

## 12.15.2 Boot Process Facts

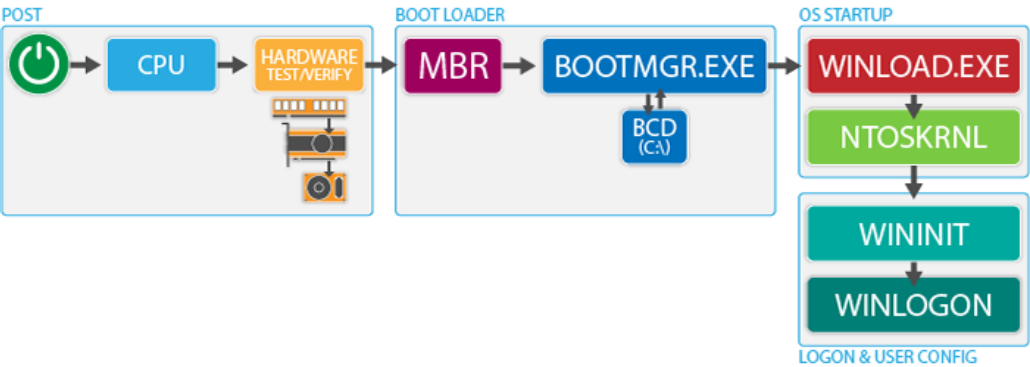
Windows systems can boot using either a legacy BIOS or a UEFI boot sequence. By understanding each of these boot sequences, you can focus troubleshooting efforts on the most likely errors.

This lesson covers the following topics:

- BIOS boot
- UEFI boot

### BIOS Boot

The following diagram and table describe the four basic stages of the Legacy BIOS boot sequence:

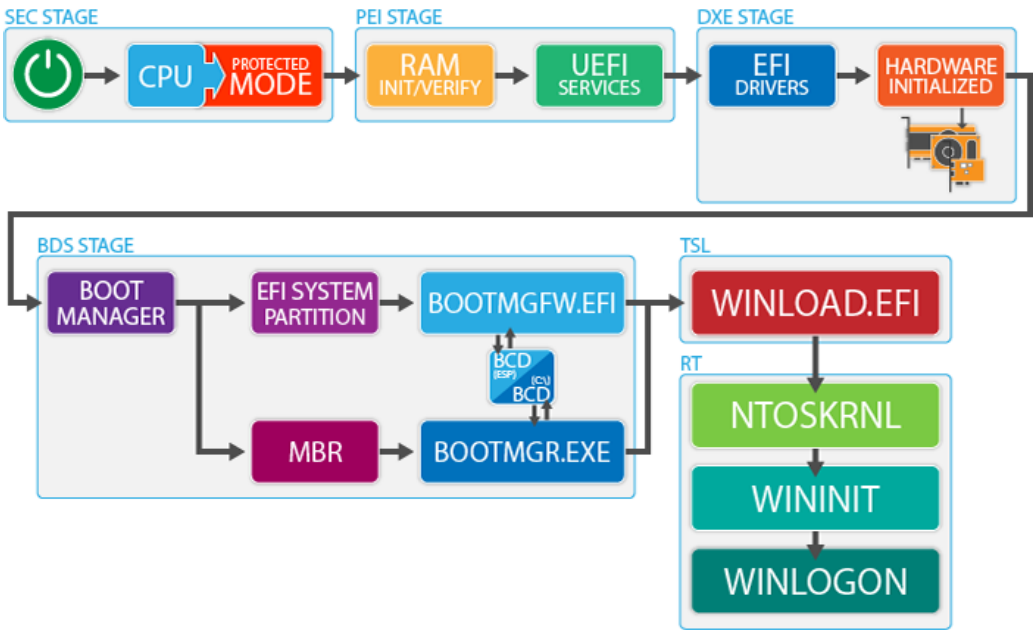


Stage	Process
POST (power-on self-test)	<p>On a system using BIOS, the following steps take place:</p> <ol style="list-style-type: none"><li>1. Power is supplied to the CPU. The CPU is hard-coded to look at a special memory address that contains a pointer (or jump program), that instructs the CPU where to find the BIOS program.</li><li>2. The CPU loads the BIOS program. The first BIOS process to run is the POST, which performs the following tasks:<ol style="list-style-type: none"><li>a. Verifies the integrity of the BIOS code.</li><li>b. Tests and initializes the following hardware devices one by one:<ul style="list-style-type: none"><li>■ Locates, sizes, and verifies system memory</li><li>■ Verifies and initializes video card (output displayed on monitor)</li><li>■ Identifies available hard disks</li></ul></li></ol></li><li>3. After POST tests complete, the BIOS identifies other system devices. It uses CMOS settings and information supplied by the devices themselves to identify and configure hardware devices. Plug-and-play devices are allocated system resources. The system typically displays information about the keyboard, mouse, and SATA drives in the system. Following this summary, you will also see information about devices and system resources.</li><li>4. The BIOS then searches for a boot drive (using the boot order specified in the CMOS).</li></ol> <p>During this sequence, system information is displayed on the screen and the option to enter the CMOS setup to configure system parameters is available.</p>
Boot loader	<p>During the boot loader stage, the following process occurs:</p> <ol style="list-style-type: none"><li>1. On the boot device, the BIOS searches for and loads the boot code in the master boot record (MBR). The MBR is located in the first sector on the disk.</li><li>2. The MBR boot code uses the partition table to identify the active disk partition.</li><li>3. On the active partition, it looks for and loads the bootmgr.exe program.</li><li>4. The bootmgr.exe program looks for the BCD store in either the C:\ directory or the System Reserved partition. The BCD store contains a list of all Windows installations on the disk.</li><li>5. If only one installation exists, bootmgr.exe automatically loads the OS. If multiple</li></ol>

	<p>installations exist, a list of bootable operating systems is displayed.</p> <p>This stage occurs after the BIOS information screen disappears, but before the Windows loading screen is shown.</p>
OS startup	<p>During this stage, the operating system is started. The operating system configures system devices and loads necessary files. The following process occurs:</p> <ol style="list-style-type: none"><li>1. The operating system loader winload.exe is started. At this stage, advanced startup options (e.g., Safe Mode) can be accessed by pressing the F8 key .</li><li>2. Winload.exe then loads the following:<ul style="list-style-type: none"><li>▪ System registry</li><li>▪ Ntoskrnl.exe</li><li>▪ Essential device drivers</li></ul></li><li>3. Control of the system is passed to ntoskrnl.exe.</li><li>4. At this point, the Windows logo is displayed and ntoskrnl.exe:<ul style="list-style-type: none"><li>▪ Loads device drivers.</li><li>▪ Starts services.</li><li>▪ Configures the OS environment.</li></ul></li></ol>
Logon and user configuration	<p>After the operating system and devices are configured, the system waits for user logon. Following logon, the operating system is configured with user-specific settings.</p> <ol style="list-style-type: none"><li>1. The wininit and winlogon programs run to allow user logon. At this point, the Welcome or user logon screen is displayed.</li><li>2. Following logon, all remaining device drivers and user settings are loaded. In addition, the current configuration profile is copied to the Last Known Good Configuration registry.</li></ol>

UEFI Boot

The Unified Extensible Firmware Interface (UEFI) is a newer specification that defines the software interface between an operating system and the computer's firmware. The following diagram and table describe the different stages of the UEFI boot sequence:



Stage	Process
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SEC (Security)	<p>Immediately after the system is powered on, the SEC sequence begins.</p> <ol style="list-style-type: none"> <li>1. Power is supplied to the CPU.</li> <li>2. The CPU switches from 16-bit Real Mode to 64-bit Protected Mode.</li> <li>3. The CPU executes a specific set of instructions to prepare the system for PEI to run.</li> </ol>
PEI (Pre-EFI Initialization)	<p>PEI initializes the system and prepares for the DXE.</p> <ol style="list-style-type: none"> <li>1. The CPU and chipset are verified and fully initialized.</li> <li>2. System memory is initialized, verified, and allocated.</li> <li>3. PEI modules are loaded to allocate system resources.</li> <li>4. The DXE is initialized and the system is prepared to transition to DXE.</li> </ol>
DXE (Driver Execution Environment)	<p>DXE initializes configured devices, mounts drives, and prepares to boot the OS.</p> <ol style="list-style-type: none"> <li>1. Device drivers are loaded into memory.</li> <li>2. Hardware devices are initialized simultaneously (e.g., video card, network card, USB controllers).</li> <li>3. System drives are mounted and initialized.</li> <li>4. The EFI boot manager is initialized.</li> </ol>
BDS (Boot Device Selection)	<p>The BDS stage runs the EFI boot manager, which identifies the system's boot configuration settings and decides how to boot the system.</p> <ol style="list-style-type: none"> <li>1. If an EFI System Partition (ESP) exists, the following process occurs: <ol style="list-style-type: none"> <li>a. On the ESP in the \EFI\Microsoft directory, the boot manager looks for and runs the bootmgfw.efi file.</li> <li>b. The bootmgfw.efi looks for the BCD store in the same directory that contains a list of all Windows installations.</li> <li>c. If only one installation exists, UEFI automatically loads it. If multiple installations exist, a list of bootable operating systems is displayed.</li> </ol> </li> <li>2. If no ESP exists, the boot manager uses Legacy BIOS mode to complete the boot sequence: <ol style="list-style-type: none"> <li>a. The MBR looks for and loads the bootmgr.exe program.</li> <li>b. The bootmgr.exe program looks for the BCD store in either the C:\ directory or the System Reserved partition.</li> <li>c. If only one installation exists, bootmgr.exe automatically loads the OS. If multiple installations exist, a list of bootable operating systems is displayed.</li> </ol> </li> </ol> <p>At the beginning of the BDS stage, the UEFI interface is executed and the option to load the EFI Shell or enter the UEFI configuration is available.</p>
TSL (Transient System Load)	<p>During TSL stage, the operating system loader is located and booted.</p> <ol style="list-style-type: none"> <li>1. The BCD store is used to identify the location of the operating system loader (for Windows, the default location is C:\Windows\system32\winload.efi).</li> <li>2. The operating system loader winload.efi is started.</li> <li>3. Winload.efi then loads the following elements: <ol style="list-style-type: none"> <li>a. System registry</li> <li>b. Ntoskrnl.exe</li> <li>c. Essential device drivers</li> </ol> </li> </ol>
RT (Run Time)	<p>After the operating system and devices are configured, the system waits for user logon. Following logon, the operating system is configured with user-specific settings.</p> <ol style="list-style-type: none"> <li>1. Control of the system is passed to ntoskrnl.exe.</li> <li>2. At this point, the Windows logo is displayed and ntoskrnl.exe: <ul style="list-style-type: none"> <li>■ Loads device drivers.</li> <li>■ Starts services.</li> <li>■ Configures the OS environment.</li> </ul> </li> <li>3. The wininit and winlogon programs run to allow user logon (at this point, the Welcome screen is displayed).</li> <li>4. Following logon, all remaining device drivers and user settings are loaded. In</li> </ol>

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Even though it seems to have more stages, the UEFI boot sequence is considerably faster than the BIOS boot sequence.