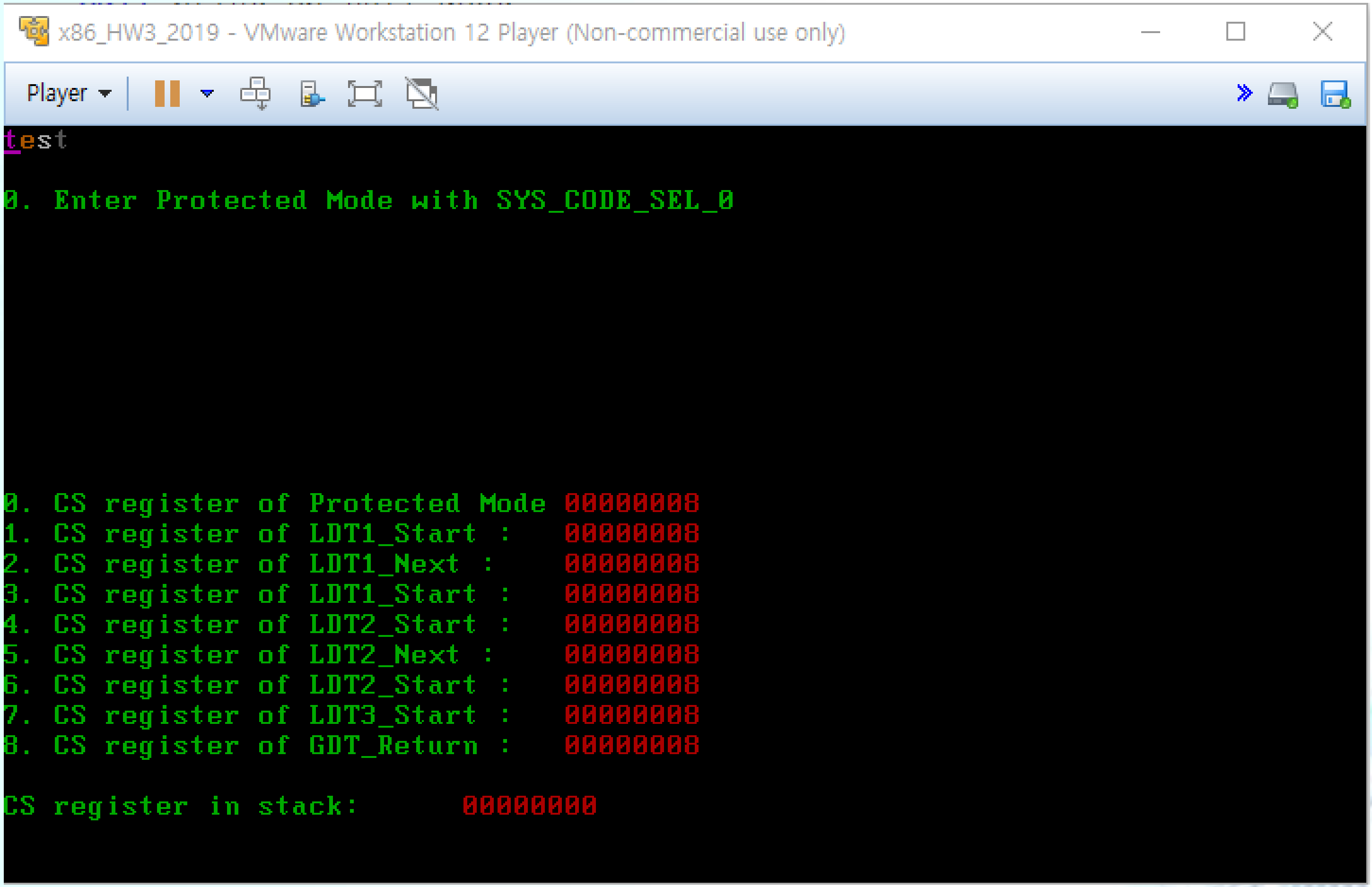
- Print strings
  - Use printf_s
    - call Printf_s
      - eax register value for variable to print
      - edi for position in VMware and bl for property(color)

3rd Homework

- Print strings
  - Strings for each label
    - LDT1_Start
      - MSG_LDT1_Start_0
      - MSG_LDT1_Start_1
    - LDT1_Next
      - MSG_LDT1_Next
    - LDT2_Start
      - MSG_LDT2_Start_0
      - MSG_LDT2_Start_1
    - LDT2_Next
      - MSG_LDT2_Next
    - LDT3_Start
      - MSG_LDT3_Start
    - GDT_Return
      - MSG_GDT_Return

3rd Homework

- **Initial program**

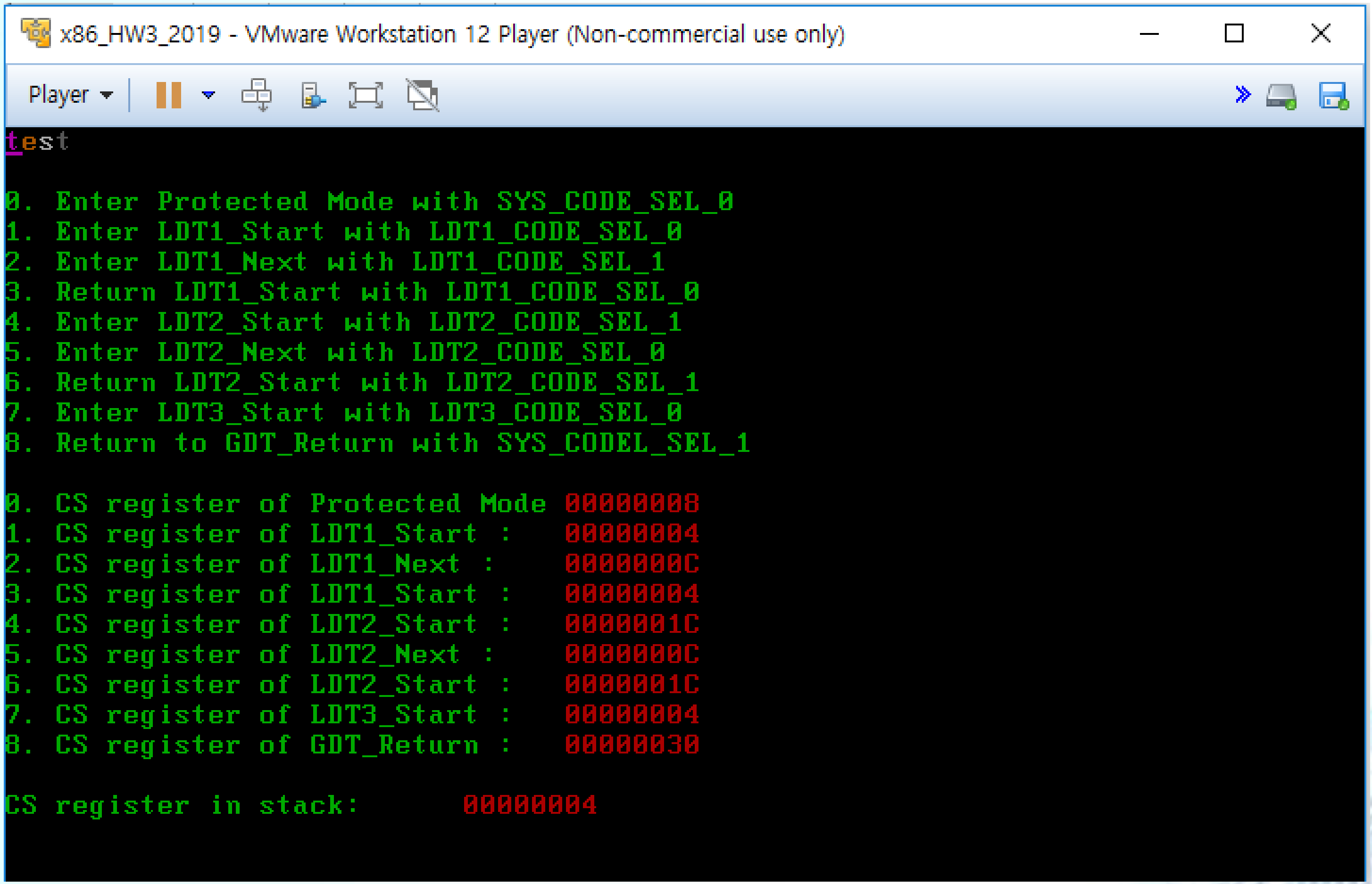


x86_HW3_2019 - VMware Workstation 12 Player (Non-commercial use only)
Player

```
test

0. Enter Protected Mode with SYS_CODE_SEL_0








0. CS register of Protected Mode 00000008
1. CS register of LDT1_Start :   00000008
2. CS register of LDT1_Next :    00000008
3. CS register of LDT1_Start :   00000008
4. CS register of LDT2_Start :   00000008
5. CS register of LDT2_Next :    00000008
6. CS register of LDT2_Start :   00000008
7. CS register of LDT3_Start :   00000008
8. CS register of GDT_Return :   00000008

CS register in stack:      00000000
```

3rd Homework

Result program



x86_HW3_2019 - VMware Workstation 12 Player (Non-commercial use only)
Player

```
test

0. Enter Protected Mode with SYS_CODE_SEL_0
1. Enter LDT1_Start with LDT1_CODE_SEL_0
2. Enter LDT1_Next with LDT1_CODE_SEL_1
3. Return LDT1_Start with LDT1_CODE_SEL_0
4. Enter LDT2_Start with LDT2_CODE_SEL_1
5. Enter LDT2_Next with LDT2_CODE_SEL_0
6. Return LDT2_Start with LDT2_CODE_SEL_1
7. Enter LDT3_Start with LDT3_CODE_SEL_0
8. Return to GDT_Return with SYS_CODEL_SEL_1

0. CS register of Protected Mode 00000008
1. CS register of LDT1_Start :   00000004
2. CS register of LDT1_Next :    0000000C
3. CS register of LDT1_Start :   00000004
4. CS register of LDT2_Start :   0000001C
5. CS register of LDT2_Next :    0000000C
6. CS register of LDT2_Start :   0000001C
7. CS register of LDT3_Start :   00000004
8. CS register of GDT_Return :   00000030

CS register in stack:      00000004
```

3rd Homework

- Time and Place
  - May 31th(Fri) 19:00
  - Semi-conductor building 2 floor computer room
    - 400212, 400202

- How to submit
  - .asm and .bin files
  - I-Campus, until May 31th(Fri) 18:59
    - format
      - 2010310000_HW3.asm
      - 2010310000_HW3.bin