Configuring server boot options on 14th generation Dell EMC PowerEdge servers

This technical white paper describes the options available from PowerEdge BIOS to manage and control boot sources such as hard drives, solid-state drives (SSDs), PXE servers, and HTTP network shares for both legacy BIOS and UEFI mode.

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Executive summary

The BIOS for the 14th generation of Dell EMC PowerEdge servers supports a wide-range of sources for bootstrapping Operating Systems (OSs), hypervisors, diagnostic programs, and other executable programs. While the industry continues the transition from legacy BIOS to the Unified Extensible Firmware Interface (UEFI), PowerEdge BIOS provides server administrators with manual and programmable methods for discovering, ordering, and enabling boot sources.

This technical white paper describes the options available from PowerEdge BIOS to manage and control boot sources such as hard drives, solid-state drives (SSDs), PXE servers, and HTTP network shares for both legacy BIOS and UEFI mode. Examples are provided to guide the configuration of boot mode, sources, and sequence by using the BIOS Graphical User Interface (GUI) and programmable methods including Dell EMC RACADM Command Line Interface (CLI).

1 Introduction

Over the lifetime of a server, evolving uses may necessitate changes in the operating software or the source of the operating software for server bootstrap. Variances in IT operational processes can also impact the form of server boot – USB drives, PXE boot of network stored images, UEFI HTTP boot, and SAN boot are a few of the possible options in addition to booting from server local hard drive storage. Further, to facilitate maintenance operations and provide assurance of a successful server boot, administrators may have to provide a sequence of boot options that can be attempted in a particular order.

Because boot sources may vary over time, modern server BIOS must provide administrators with options to select specific boot sources and the means to order those options as dictated by IT processes.

The BIOS for the 14th generation of Dell EMC PowerEdge servers supports a wide range of sources for bootstrapping operating systems (OSs), hypervisors, diagnostic programs, and other executable programs. PowerEdge BIOS provides server administrators with manual and programmable methods for discovering, ordering, and enabling selected boot sources, supporting these options in either legacy BIOS mode or Unified Extensible Firmware Interface (UEFI) mode.

This technical white paper describes the boot options of the PowerEdge BIOS and provides illustrated examples for managing the sources and sequence for boot operations.

2 Understanding PowerEdge boot mode

The 14th generation of Dell EMC PowerEdge servers supports both legacy BIOS mode and Unified Extensible Firmware Interface (UEFI) mode. Legacy BIOS boot mode is used to boot older OSs or diagnostic software that do not follow the UEFI standard—UEFI boot mode is used for booting newer UEFI-aware software. Note that the term "BIOS" is often used to refer to the server firmware that initializes the hardware and loads the OS, regardless of the current Boot Mode.

For more information about PowerEdge support for legacy BIOS and UEFI modes, see the white paper Boot Mode Considerations: BIOS vs. UEFI available on the Dell EMC TechCenter.

The version-dependent features of 14G BIOS are described hereafter in this technical white paper. To enable the features below, ensure that your 14G servers are operating by using the following versions:

Table 1 Minimum required BIOS version for latest BIOS boot sequence features

PowerEdge Model	BIOS Version
R440	1.4.5
R540	1.4.5
R640	1.4.5
R740	1.4.5
R740xd	1.4.5
R940	1.4.5
FC640	1.4.5
M640	1.4.5
T440	1.4.5
T640	1.4.5
C6420	1.4.5
R7920	1.4.5
R840	1.2.0 or later
R940xa	1.2.0 or later
C4140	1.2.6
R6415	1.4.0 or later
R7415	1.4.0 or later
R7425	1.4.0 or later

2.1 Differences in boot mode

In the UEFI Boot mode, the boot loader is stored as an executable file on a .FAT file system. The BIOS can potentially have multiple boot options, each pointing to different files on the same storage device.

In the legacy BIOS Boot mode, the boot loader is stored on the Master Boot Record (MBR) of a storage device. From the legacy BIOS Boot Mode point of view, a boot device has only a single boot entry.

2.2 Boot mode BIOS settings

The BIOS Boot Mode can be set by using a number of interfaces: BIOS User Interface, RACADM command line interface (CLI), iDRAC WS-Man, iDRAC RESTful application programming interfaces, and also an iDRAC Server Configuration Profile (SCP) file. Throughout this technical white paper, examples are provided by using the BIOS user interface and RACADM CLI. For more information about using WS-Man, iDRAC RESTful API, or an SCP file to configure PowerEdge BIOS settings, visit the iDRAC home page delltechcenter.com/idrac to access the product documentation, white papers, and other resources.

When using the BIOS user interface or RACADM, use these attributes to set the BIOS boot mode:

Table 2 Boot mode BIOS settings

	BIOS User Interface	RACADM
Attribute	Boot Mode	BIOS.BiosBootSettings.BootMode
Possible Values	- UEFI - BIOS	- Uefi - Bios

Note: BIOS attribute changes require a server reboot to make the changes effective. Changes to BIOS attributes such as those shown in the following examples mark the attributes with pending changes; those changes are applied when the server is rebooted.

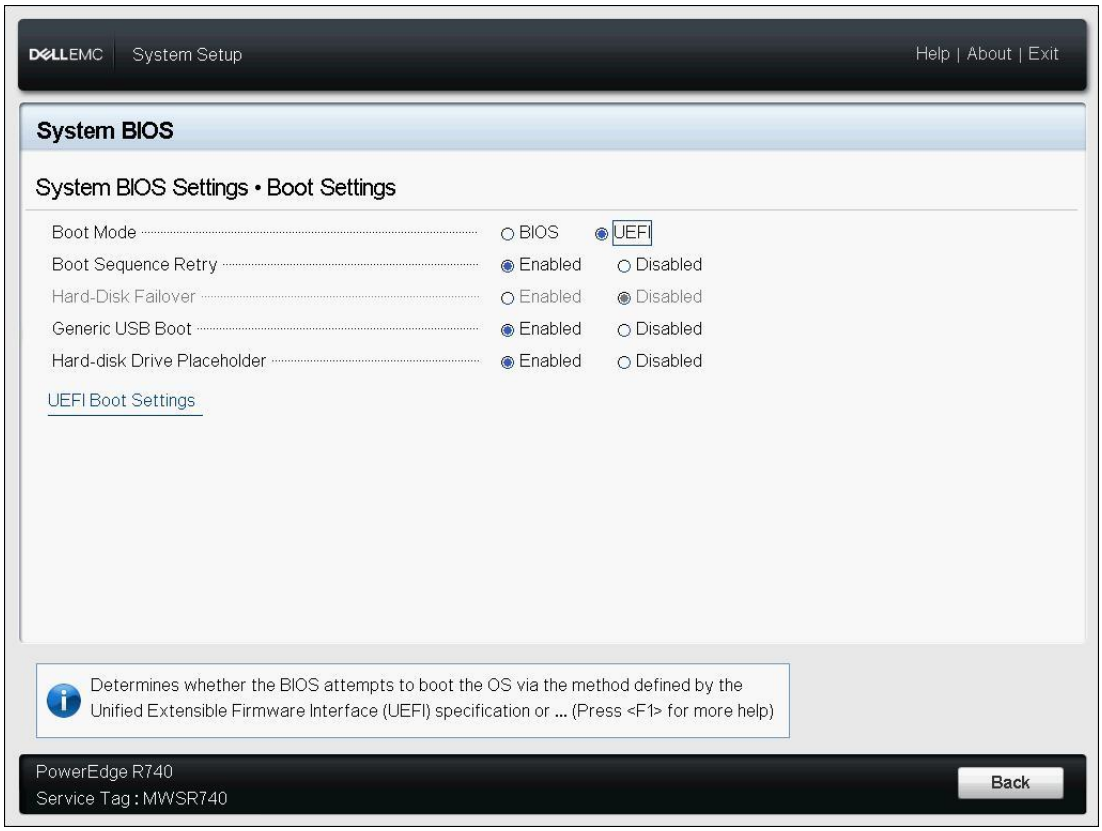

Figure 1 Selecting UEFI boot mode via BIOS user interface

```
C:\Users\Administrator>racadm set BIOS.BiosBootSettings.BootMode Bios
[Key=BIOS.Setup.1-1#BiosBootSettings]
RAC1017: Successfully modified the object value and the change is in
       pending state.
       To apply modified value, create a configuration job and reboot
       the system. To create the commit and reboot jobs, use "jobqueue"
       command. For more information about the "jobqueue" command, see RACADM
       help.
```

Figure 2 Selecting legacy boot mode by using RACADM

3 Boot Sequence

The PowerEdge BIOS creates and maintains a list of boot options. In legacy BIOS boot mode, each boot option refers to a bootable legacy device found on the system. In the UEFI boot mode, each boot option refers to a bootable UEFI device or a specific UEFI image file on a boot device. In either boot mode, the boot list is retained across server reboots. After each server boot, the BIOS performs boot option enumeration, scanning the devices currently available on the system and updating the boot list to include the currently available devices. The BIOS enumerates only boot options for the current boot mode.

The Boot Sequence dictates the order in which the boot options will be attempted by the BIOS to boot an OS or other program. During boot option enumeration, boot options for newly discovered devices are added to the end of the boot list. The boot sequence lists are handled differently in UEFI and legacy BIOS Boot Mode.

3.1 Default Boot Sequence

The following is the default boot order for all the PowerEdge servers:

- **Floppy —** USB floppy, floppy-emulated USB key, floppy-emulated virtual, and floppy-emulated vFlash
- **Optical —** ATA, USB, and virtual CD, or virtual DVD
- **Hard Disk —** ATA, SAS, RAID, or HBA, USB, virtual, vFlash, and SCSI, if implemented as HDD boot device
- **Network —** PXE and iSCSI, if implemented as network boot device
- **Other —** All other devices not matching the above criteria - such as user created UEFI boot options

These default boot order applies to both the legacy and UEFI boot lists. The legacy hard drive sequence however does not have a default ordering. Hard drives are added to the end of the hard drive sequence in the order they are discovered by BIOS—typically this follows a port number ordering but this is not guaranteed.

3.2 UEFI Boot Sequence

3.2.1 Removable media

In UEFI Boot Mode, removable media (see Floppy and Optical items in the earlier section) is automatically added to the boot sequence. When a boot attempt is made for a removable media boot entry, BIOS will attempt to boot to the file `efi\boot\bootx64.efi` from a FAT file system on the removable media device, if it exists.

3.2.2 Fixed disk drives

In UEFI Boot Mode, fixed media (see Hard Disk items in the earlier section) may or may not be added to the boot sequence. Unlike legacy Boot Mode, in UEFI Boot Mode, the OS has the ability to add to and modify the boot sequence.

The most common way for a boot entry for a fixed disk drive such as a PERC RAID controller virtual drive to be added is by the OS. During the OS installation process, the OS adds an entry for itself and places it first in the boot sequence.

If an OS has not been installed, it is still possible to have a UEFI boot entry. A boot entry for a fixed disk will be added if the file `efi\boot\bootx64.efi` exists on a FAT filesystem.

3.2.3 Hard Disk drive placeholder

In certain instances, administrators may wish to reserve a boot entry for a fixed disk in the UEFI Boot Sequence before an OS is installed or before a physical or virtual drive has been formatted. When a Hard-Disk Drive Placeholder is set to Enabled, the BIOS will create a boot option for the PERC RAID (Integrated or in a PCIe slot) disk if a partition is found, even if there is no FAT filesystem present. When set to Disabled, BIOS will only add a boot option if a UEFI boot file is found.

This allows the Integrated RAID controller to be moved in the UEFI Boot Sequence prior to the OS installation.

The Hard-disk Driver Placeholder default is disabled and can be changed with the following BIOS Attribute. It is available only in UEFI Boot Mode.

Table 3 Hard drive placeholder settings

	Name	Programmatic Name
Attribute	Hard-disk Drive Placeholder	HddPlaceholder
Possible Values	- Disabled - Enabled	- Disabled - Enabled

3.2.4 Summary of how UEFI Fixed-disk Boot Options are displayed in BIOS

- When OS has not been installed, “efi\boot\bootx64.efi” does not exist, and the BIOS Attribute Hard-disk Drive Placeholder is set to Enabled.

- When OS has not been installed, but “efi\boot\bootx64.efi” exists:

- When OS has been installed (in this example Microsoft Windows Server):

3.2.5 Generic USB Boot

In addition to enabling reservation of virtual drives within the boot sequence, administrators may want to reserve a boot entry for USB Boot Options, so it can be placed in the UEFI Boot Sequence even when the device is not present. This allows a USB drive to be added or removed without affecting its position in the boot sequence.

When enabled, a “Generic USB” entry will be placed in the UEFI Boot Sequence. When BIOS is iterating through the boot sequence and detects this option, it will attempt to boot the first external or iDRAC virtual USB device in the UEFI Boot Sequence.

By default, the USB Boot placeholder feature is disabled and can be changed with the following BIOS Attribute. It is available only in UEFI Boot Mode.

Table 4 Generic USB Boot settings

	Name	Programmatic Name
Attribute	Generic USB Boot	GenericUsbBoot
Possible Values	- Disabled - Enabled	- Disabled - Enabled

3.3 BIOS Boot Sequence

The legacy BIOS Boot Sequence consists two lists:

- A parent list containing boot options for every legacy device in the system and a child list.
- The hard drive list, which defines the boot order of hard drives. For hard drives, only one entry is added to the hard drive list per storage controller (for example, one entry per PERC).

3.4 BIOS Sequence Retry

The PowerEdge BIOS provides the option to retry boot operations. The Boot Sequence Retry attribute controls if BIOS reattempts the Boot Sequence after every 30 seconds. The primary use case is to support reattempting a PXE boot if the PXE server was not initially available. Boot Sequence Retry is enabled by default.

Table 5 BIOS Sequence Retry settings

	Name	Programmatic Name
Attribute	Boot Sequence Retry	BootSeqRetry
Possible Values	- Enabled - Disabled	- Enabled - Disabled

3.5 Changing Boot Sequence

After the Boot sequence is established, changes in operational processes might necessitate changing the order in which a boot operation is attempted. There are two sets of BIOS Attributes that can be used modify the boot sequence.

3.5.1 Boot Sequence Attributes

The BIOS Boot Sequence can be altered by using the BIOS User Interface or one of the programmable interfaces. Using the BIOS User Interface, on the **System Setup** page (click F2 when the company logo is displayed during boot), select **Boot Settings → UEFI Boot Settings** to view the list of boot devices. Select

the required boot device and use the '+' key to move the selected device up (earlier) or the '-' key (later) in the Boot Sequence.

Using a programmatic interface such as RACADM, the UefiBootSeq attribute will contain a comma-delimited list of boot entries in Fully-Qualified Device Descriptor (FQDD) format. To change the Boot Sequence, get the current attribute value, rearrange the list with the desired sequence, and then set the attribute to update the Boot Sequence. All entries returned in the existing UefiBootSeq, and only those entries, must be provided in the updated list.

Table 6 Boot Sequence settings

	Name	Programmatic Name
Attribute (UEFI Boot Mode)	UEFI Boot Sequence	UefiBootSeq
Attribute (BIOS Boot Mode)	Boot Sequence	BootSeq
	Hard-Disk Drive Sequence	HddSeq
Possible Values	An enumerated list of boot devices that can be changed in F2 BIOS Setup.	A comma-delimited list of the boot devices using programmatic names.

Here is a programmatic example by using the RACADM CLI:

1. Obtain the current boot sequence.

```
C:\Users\Administrator>racadm get bios.bootsettings.uefibootseq
[Key=BIOS.Setup.1-1#bootsettings]
UefiBootSeq=Disk.SATAEmbedded.E-1,NIC.PxeDevice.1-1
```

2. Set a new boot sequence with PXE first.

```
C:\Users\Administrator>racadm set bios.bootsettings.uefibootseq NIC.PxeDevice.1-1,Disk.SATAEmbedded.E-1,Floppy.iDRACVirt
ual.1-1,Optical.iDRACVirtual.1-1
[Key=BIOS.Setup.1-1#bootsettings]
RAC1017: Successfully modified the object value and the change is in
       pending state.
       To apply modified value, create a configuration job and reboot
       the system. To create the commit and reboot jobs, use "jobqueue"
       command. For more information about the "jobqueue" command, see RACADM
       help.
```

3.5.2 SetBootOrderFqddN

A more flexible means to programmatically set the boot order is provided by the use of the SetBootOrderFqddN attributes, where N is 1–16. Note that these attributes are not available from the BIOS User Interface.

Table 7 SetBootOrderFqddN settings

	Programmatic Name
Attribute	SetBootOrderFqdd1 – SetBootOrderFqdd16
Possible Values	A comma-delimited list of the boot devices using programmatic names.

Using the SetBootOrderFqddN attributes provides a more flexible method of changing Boot Sequence and has several benefits versus using the Boot Sequence attributes including:

- The device is not required to be present in the boot list on current boot. This allows enabling a device and setting its place in the boot sequence with a single job or reboot.
- Only the necessary devices must to be specified; not necessary to read/modify/write the boot sequence.

Details for using SeqBootOrderFqddN attributes:

- The value for each SetBootOrderFqddN attribute specifies one or more boot devices.
- The attributes are processed in order—SetBootOrderFqdd1 will be applied first, followed by SetBootOrderFqdd2, and so on.
- If a specified device is not present on the system, it is skipped by BIOS.
- Unlike many BIOS attributes which are set to a state, SetBootOrderFqddN attributes are “one-shot” attributes. They are processed once on the subsequent server boot to update the boot order, and then they are reset (values deleted). Because the values are not retained, there are no values provided if a SetBootOrderFqddN attribute is read.

As an example, the following RACADM sequence illustrates enabling PXE boot and placing it first in the boot order. At the start of this example, the boot sequence does not include PXE. Using the UefiBootSeq attribute, PXE must be enabled first, the server rebooted, and then the UefiBootSeq could be modified to place PXE first in the sequence. That process can be simplified by using the SetBootOrderFqddN attributes.

1. View the current boot sequence.

```
C:\Users\Administrator>racadm get bios.bootsettings.uefibootseq
[Key=BIOS.Setup.1-1#bootsettings]
UefiBootSeq=Disk.SATAEmbedded.E-1,NIC.PxeDevice.1-1,Floppy.iDRACVirtual.1-1,Optical.iDRACVirtual.1-1
```

2. Enable PXE boot, set boot sequence, and then apply job by rebooting the server:

```
C:\Users\Administrator>racadm set bios.networksettings.PxeDev1EnDis Enabled
[Key=BIOS.Setup.1-1#networksettings]
RAC1017: Successfully modified the object value and the change is in
       pending state.
       To apply modified value, create a configuration job and reboot
       the system. To create the commit and reboot jobs, use "jobqueue"
       command. For more information about the "jobqueue" command, see RACADM
       help.

C:\Users\Administrator>racadm set bios.PxeDev1Settings.PxeDev1Interface NIC.Integrated.1-1-1
[Key=BIOS.Setup.1-1#PxeDev1Settings]
RAC1017: Successfully modified the object value and the change is in
       pending state.
       To apply modified value, create a configuration job and reboot
       the system. To create the commit and reboot jobs, use "jobqueue"
       command. For more information about the "jobqueue" command, see RACADM
       help.

C:\Users\Administrator>racadm set bios.biosbootsettings.SetBootOrderFqdd1 NIC.Integrated.1-1-1
[Key=BIOS.Setup.1-1#biosbootsettings]
RAC1017: Successfully modified the object value and the change is in
       pending state.
       To apply modified value, create a configuration job and reboot
       the system. To create the commit and reboot jobs, use "jobqueue"
       command. For more information about the "jobqueue" command, see RACADM
       help.
```

```
C:\Users\Administrator>racadm jobqueue create BIOS.Setup.1-1 -r pwrcycle -s TIME_NOW
RAC1024: Successfully scheduled a job.
Verify the job status using "racadm jobqueue view -i JID_xxxxx" command.
Commit JID = JID_288238804866
Reboot JID = RID_288238805124
```

4 Summary

The BIOS for the 14th generation of Dell EMC PowerEdge servers supports a wide-range of sources for bootstrapping Operating Systems (OSs), hypervisors, diagnostic programs, and other executable programs. While the industry continues the transition from legacy BIOS to the Unified Extensible Firmware Interface (UEFI), PowerEdge BIOS provides server administrators with manual and programmable methods for discovering, ordering, and enabling boot sources.

This technical white paper describes the options available from PowerEdge BIOS to manage and control boot sources such as hard drives, solid-state drives (SSDs), PXE servers, and HTTP network shares for both legacy BIOS and UEFI mode.

5 Additional Information

- For more information on iDRAC9 and 14G BIOS, visit the BIOS section of the iDRAC9 white paper library on Dell Techcenter http://delltechcenter.com/idrac
- Details on using the RACADM command line interface are available from http://en.community.dell.com/techcenter/systems-management/w/wiki/3205.racadm-command-line-interface-for-drac
- The Unified Extensible Firmware Interface (UEFI) is documented here http://www.uefi.org/