

Intel® Ethernet Controller E810
64-Bit Legacy PXE

Application Note

Ethernet Products Group (EPG)

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Revision 1.1
737242-001

Revision History

Revision	Date	Comments
1.1[1]	March 14, 2024	Initial public release.

1. There are no previous publicly-available versions of this document.

1.0 PXE and the Preboot Process

The preboot process allows you to load an operating system onto a new server from a remote location. You can simply rack a server, connect it to the network, and have the system come up with no additional interaction. However, in the background, there are many things happening to make this a seamless process.

When the server is plugged into the rack and connected to a network, the network must have a PXE server for the remote boot process to be successful. To simplify the explanation, this discussion is limited to PXE boot.

The PXE server contains an existing operating system image ready to be transferred to the requesting PXE client. This operating system image often contains specific information about the network, such as DNS settings and file share locations that have been configured by the network system administrator.

It takes time to set up an operating system with all location and DNS information, but time savings is realized when this operating system is installed many times. Some data centers, such as financial and medical, are required by law to periodically clean their systems of all data, and the preboot process can be used here as well.

The method of plugging the server into a rack and finding the right location of a PXE server is simple. When the server is attached to the rack and turned on, the PXE client software sends out a DHCP Discover request, as shown in Figure 1.

```
0.0.0.0                 255.255.255.255         DHCP        594 DHCP Discover
192.168.169.100         255.255.255.255         DHCP        342 DHCP Offer
0.0.0.0                 255.255.255.255         DHCP        590 DHCP Request
192.168.169.100         255.255.255.255         DHCP        342 DHCP ACK
```

Figure 1. PXE Client Using the DHCP Protocol to Locate a PXE Server and Allocate an IP Address to the Client

The PXE server and client communicate back and forth with an **Offer**, a **Request**, and an Acknowledgment (**ACK**), finalizing the process of the PXE client locating the PXE server. Now, the PXE server sends an operating system image to the PXE client to install.

Sometimes the client can be offered a menu of operating systems from which to choose, but most data centers offer only one highly-customized operating system image to fill their needs. After the operating system image is completely transferred to the PXE client, the PXE client releases control to the system on which it is running, and the system starts installing the operating system image.

2.0 Legacy PXE and 32-Bit Addressing

Legacy PXE has been around since the PXE specification was first published in 1999. At the time, computers had limited hardware compared to today's computers. 32-bit microprocessors where common and memory was limited.

When PXE boots up, it initially boots in real mode (16-bit). Since the introduction of the Intel® 80386 processor, the preboot environment can use a real mode, which allows for 32-bit addressing.

Before the introduction of the Intel® Ethernet 800 Series (Intel® Ethernet 800 Series), the Intel® Boot Agent (PXE) only understood 32-bit addresses. If PXE is run in a 64-bit environment, the 64-bit addresses are truncated down to 32-bit and cause PXE to fail.

In Figure 2, we can look at the Base Address register to confirm if PXE is running with only 32-bit addresses.

```
Memory Resources          2
Memory Resource 1         0x00000000'D4700000 - Memory
Memory Resource 2         0x00000000'D473A000 - Memory
Memory Resource 3         --------------------------
```

Figure 2. Confirmation - All Addresses Within the 64-bit BAR Do Not Exceed 32-Bit Addressing

In Figure 3, we can see that the addresses exceed 32-bit addressing.

```
Memory Resources          2
Memory Resource 1         0x000A3352'D4700000 - Memory
Memory Resource 2         0x000A3352'D473A000 - Memory
Memory Resource 3         --------------------------
```

Figure 3. Addressing Exceeding 32-Bit Addressing Size in the 64-Bit BAR

To prevent memory address space from exceeding 32-bit addressing, some Intel Network Interface Cards (NICs) can limit address requirements. The BAR32 bit can be accessed via Intel's **BootUtil** program to enable 32-bit BARs. Enabling the BAR32 bit allows for legacy PXE to run in a 64-bit BAR environment.

The other method is to disable above 4G memory in BIOS. What this does is globally force all PCI devices to use only 32-bit BARs. However, forcing global 32-bit BARs can cause problems for some PCI devices. For instance, graphics cards that have amounts of memory are limited to only 4G of RAM. It is always best to use the BAR32 bit when possible. If not using a legacy PXE and are booting in a UEFI environment, 32-bit addressing restrictions do not matter.

3.0 64-Bit Legacy PXE for the E810

With the introduction of Intel® Ethernet 800 Series Network Adapters, Intel changed the Intel® Boot Agent to be able to understand and run 64-bit addresses. Meaning that the BAR32 bit or setting BIOS to below 4G of RAM is no longer needed.

Another big change with the Intel® Ethernet 800 Series is Single PXE Option ROM (SPOR). Instead of storing one OPROM per port in the system's Run-Time Upper Memory Area (RTUMA) space, the SPOR method uses one OPROM per Intel® Ethernet 800 Series Network Adapter. For instance, if two ports of an Intel® Ethernet 800 Series Network Adapter are using PXE, only one PXE OPROM is stored in RTUMA space.

With the Intel® Ethernet 800 Series 64-bit PXE and SPOR, memory constrictions are no longer an issue for most users, thus simplifying the use of Intel® Ethernet 800 Series Network Adapters in a preboot environment. Legacy PXE continues to be relevant to users of Intel's network devices, and 64-bit PXE and SPOR are welcome additions.

4.0 References

Document	Doc ID / Link
Preboot Execution Environment (PXE) Specification, Version 2.1, September 20, 1999	Link
Single PXE Option ROM (SPOR) on the Intel® Ethernet 800 Series White Paper, November 20, 2020	633914



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