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
  
  o Strictly converting one address value into a physically meaningful location in the RAM.

- Real mode segmented model means
  
  o strictly converting two address values into a physically meaningful memory location.
  
  o 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:

![Segment Register CS](image)

- **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:

  \[ 2^{20} = 1,048,576 \text{ bytes}. \]

  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:

![Diagram]

**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 0FFFFh, 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!