

Real Mode

Real mode, also called real address mode, is an operating mode of all x86-compatible CPUs. The mode gets its name from the fact that addresses in real mode always correspond to real locations in memory. Real mode is characterized by a 20-bit segmented memory address space (giving exactly 1 MiB of addressable memory) and unlimited direct software access to all addressable memory, I/O addresses and peripheral hardware. Real mode provides no support for memory protection, multitasking, or code privilege levels.

Before the release of the 80286, which introduced protected mode, real mode was the only available mode for x86 CPUs; and for backward compatibility, all x86 CPUs start in real mode when reset, though it is possible to emulate real mode on other systems when starting on other modes.

Protected mode

In computing, protected mode, also called protected virtual address mode, is an operational mode of x86-compatible central processing units (CPUs). It allows system software to use features such as virtual memory, paging and safe multi-tasking designed to increase an operating system's control over application software.

When a processor that supports x86 protected mode is powered on, it begins executing instructions in real mode, in order to maintain backward compatibility with earlier x86 processors. Protected mode may only be entered after the system software sets up one descriptor table and enables the Protection Enable (PE) bit in the control register 0 (CR0).

Protected mode was first added to the x86 architecture in 1982, with the release of Intel's 80286 (286) processor, and later extended with the release of the 80386 (386) in 1985. Due to the enhancements added by protected mode, it has become widely adopted and has become the foundation for all subsequent enhancements to the x86 architecture, although many of those enhancements, such as added instructions and new registers, also brought benefits to the real mode.

A20 line

The A20, or addressing line 20, is one of the electrical lines that make up the system bus of an x86-based computer system. The A20 line in particular is used to transmit the 21st bit on the address bus.

Global Descriptor Table [GDT]

The Global Descriptor Table (GDT) is a data structure used by Intel x86-family processors starting with the 80286 in order to define the characteristics of the various memory areas used during program execution, including the base address, the size, and access privileges like executability and writability. These memory areas are called segments in Intel terminology.

Cr0 Register

The CR0 register is 32 bits long on the 386 and higher processors. On x64 processors in long mode, it (and the other control registers) is 64 bits long. CR0 has various control flags that modify the basic operation of the processor.

It is used for enabling protected mode.

How the Code Works

- Enable the A20 line
- Set the VGA text mode to a known value
- Load 32bit GDT
- Enable protected mode
- Set Segment registers
- Print “Hello World! ” in protected mode
- Print value of cr0 register in binary

Boot Instructions

On the terminal, go to the directory with the .asm file and type:

```
nasm -f bin -o Q1_boot_2019341.bin Q1_boot_2019341.asm
```

Now, you have the required bootable binary file

To run, it in qemu emulator:

```
qemu-system-i386 -fda Q1_boot_2019341.bin
```

The emulated bootloader will print “Hello World!” and the value of cr0 register on the screen.