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.

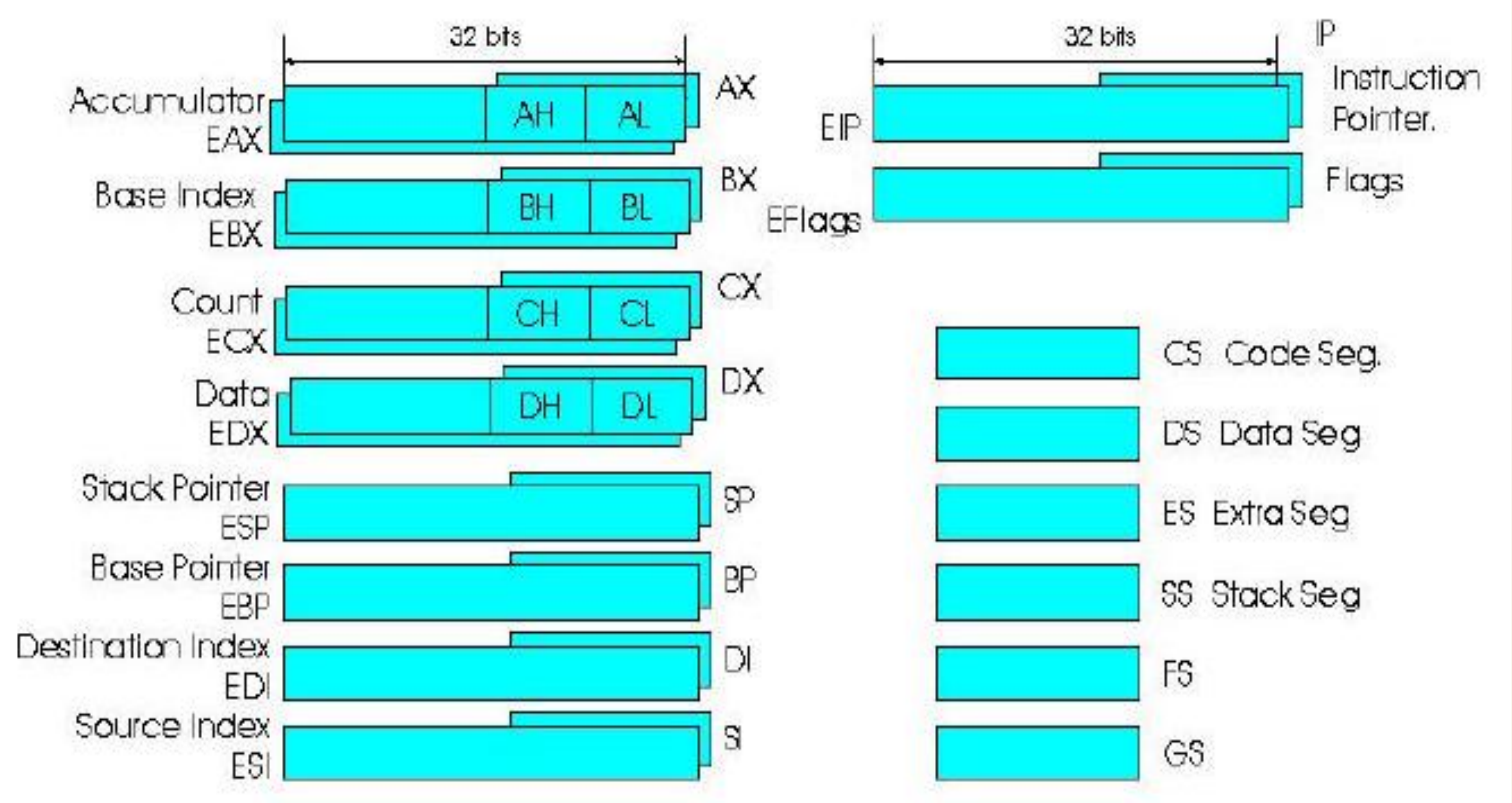
The 80x86 Family

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

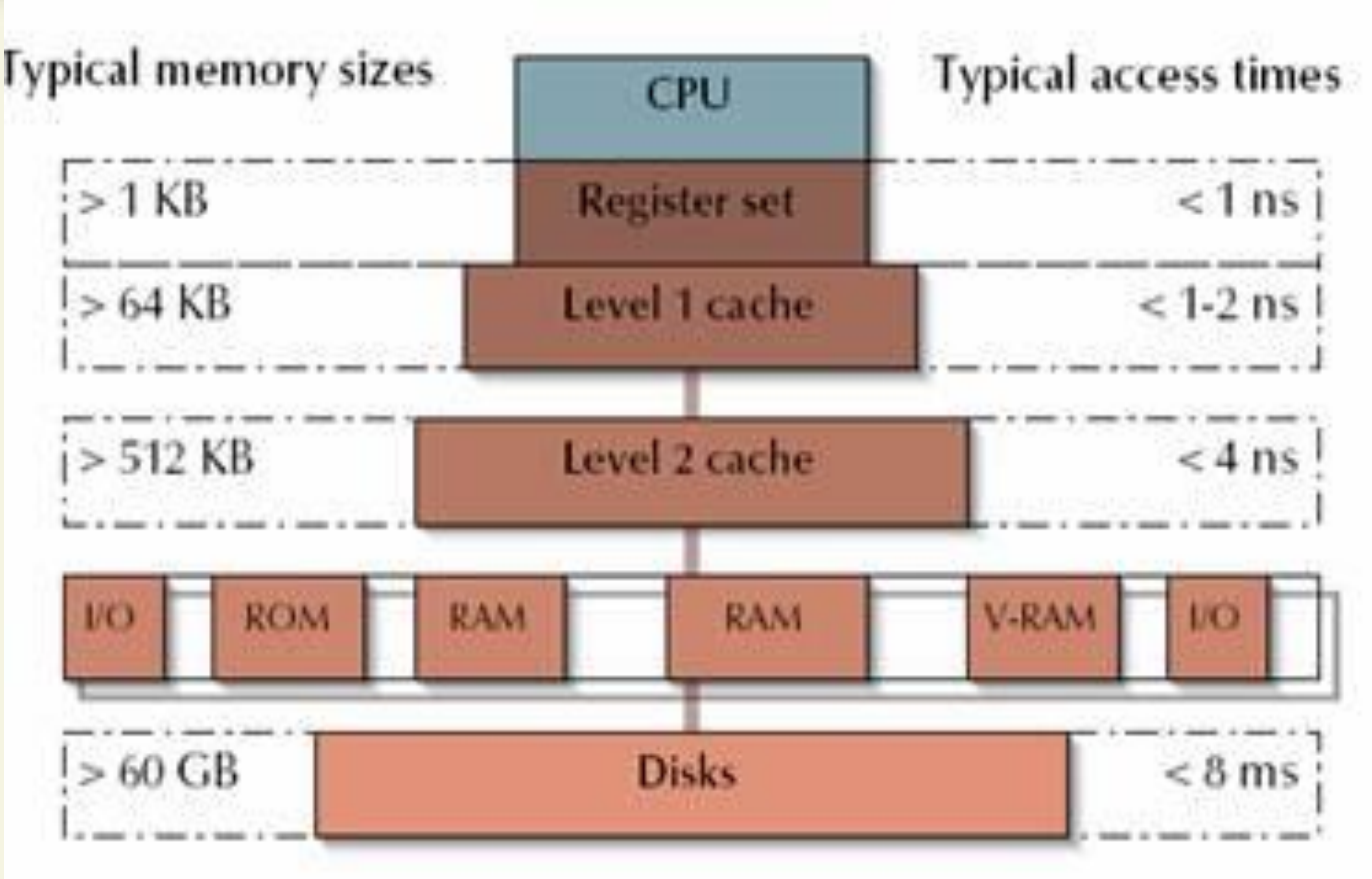
Processor	Data Bus	Register Size
8088	8-bit	16-bit
8086	16-bit	16-bit
286	16-bit	16-bit
386	32-bit	32-bit
486/AMD-5x86	32-bit	32-bit
Pentium/AMD-K6	64-bit	32-bit
Pentium Pro/Celeron/II/III	64-bit	32-bit
AMD Duron/Athlon/Athlon XP	64-bit	32-bit
Pentium 4	64-bit	32-bit
Itanium	64-bit	64-bit
AMD Athlon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

Intel Family Register Organization



Note: 32 bit registers are not available on 8086, 8088, or 80286

Memory Organization

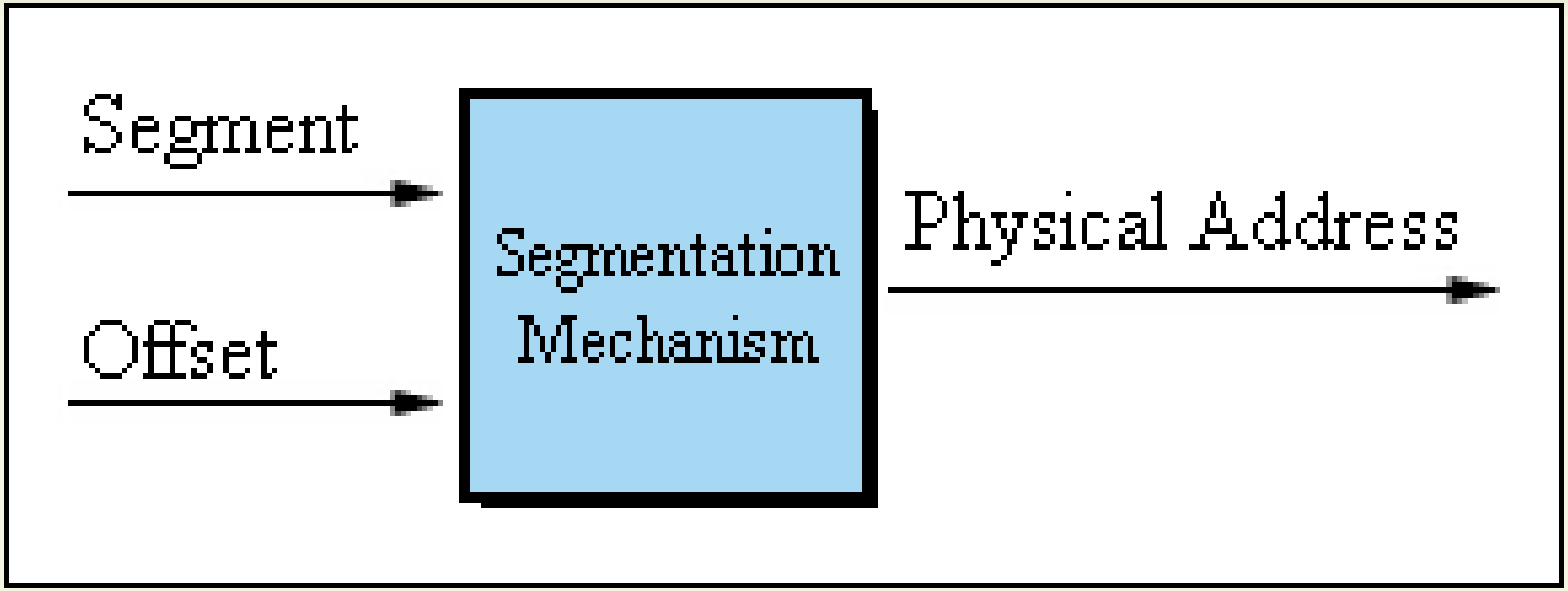


(Ref: Aurora Simionescu, Memory organization and access of 80x86 processors)

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

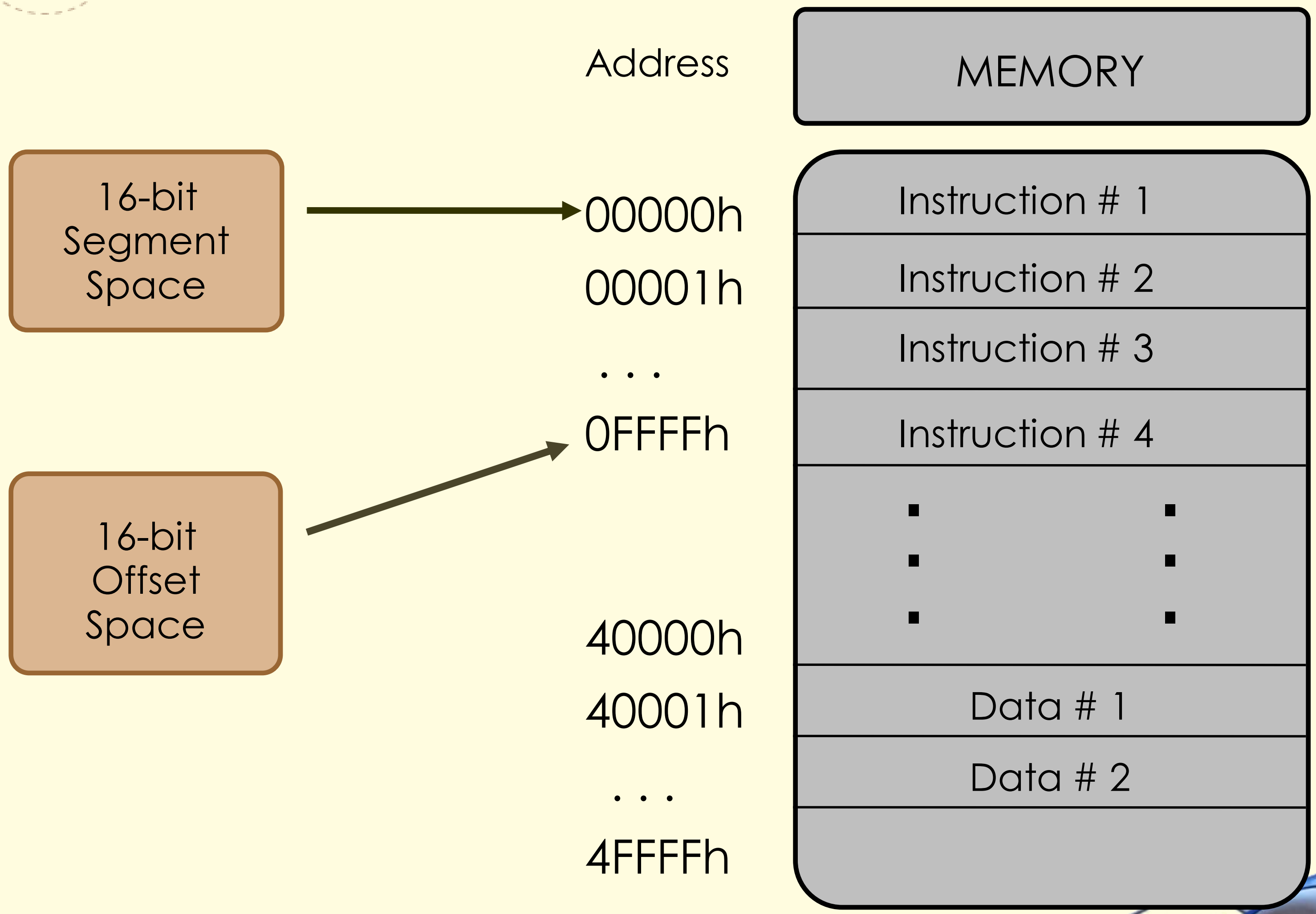


Real-mode memory translation process

Real Mode Memory Addressing

Segment Register	*Designated Role*
CS	**Code Segment Register** This register points to the currently active code segment. Used in conjunction with the IP register to point to the next instruction to be fetched and executed by the processor.
DS	**Data Segment Register** This register usually points to the default data segment which contains the global and static variables of the active application.
ES	**Extra Segment Register** General purpose segment register used mostly for data transfers between different segments.
SS	**Stack Segment Register** This register points to the segment containing the active stack. The top of stack is located at address SS:SP.
FS GS	**General Purpose Segment Registers** First introduced on the 80386, these segment registers can be used for any purpose in your application code.

Real Mode Memory Addressing



Address

MEMORY

16-bit Segment Space

16-bit Offset Space

00000h

00001h

. . .

0FFFFh

40000h

40001h

. . .

4FFFFh

Instruction # 1

Instruction # 2

Instruction # 3

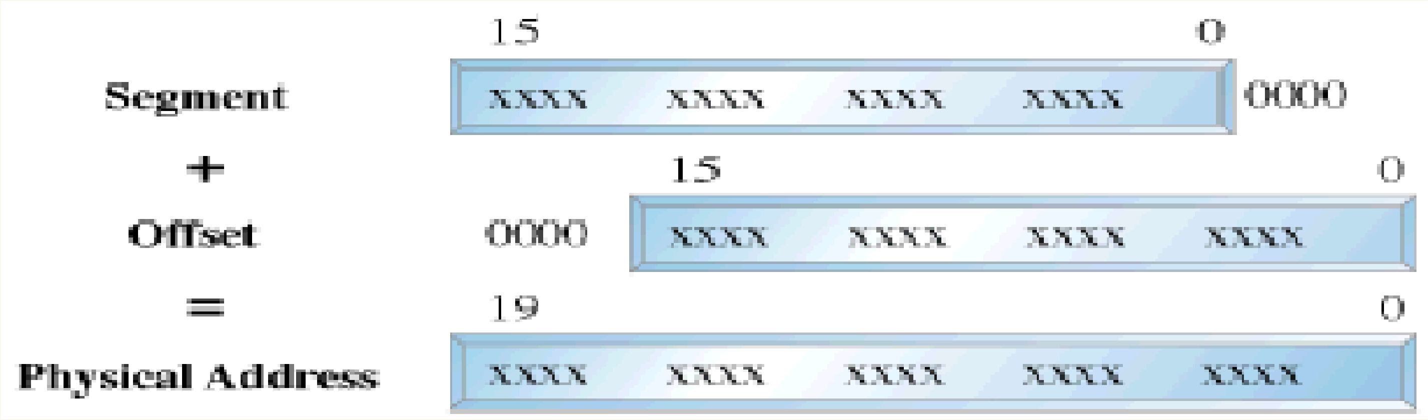
Instruction # 4

Data # 1

Data # 2

Real Mode Memory Addressing

- Characterized by a 20 bit segmented memory address space



Real Mode Memory Addressing

- instruction can address any space within the 1 MB of RAM
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- Ex. 1000:1F00

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$$\begin{array}{lr} & \mathbf{10000} \\ \mathbf{+} & \mathbf{1F00} \\ \hline & \mathbf{11F00} \end{array}$$

First, multiply the segment value by 10h.
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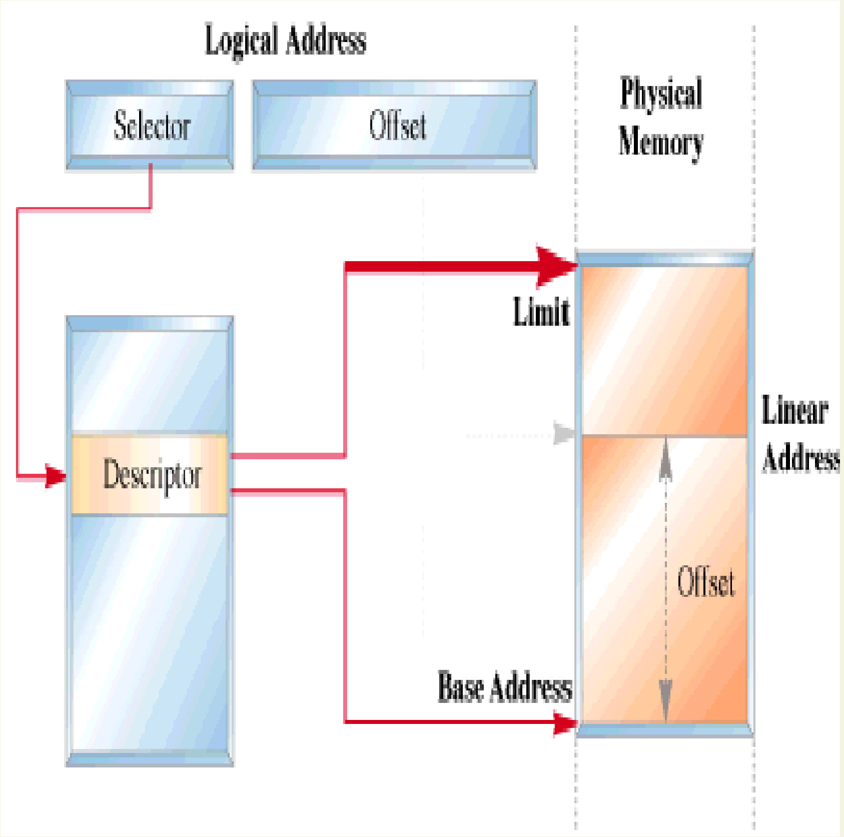
Real Mode Memory Addressing

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.

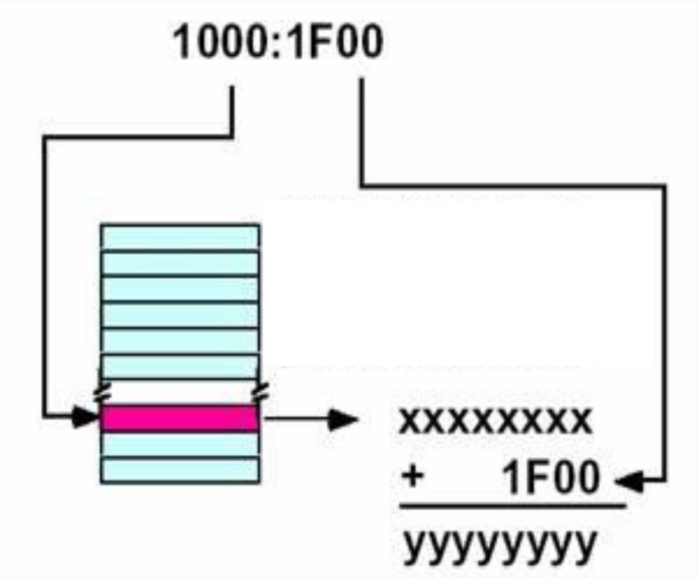
Protected Mode Memory Addressing



- 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



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.

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]