II. 80x86 Family of Microprocessors

Programming Model

Objectives

At the end of the lecture, the students should be able to:

- discuss the 80x86 Family of Microprocessors,

- differentiate: Real Mode vs. Protected Mode, and

- discuss different addressing modes used in assembly programming.

The 80x86 Family

Processor	Data Bus	Address Bus	Maximum Addressable Memory
8088	8	20	1MB
8086	16	20	1MB
80286	16	24	16MB
80386	32	32	4GB
80486	32	32	4GB
Pentium	64	32	4GB

Intel and Intel-compatible Processors

Processor	Data Bus	Register Size
8088	8-bit	16-bit
8086	16-bit	16-bit
286	16-bit	16-bit
386	32-bit	32-bit
486/AMD-5x86	32-bit	32-bit
Pentium/AMD-K6	64-bit	32-bit
Pentium Pro/Celeron/II/III	64-bit	32-bit
AMD Duron/Athlon/Athlon XP	64-bit	32-bit
Pentium 4	64-bit	32-bit
Itanium	64-bit	64-bit
AMD Athlon 64	64-bit	64-bit

Intel Family Register Organization
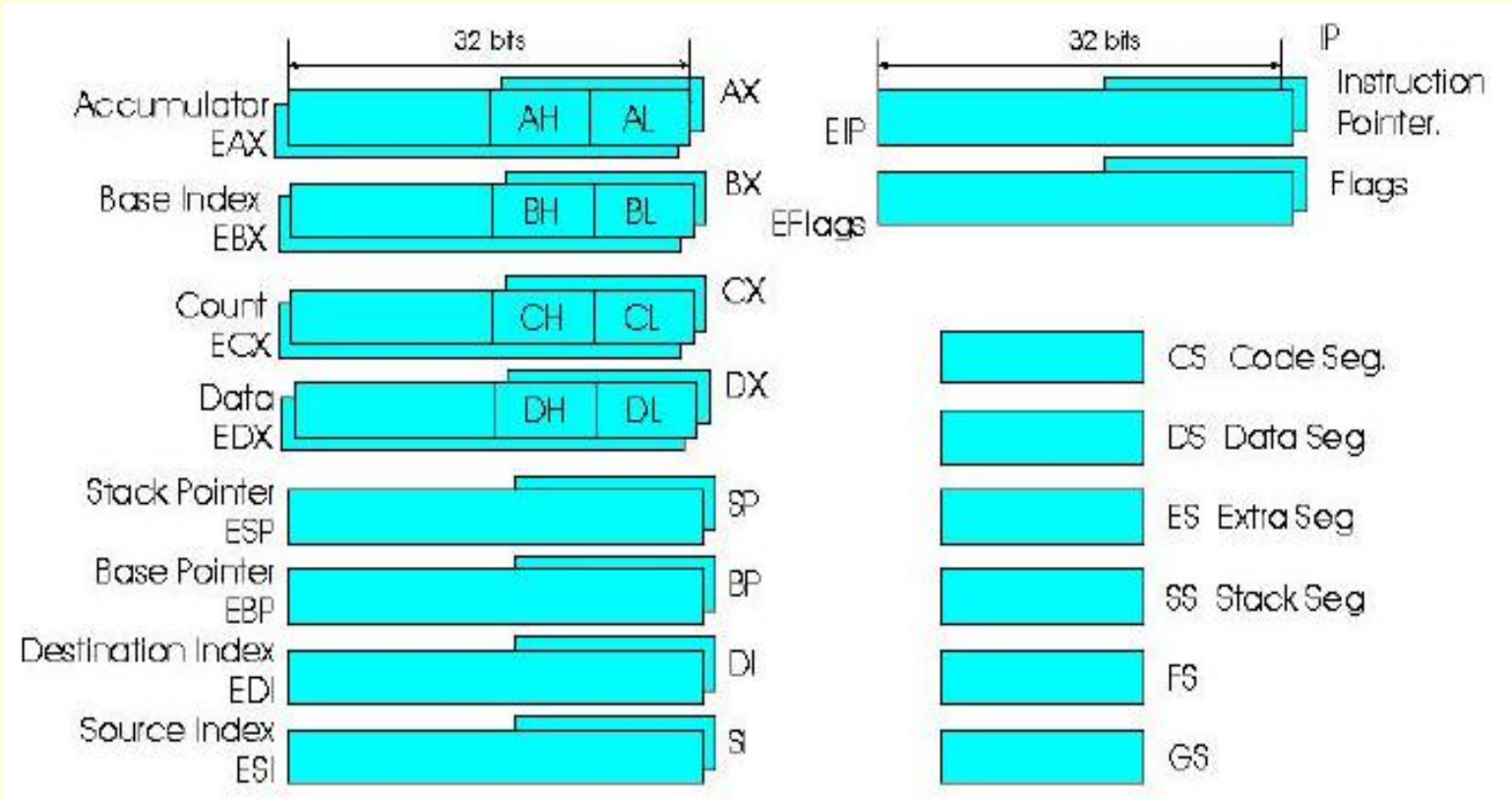
Note: 32 bit registers are not available on 8086, 8088, or 80286

Memory Organization

Typical memory sizes		Typical access times
	CPU	
> 1 KB	Register set	< 1 ns
> 64 KB	Level 1 cache	< 1-2 ns
> 512 KB	Level 2 cache	< 4 ns
	I/O ROM RAM RAM V-RAM I/O	
> 60 GB	Disks	< 8 ms
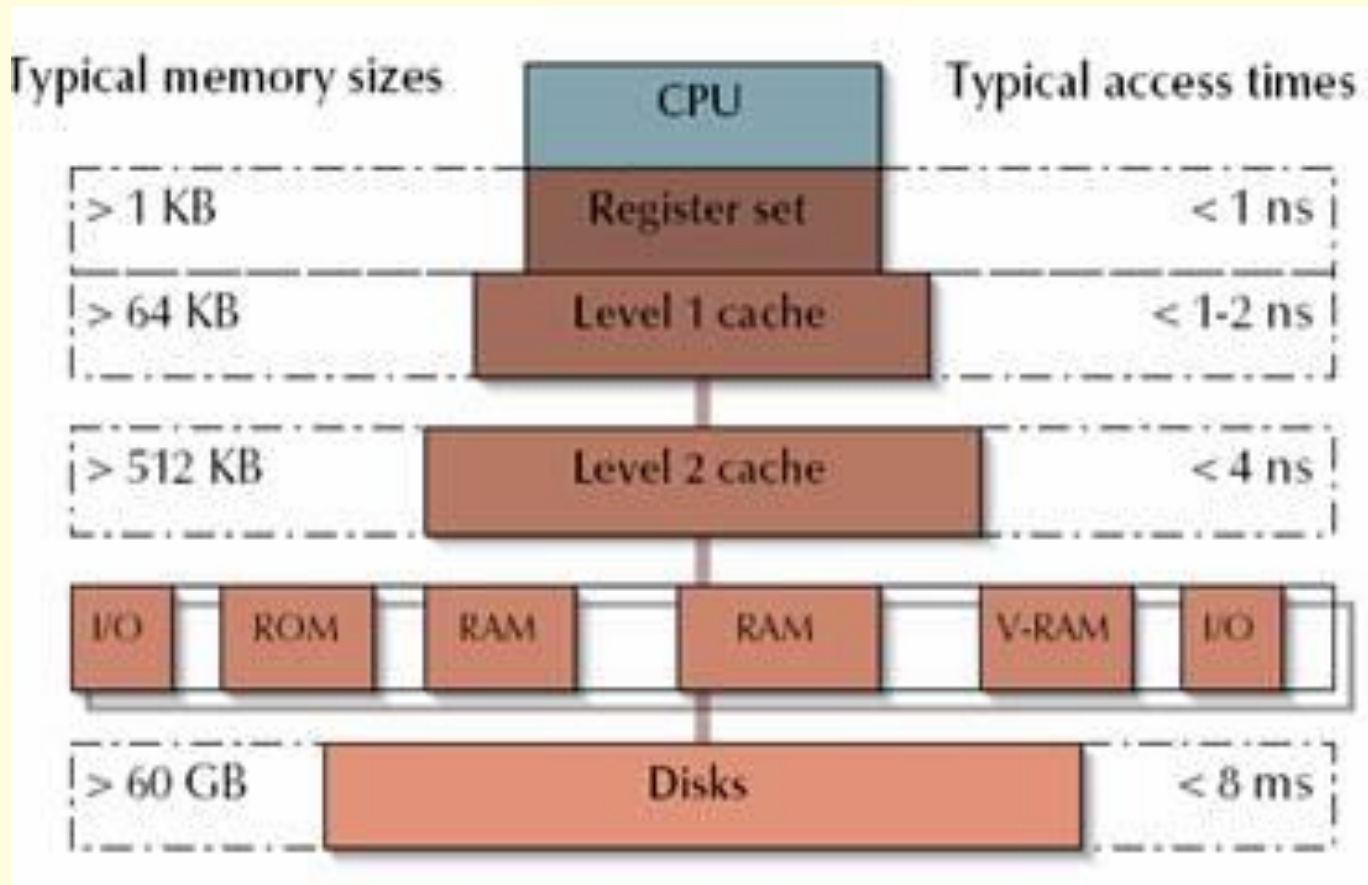
(Ref: Aurora Simionescu, Memory organization and access of 80x86 processors)
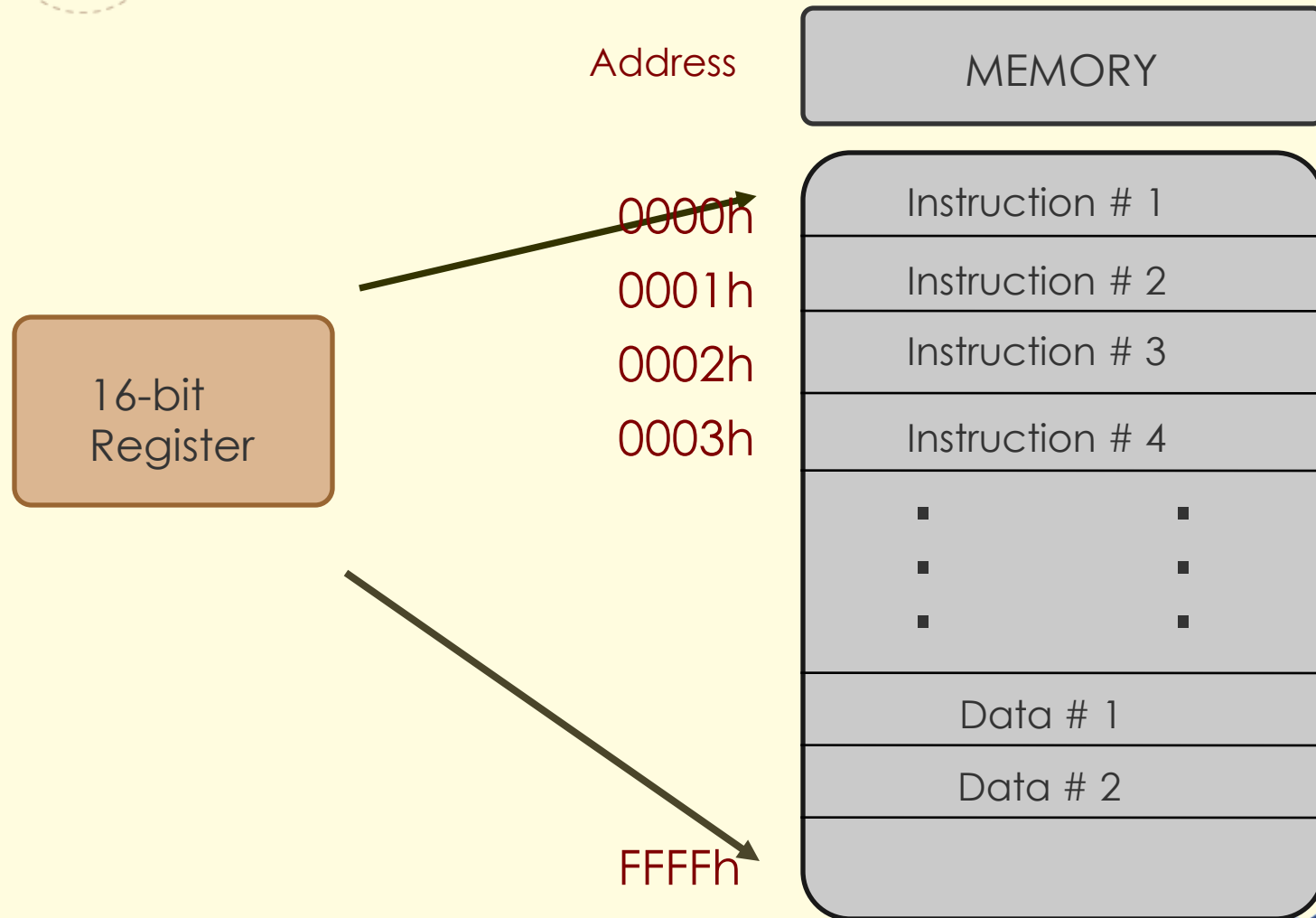
Real Mode and Protected Mode

- are operational modes of x86-compatible CPUs
- Real mode was invented first, original segment:offset addressing
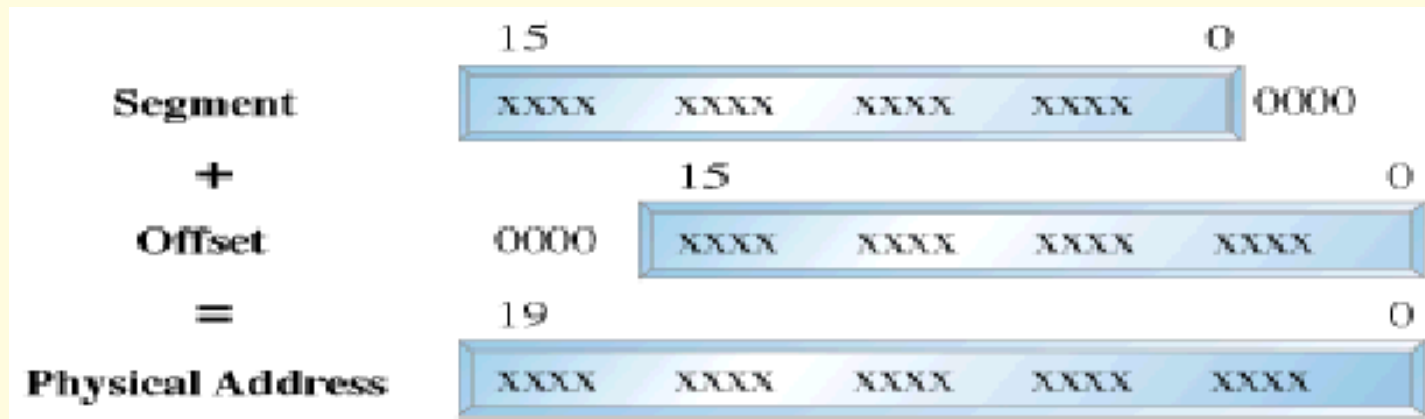- Protected mode is a modification of real mode addressing.
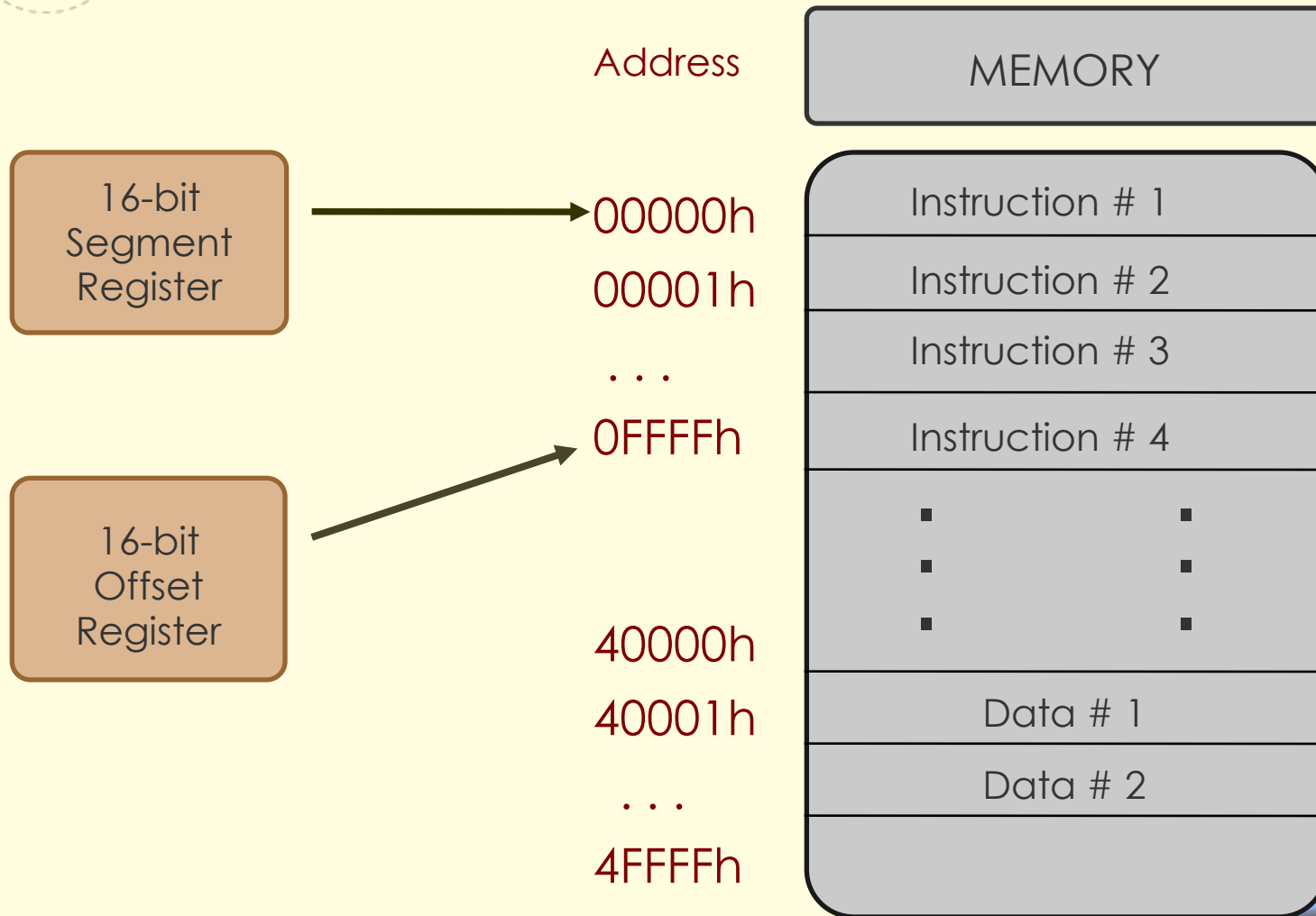
Real Mode Memory Addressing

Address

MEMORY

16-bit Register

Address	Memory
0000h	Instruction # 1
0001h	Instruction # 2
0002h	Instruction # 3
0003h	Instruction # 4
	▪ ▪
	▪ ▪
	▪ ▪
	Data # 1
	Data # 2
FFFFh	

Real Mode Memory Addressing

- Characterized by a 20 bit segmented memory address space

Real Mode Memory Addressing

Address

16-bit Segment Register	→	00000h	MEMORY

16-bit Offset Register

Address	MEMORY
00000h	Instruction # 1
00001h	Instruction # 2
. . .	Instruction # 3
0FFFFh	Instruction # 4
	▪ ▪ ▪
40000h	
40001h	Data # 1
. . .	Data # 2
4FFFFh	

Real Mode Memory Addressing

- instruction can address any space within the 1 MB of RAM

- programs in real mode are typically part of OS or a special application

- Ex. 1000:1F00

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Their sum produces the physical address.

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- Ex. 1000:1F00

10000

+ 1F00

11F00

First, multiply the segment value by 10h.
Then add in the offset portion.
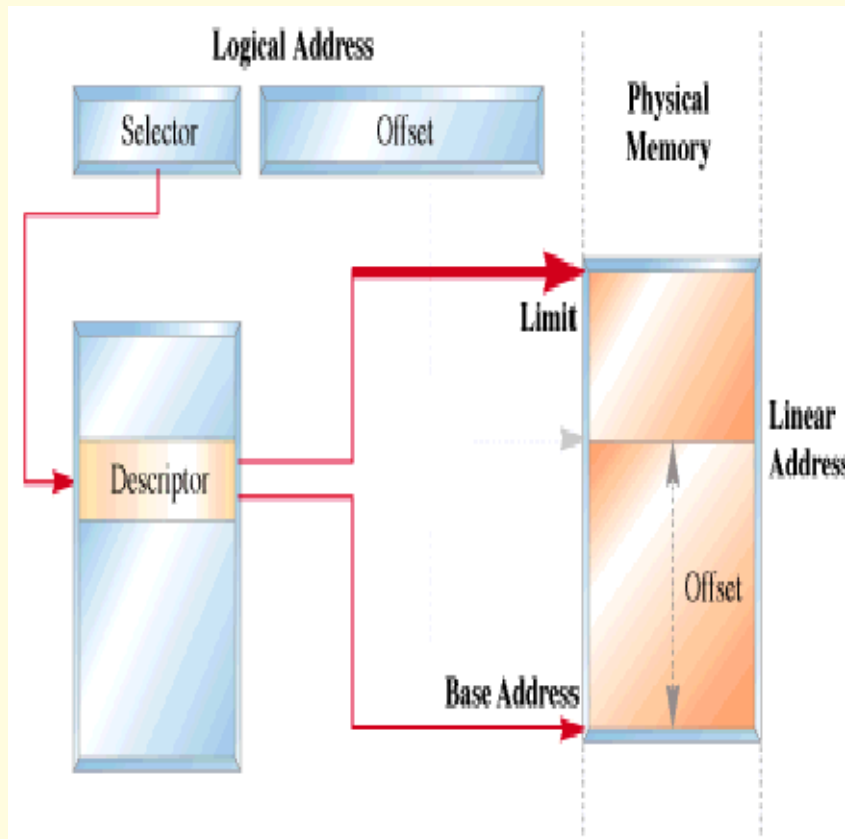Their sum produces the physical address.

Real Mode Memory Addressing

Disadvantage:

- Many segment:offset pairs refer to the same exact memory locations.

- For example, the segment:offset address 047C:0048, 047D:0038 or 047E:0028 all refer to the physical address: 04808

- This can complicate the comparison of segmented addresses.
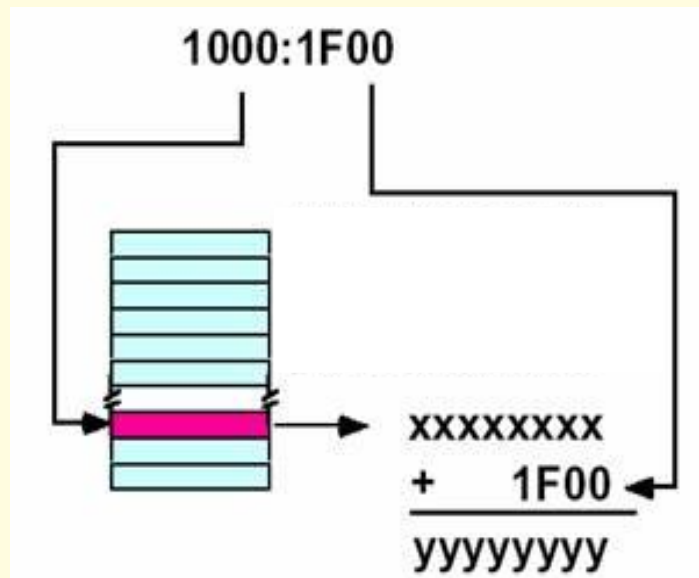
Protected Mode Memory Addressing

- Has features designed to enhance multitasking and system stability, memory protection and support for virtual memory.

Protected Mode Memory Addressing

- the mode that computer runs in when it has to support multiple users

- Linux, UNIX, Windows 9x, Windows NT uses protected mode

1000:1F00

Use the segment as an index into the segment descriptor array.

Fetch the value at this location and add it to the offset to obtain the physical address.

xxxxxxxx
+   1F00
yyyyyyyy

II. 80x86 Family of Microprocessors

Addressing Modes

Addressing Modes

- the way we address/specify operands in instructions

Three general types:

- Immediate

- Register

- Memory/Direct

Addressing Modes

- Immediate - transfers an immediate byte or word of data into the destination register or memory location

    ex.   mov cx, 10

- Register - transfers a byte or word from the source register to the destination register

    ex.   mov ax, bx

Addressing Modes

- Memory/Direct - moves a byte or word between a memory location and a register

    ex.   mov ax, [num1]

            mov cx, [B800h]

Other Addressing Modes

- Register Indirect - transfers a byte or word of data between a register and the memory location addressed by an index register(DI or SI) or base register (BP or BX)

  ex.   mov ax, [bx]

Other Addressing Modes

- Base Indexed - transfers a byte or word of data between a register and the memory location addressed by a base register (BP or BX) plus index (DI or SI) register

    ex.   mov dx, [bx + di]

Other Addressing Modes

- Register Relative - transfers a byte or word of data between a register and the memory location addressed by an index register (DI or SI) or base register (BP or BX) plus displacement

    ex.   mov dx, [bx + 1000h]

Other Addressing Modes

- Base Relative Plus Index - transfers a byte or word of data between a register and the memory location addressed by a base register (BP or BX) plus index register (DI or SI) plus displacement

  ex.   mov ax, [bx + si + 100h]

Quiz

1. In real mode addressing, if the segment:offset address is 1234:1001, **what is its equivalent physical address?**
2. Given the following registers and memory segments,

		1234h	11
DI	1234h	1235h	6
SI	1236h	1236h	27
		1237h	19

what would be the value of AL after the assembly code **mov AL, [SI]** is executed?