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DHCPv6 option for network boot
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Abstract

The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) provides a framework for passing configuration information to nodes on a network. This document describes a new option for DHCPv6 to convey information, required for network booting, to the nodes.

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1. Introduction

Network booting means that a node which should be booted fetches the files required for booting via its network device from a server. Network booting is, for example, very useful in environments where the administrators have to maintain a large number of nodes. Since all boot and configuration files are stored on a central server, the maintenance of all nodes can be kept simple this way.

A typical boot file would be, for example, an operating system kernel or a boot loader program. To be able to download such a file, the firmware (BIOS) running on the client node must be provided with information such as: the server on which the boot files can be found, the protocol to be used for the download (for example TFTP [RFC1350]) and the name of the boot file. Since some kernels or boot loaders need to be provided with additional parameters, there should also be the possibility to pass additional parameters along with the server address, the protocol and the file name.

DHCPv6 allows client nodes to ask a DHCPv6 server for configuration parameters. Contrary to its IPv4 predecessor, DHCPv6 does not yet define a way to query network boot options such as the IPv6 address of a boot file server and boot file names. Therefore this document defines a new DHCPv6 option which is required for network booting clients.

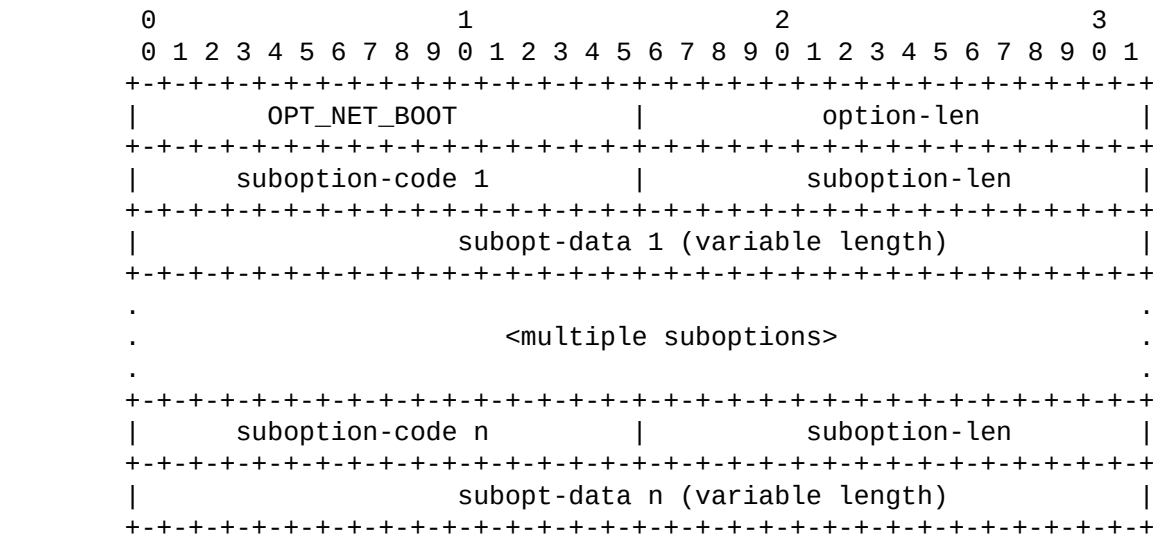
2. Conventions

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

Terminology specific to IPv6 and DHCPv6 are used in the same way as defined in the "Terminology" sections of RFC 3315 [RFC3315].

3. Netboot option format

The netboot option is used as an encapsulation for suboptions which carry the actual information needed to boot a client. This option will be used by clients to request boot information from a server.



option-code OPT_NET_BOOT (TBD1).

option-len Length of the netboot option in octets (not including the size of the option-code and option-len fields).

suboption-code, suboption-len and subopt-data together comprise a suboption for the netboot option. The 16-bit unsigned suboption-code values are drawn from a private namespace of the netboot option managed by IANA (cf. Section 8). The 16-bit unsigned suboption-len values indicate the length of the subopt-data field in octets.

Multiple occurences of each suboption-type can occur within a netboot option (for example when more than one boot server is available). Clients MUST process the suboptions in the order in which they appear in the message sent by the server.

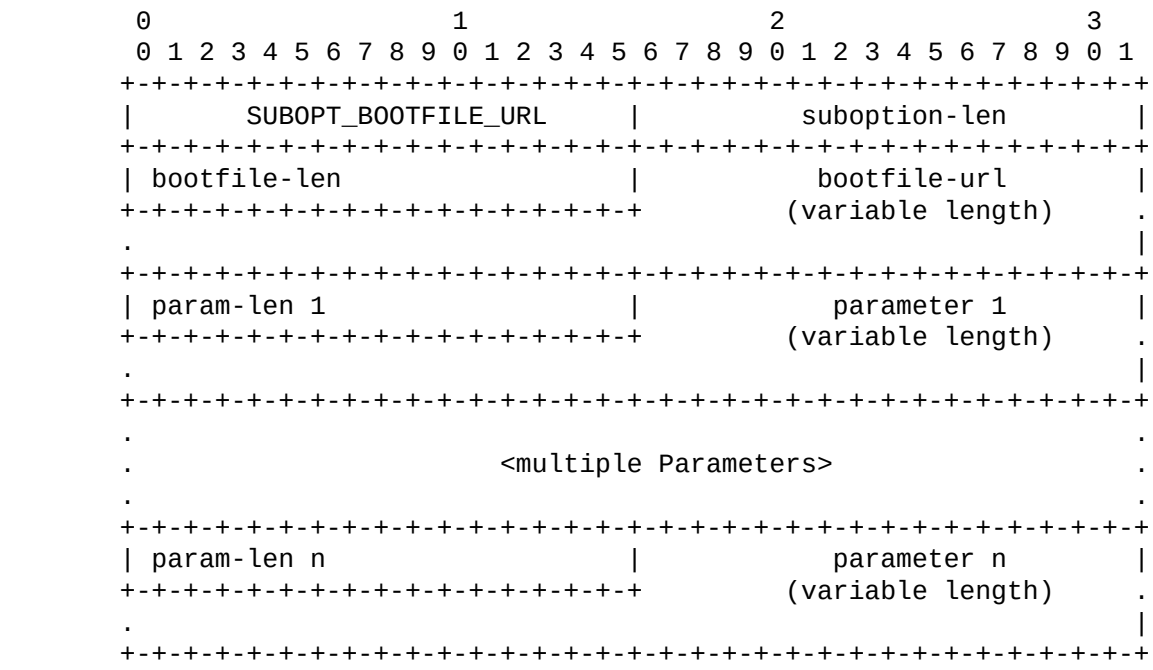
So far, only the suboptions in the following chapters have been defined. Other suboptions might be defined in future RFCs.

4. Suboptions

4.1. Suboption: Boot file Uniform Resource Locator (URL)

This suboption consists of multiple ASCII strings. It is used to convey an URL to a boot file together with additional parameters for the boot file (e.g. parameters for the kernel or boot loader

program).



Format description:

suboption-code SUBOPT_BOOTFILE_URL (1).

suboption-len Length of the bootfile suboption in octets (not including the size of the suboption-code and suboption-len fields).

bootfile-len 16-bit integer that specifies the length of the bootfile-url in octets (not including the bootfile-length field).

bootfile-url This ASCII string is the URL (conforming to [RFC3986]) for a boot file. This string starts with the protocol which is used for downloading. Separated by "://", the hostname or IPv6 address of the server hosting the boot file (see also the note below) follows, and then the path, file name and query parts of the URL. The string is not null-terminated.

param-len 1...n This is a 16-bit integer which specifies the length of the following parameter in octets (not including the parameter-length field).

parameters 1...n These ASCII strings are parameters needed for booting, e.g. kernel parameters. The strings are not null-terminated. The firmware should pass these parameters in the order they appear in the SUBOPT_BOOTFILE_URL suboption to the boot file which has been specified in the bootfile-url field. In cases where no parameters are needed, everything but the boot file URL (including its length field) can be omitted.

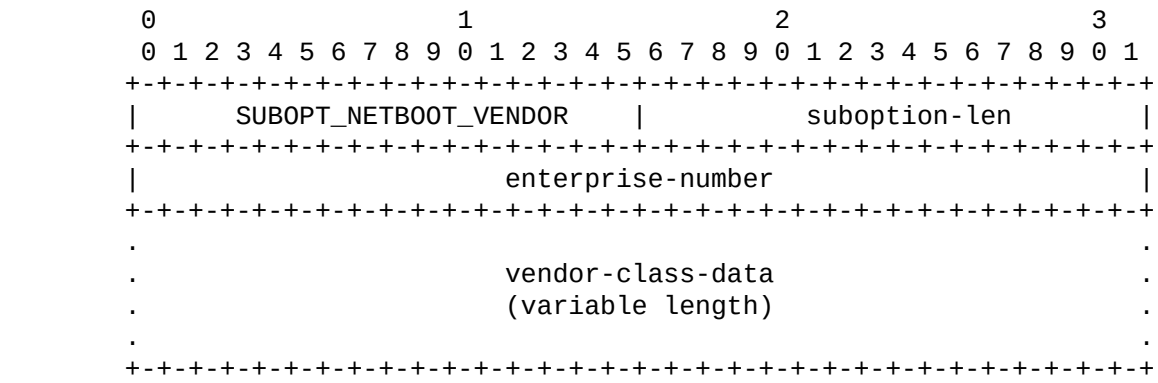
Note about the bootfile-url: This string can either contain a hostname or a literal IPv6 address to specify the server where the boot file should be downloaded from. All clients which implement the SUBOPT_BOOTFILE_URL suboption MUST be able to handle IPv6 addresses here and SHOULD also be able to handle a hostname in the URL. The IPv6 address in the URL then MUST be enclosed in "[" and "]" characters, conforming to [RFC3986]. Clients SHOULD also be able to handle hostnames in the URLs. However, in this case the firmware implementation on the client machine must support DNS, too. Due to size limitations, this might not be possible in all firmware implementations, so support for hostnames in the URLs is only optional.

Since multiple occurrences of SUBOPT_BOOTFILE_URL can be present in a single OPT_NETBOOT message, clients MUST process them in the order in which they appear within the message. For example in the case of a boot file URL the first file should be downloaded and executed. In case of a failure the process should continue with the second one and so on.

4.2. Suboption: Vendor class extension

With this suboption, vendors can define their own netboot suboptions: It can be used by clients and servers to exchange vendor-specific information which is related to network booting.

This suboption can occur multiple times within a OPT_NET_BOOT option (also with different enterprise-numbers in case a server and client implementation supports different vendor extensions). Clients MUST process them in the order in which they appear within the message. Unsupported vendor extensions MUST be ignored.



Format description:

suboption-code SUBOPT_NETBOOT_VENDOR (2).

suboption-len Length of the vendor class suboption in octets (not including the size of the suboption-code and suboption-len fields).

enterprise-number The enterprise number of the vendor as registered with IANA (see [VENDORIDS]).

vendor-class-data Vendor-specific information. The meaning is defined by the vendor identified by the enterprise-number. It is suggested that the vendor-class-data SHOULD be composed of a series of separate items with a two-octets length field at the beginning of each item, as it is described for the vendor class option in chapter 22.16 of [RFC3315].

5. Appearance of the Netboot option

The netboot option MUST NOT appear in DHCPv6 messages other than the types Solicit, Advertise, Request, Renew, Rebind, Information-Request and Reply.

The option-code of the netboot option MAY appear in the Option Request Option in the DHCPv6 message types Solicit, Request, Renew, Rebind, Information-Request and Reconfigure.

The suboptions MUST appear only in the netboot option.

6. Boot protocol considerations

RFC 906 [RFC906] suggests to use TFTP for bootstrap loading. Because it is easy to implement this protocol in firmware (where one has to deal with size and complexity constraints), this is still the recommended protocol for network booting. Every firmware implementation SHOULD at least support this protocol. The boot file URLs then must be specified according to RFC 3617 [RFC3617].

An alternative approach to TFTP network booting is to bootstrap the system with iSCSI. In this case, the URL in the SUBOPT_BOOTFILE_URL suboption MUST be specified according to the "iscsi:" string definition in chapter 5 of [RFC4173]. Note that [RFC4173] also suggests that the "iscsi:" string should be specified in the so-called "Root Path" option. However, this option does not exist for DHCPv6 yet, and with the SUBOPT_BOOTFILE_URL it is also not necessary anymore. So for IPv6 iSCSI booting, the "iscsi:" string MUST be specified as URL in the SUBOPT_BOOTFILE_URL suboption instead.

In some different scenarios, it might also be useful to use other protocols like FTP or HTTP for network booting, so a firmware implementation can support these protocols, too. Then it is up to the network administrator to choose the appropriate boot protocol for the network, and to specify the right boot file URLs in the DHCPv6 server configuration file.

7. IANA considerations

The following option needs to be assigned by the IANA from the option number space defined in the chapter 22 of the DHCPv6 RFC [RFC3315].

Option name	Value	Specified in
OPT_NET_BOOT	TBD1	Section 3

The OPT_NET_BOOT option also defines a new 16-bit integer suboption field, for which IANA is to create and maintain a new sub-registry entitled "Netboot Suboptions" under the OPT_NET_BOOT option. Initial values for the Netboot Suboptions registry are given below; future assignments are to be made through IETF Review (see [RFC5226]). Assignments consist of a suboption name and its associated value.

Suboption name	Value	Specified in
SUBOPT_BOOTFILE_URL	1	Section 4.1
SUBOPT_NETBOOT_VENDOR	2	Section 4.2

8. Security considerations

The new DHCPv6 option described in this document could be sent in untrusted networks by malicious people with a fake DHCPv6 server to confuse the booting clients. The clients could be provided with a wrong URL so that the boot either fails, or even worse, the client boots the wrong operating system which has been provided by a malicious file server. To prevent this kind of attack, clients SHOULD use authentication of DHCPv6 messages (see chapter 21. in RFC 3315 [RFC3315]).

Note also that DHCPv6 messages are sent unencrypted by default. So the boot file URL options are sent unencrypted over the network, too. This can become a security risk since the URLs can contain sensitive information like user names and passwords (for example a URL like "ftp://username:password@servername/path/file"). At the current point in time, there is no possibility to send encrypted DHCPv6 messages, so it is strongly recommended not to use sensitive information in the URLs in untrusted networks.

9. Acknowledgements

The authors would like to thank Ketan P. Pancholi and Alfred Hoenes for corrections and suggestions.

Vijayabhaskar Kalusivalingam and Senthil Balasubramanian published a similar draft for IPv6 network booting some years ago (available at http://tools.ietf.org/html/draft-ietf-dhc-dhcpv6-opt-rboot-00), which however was abandoned for unknown reasons.

10. References

10.1. Normative References

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[RFC4173] Sarkar, P., Missimer, D., and C. Sapuntzakis, "Bootstrapping Clients using the Internet Small Computer System Interface (iSCSI) Protocol", RFC 4173, September 2005.

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[VENDORIDS] IANA, "Private Enterprise Numbers", <http://www.iana.org/assignments/enterprise-numbers>.

10.2. Informative References

[RFC1350] Sollins, K., "The TFTP Protocol (Revision 2)", STD 33, RFC 1350, July 1992.

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