REAL MODE MEMORY ADDRESSING

Two Real modes of addressing on 80x86

Pentium 4 comes up in the **real-mode** after it is **reset**. It will remain in this mode unless it is switched to protected-mode by **software**.

• In real mode, the Pentium 4 operates as a very high performance 8086.

• Pentium 4 can be used to execute the **base instruction set** of the **8086** MPU (backward compatibility).

In addition, a number of **new** instructions (called **extended instruction set**) have been added to enhance its performance and functionality (such new instructions can be run in the real-mode as well as the protected-mode). In real-mode, only the first **1 M bytes** of memory can be addressed with the typical **segment:offset** logical address. Each **segment** is **64K bytes** long.

• Notice that the Pentium 4 microprocessor has **36 bit address bus**, which means it can support up to 236 = **64G bytes** of total memory (which cannot be addressed in real-mode but can be addressed in protected mode).

- **Real mode flat model** means
  - Strictly converting ***one*** *address value* into a *physically meaningful location* in the RAM.
- **Real mode segmented model** means
  - strictly converting ***two*** *address values* into a physically meaningful memory location.
  - gives access to one megabyte (1,048,576 bytes) of directly addressable memory, known as *real mode memory*.

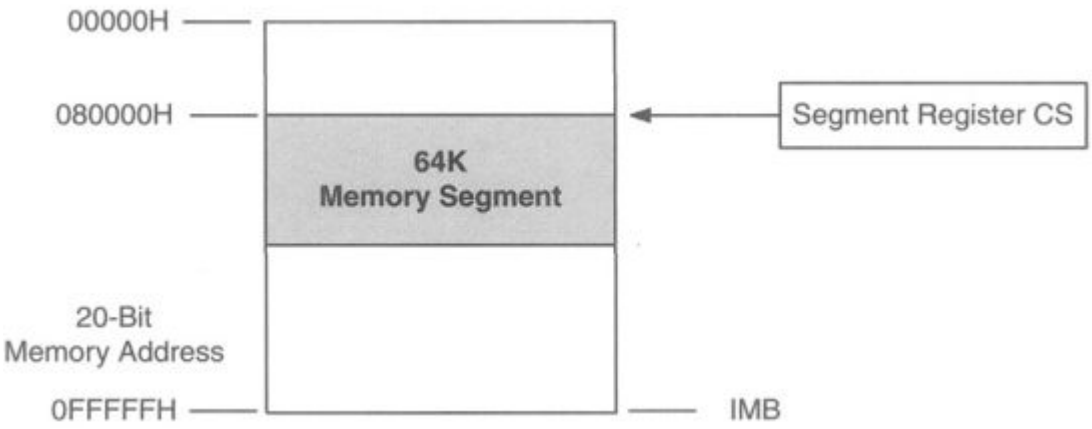
a. Segment Registers

- Segment registers are basically *memory pointers* located inside the CPU.
- Segment registers point to a place in memory where one of the following things begin:

1. Data storage

2. Code execution.

Example: *code segment register* CS points to a 64K region of memory:



b. Real Mode Segmented Model

- Segmented organization
  - 16-bit wide segments
- Two components
  - Base (16 bits)
  - Offset (16 bits)
- Two-component specification is called *logical address*, also called *effective address*.
- Logical address translates to a 20-bit *physical address*.

c. Real Mode Segmented Model, Cont.

Addresses are limited to 20 bits:

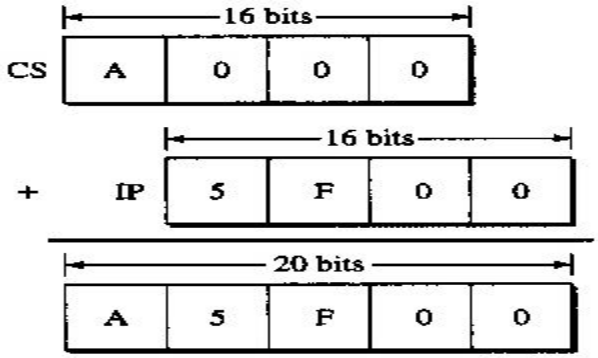
2^{20}=1,048,576 bytes.

Physical address is generated by adding a

16-bit segment register, shifted left four bits

plus a 16 bit-offset.

- Generating 20-bit **physical address** in Real Mode:



d. Problems Related to Segmentation

- Segmentation often caused grief for programmers who tried to access large data structures:
  - Since an offset cannot exceed 16 bits, you cannot increment beyond 64k.
  - Instead, program must watch out for a 64k boundary and then play games with the segment register.
- This nightmare was originally created to support CP/M-80 programs ported from 8080 chip to 8086.
  - Successful short-term thinking;
  - Catastrophically bad long-term thinking that resulted in never-ending Windows 9x problems!

e. Address Space in Real Mode

Address space in **real mode segmented model** runs from

- 00000h to 0FFFFFh, within *one megabyte of memory*.
- For compatibility reasons, Pentium CPU is capable of switching itself into real mode segmented model, is effectively *becoming* a good old 8086 chip!