

Network Working Group  
Dynamic Host Configuration Working Group  
Category: Standards Track  
INTERNET-DRAFT

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October 1999  
Expires: March 2000

**New Option Review Guidelines and Additional Option Namespace**  
<[draft-ietf-dhc-option-review-and-namespace-01.txt](#)>

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Abstract

This document outlines deficiencies that have become evident since [RFC 2131](#) and [RFC 2132](#) were published regarding the allocation of new option codes, the review of drafts covering these new option codes, and the availability of option codes for new parameters. The document then presents proposals for correcting these deficiencies.

## **1. Introduction**

The rapid and wide-spread adoption of DHCPv4 has lead to an increasing number of new DHCP option drafts under DHC WG review. Experience with the current IANA option code allocation process and the DHC WG option draft review process has identified a number of deficiencies, namely:

- \* We're rapidly going through the remaining option codes, and face the possibility of exhausting the remaining codes before the wide-spread adoption of IPv6 is achieved.
- \* There are no guidelines to help the DHC WG and the DHCP community at large gauge the impact of the addition of new

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options. Some options that have been proposed require changes to the DHCP protocol itself and/or current implementations. Because the adoption of such options has a greater impact on the DHCP community than other, simple "payload" options, these options require more scrutiny by the DHC WG and IESG.

- \* Because some options could change the DHCP protocol itself, we need a method of explicitly communicating the change of DHCP versions among implementations. Today, we have no such method.
- \* There is no provision to preserve compatibility with earlier versions of the protocol.

Interoperability testing at Connectathon (1997, 1998, and 1999) has shown a reduction in the level of interoperability between implementations. These interoperability problems were found to be due to confusion among implementors about how certain features of the protocol should be implemented. Improvement (tightening) of the general [RFC 2131](#) and [RFC 2132](#) drafts as well as the tightening of new option specifications (using the guidelines defined in this document) will help increase the level of interoperability.

## **1.1 Conventions Used in the Document**

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](#) [5].

## **1.2 Terminology**

[RFC 2132](#)-form options    The [RFC 2132](#) [2] option block form is currently in use by DHCPv4, and is documented in [RFC 2131](#) [1]. This option form is identified by the BOOTP magic cookie {99, 130, 83, 99}.

RFC TBD-form options    A new option block form recommendation to alleviate option code exhaustion (described in [section 3.6](#) below). This option form will be identified by a TBD

## **2. Option Review Guidelines**

We tackle the option code review problem by defining a set of option categories based upon the impact the adoption of an option will have on the DHCP community. Option drafts appropriately categorized aid reviewers by helping them evaluate the draft. Once the DHC WG and the draft author(s) agree on the category of the proposed option, that category will be listed explicitly in the abstract of the option draft.

### **2.1. Hints for selecting the correct option category**

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- A) This option has no relationship to other existing or proposed options. It would not require change of existing DHCP client, server, or BOOTP relay agent implementations. It would not change the version of the DHCP protocol. Its introduction would not invalidate previous version(s) of the DHCP protocol. Is this option better handled by the Service Location Protocol (SLP) [\[7\]](#)? If it provides data which is unrelated to network interface configuration, then the option proposer SHOULD consider the use of SLP for the delivery of this data, if SLP is deployed widely enough to meet her needs.
- B) This option has no relationship to other existing or proposed options. It would not require change of existing DHCP client, server, or BOOTP relay agent implementations. It would not change the version of the DHCP protocol. Its introduction would not invalidate previous version(s) of the DHCP protocol. It isn't a candidate for SLP. Is this option useful to the DHCP community at large (e.g. implementors) or is it specific to a particular implementation? If it is the latter, then the proposer of the option should consider using the encapsulated vendor space available to your implementation to encode this information. Note that most DHCP implementations only support default option types for encapsulated options. (see [Section 3.5](#) below).
- C) This option has no relationship to other existing or proposed options. It would not require change of existing DHCP client, server, or BOOTP relay agent implementations. It would not change the version of the DHCP protocol. Its introduction would not invalidate previous version(s) of the DHCP protocol. It is not a candidate for SLP or the vendor's option space. Can this option be effectively encoded in the default option type ([Section 3.5](#) below)? For example, can it

be communicated as a single ASCII string? A list of IP addresses? If so, then one of the default formats should be used.

- D) This option would have a implicit or explicit relationship between it and other existing options or other proposed options, or the data it represents cannot be carried in a default option type ([Section 3.5](#) below). It MAY change the behavior of existing DHCP client, server, and/or BOOTP relay agent implementations. It would not change the DHCP protocol version. Its introduction would not invalidate previous version(s) of the DHCP protocol.

Examples of implicit/explicit option relationships:

Option	Related Options
-----	-----
Vendor Class Identifier	Encapsulated vendor option(s)
User Class Identifier	Standard option's scope

- E) The addition of this option would change Table 3, "Fields and options used by DHCP servers" and/or Table 5, "Fields and

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options used by DHCP clients" in [RFC 2131](#) [1], and thus change the DHCP protocol. Pre-existing versions / implementations would continue to interoperate.

- F) The addition of this option would invalidate previous versions of the DHCP protocol, preventing client, server, and/or BOOTP relay agents implementing the earlier version(s) from functioning.

Guidelines	Option Category
-----	-----
A	None. Use SLP to register and deliver your information.
B	None. Use your Vendor-specific option space for your option.
C	Category One
D	Category Two
E	Category Three
F	Category Four

## **2.2. Category One Options**

Options in this category MUST NOT require changes to the DHCP protocol, server, client, or BOOTP relay agent implementations. They MAY be either [RFC 2132](#)-form or RFC TBD-form options. They MUST NOT be dependent on other options being present or absent. Earlier versions/implementations of the protocol continue to interoperate in the presence of these options. Administrative tools and DHCP protocol debugging tools which generically support the default option types MAY need to be reconfigured in order to permit management of the new option. Options of this type are "payload" options, and MUST be of one of the default option types for the option block form ([RFC 2132](#) or RFC TBD).

Acceptance criteria:

Working group/IETF community review:	Yes.
IANA option number registration:	Yes.
Interoperability testing (2 or more implementations)	No.
DHCP protocol version change:	No.

## **2.3. Category Two Options**

Options in this category MUST NOT require changes to the DHCP protocol. They MAY require changes to server, client, relay agent implementations, administrative tools, and DHCP protocol debugging tools. They MAY depend on the presence or absence of other options, as long as those other options are NOT in Table 3 or Table 5 of [RFC 2131](#) [1]. Any dependence on other options MUST be made

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explicit in the new options draft. Existing versions / implementations of the protocol continue to interoperate in the presence of messages containing category two options. Options of this type are "affect implementation" options.

An option MUST be designed in such a way as a reply/response from non-compliant implementations can be easily distinguished from those of compliant implementations. An option MUST NEVER change the interpretation of existing options. The option draft author MUST specify a compliant implementation's behavior if that implementation receives a reply/response from a non-compliant implementation.

Acceptance criteria:

Working group/IETF community review:	Yes.
IANA option number registration:	Yes.
Interoperability testing (2 or more implementations)	Yes.

DHCP protocol version change:

No.

#### **2.4. Category Three Options**

Options in this category EXPLICITLY change the DHCP protocol. They WILL require changes to server, client, and/or relay agent implementations. They MAY depend on the presence or absence of other options. Any dependence on other options MUST be made explicit in the new option draft. The addition of such options result in changes to Table 3, "Fields and options used by DHCP servers" and/or Table 5, "Fields and options used by DHCP clients" in [RFC 2131](#) [1]. Existing versions / implementations of the protocol continue to interoperate in the presence of traffic containing category three options. Administrative tools MUST be changed to support options of this type. DHCP protocol debugging tools would need to be updated to recognize these options. Options of this type are known as "affect protocol" options. The acceptance of a Category Three option results in incrementing the DHCP version option value.

An option MUST be designed in such a way as a reply/response from non-compliant implementations can be easily distinguished from those of compliant implementations. The option draft author MUST specify a compliant implementation's behavior if that implementation receives a reply/response from a non-compliant implementation. An option MUST NEVER change the interpretation of existing options. Category Three option implementations can easily detect a non-compliant implementation due to the absence of the DHCP version option or a lower than expected version number.

Acceptance criteria:

Working group/IETF community review:	Yes.
IANA option number registration:	Yes.
Interoperability testing (2 or more implementations)	Yes.
DHCP protocol version change:	Yes.

#### **2.5. Category Four Options**

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Options in this category would EXPLICITLY change the DHCP protocol in a non-backward compatible manner. They would require changes to ALL DHCP client, server, and/or BOOTP relay agent implementations. They INVALIDATE one or more of the previous versions of the BOOTP/DHCP protocol.

Because category four options invalidate previous versions of the protocol, they are NOT candidates for acceptance. Changes to the

the DHCP protocol MUST BE backward compatible.

### **3. Specification of DHCP protocol version and DHCP option block form.**

We define two [RFC 2132](#)-form options. The first is used by a DHCP client to request a response in a certain option block form. The second option is used by both DHCP clients and servers to identify the version of protocol used in the messages generated.

#### **3.1. DHCP Option Block Request Option**

This option is used by RFC TBD client implementations to request RFC TBD-form replies from RFC TBD server implementations. This option is included in [RFC 2132](#)-form DHCPDISCOVERs, INIT-REBOOT DHCPREQUESTs, and DHCPINFORMs to request RFC TBD-form replies.

This option MUST NEVER be used by DHCP servers in their responses to DHCP clients.

The DHCP Option Block Request Option is of the [RFC 2132](#)-form, and consists of a single 4 octet string holding the magic cookie of the desired option block form.

```
code len    magic cookie
+---+---+-----+
| X | 4 |      ...      |
+---+---+-----+
```

#### **3.2. DHCP Version Option**

This option represents the DHCP version. DHCP messages without this option are [RFC 2131](#) [1]. The addition of Category Three option(s) (perhaps grouped together) result in a DHCP version change. All implementations supporting versions greater than [RFC 2131](#) MUST include the DHCP version option in all messages, generated by both client or server.

The DHCP Protocol Version Option is of the [RFC 2132](#)-form, and consists of an single unsigned 16bit integer. The first Category Three option accepted by the DHC WG will be assigned version zero (0).

```
code len    value
+---+---+-----+
| Y | 2 | (0-65535) |
+---+---+-----+
```

DHCP protocol versions MUST be backward compatible with earlier versions.

### **3.3 Allocation of options from [RFC 2132](#) or RFC TBD option name spaces**

Allocation of new options from the RFC TBD name space can only occur if we have two (2) or more RFC TBD option name space implementations which have demonstrated interoperability. Such interoperability testing could occur at the next Connectathon event (held late February/early March every year).

The selection of which name space from which to allocate an option is left to the DHC WG and IESG, following the process outlined in Ralph Drom's "Procedure for Defining New DHCP Options" [[4](#)].

### **3.4. [RFC 2132](#) Option Block Form**

For convenience, I have extracted the description of [RFC 2132](#)-form options from [RFC 2132](#) [[2](#)].

```
code len    value
+---+---+-----
|   |   |       ...
+---+---+-----
```

Options of this form consist of three single octet fields: code, len, and value.

The code value is a single octet (0-255). 0 (pad) and 255 (end) are the only codes that do not follow the code, len, value form. Len is a single octet (0-255) describing the length of the value field. Value contains the data payload.

### **3.5. [RFC 2132](#)-form Default Option Types**

- 1) Single variable-length ASCII string.
- 2) Single variable-length OCTET string.
- 3) 1-X Multiple of NUMBERS (1, 2, 4, 8 octets each). May consist of a LIST where the list entries are defined as multiple NUMBERS.

Example: "A variable-length list of 2 32bit NUMBERS representing the offset and length of a block of data"

- 4) 1-X Multiple of IPv4 addresses. May consist of a LIST where the list entries consist of multiple IP addresses.

Example: "A list of static routes (destination, router), ..."

If an implementation encounters [RFC 2132](#)-form options which it does



not understand, it will simply skip over the option (using that option's len field) and continue option processing. This behavior

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ensures that [RFC 2131](#) compliant implementations safely ignore new options (e.g. the DHCP version option). Current DHCP implementations SHOULD ignore any non-RFC 2132-form option block.

### **[3.6.](#) Proposed RFC TBD Option Block Form**

We propose the creation of the following option block form described below, which greatly increases the option space and size of individual options. We feel that the adoption of this option block form will resolve the approaching [RFC 2132](#) standard option code availability problem.

Code	Len	Data
+-----+	+-----+	+-----+
uint16_t	uint16_t	...
+-----+	+-----+	+-----+

Code value is a network-order double-octet unsigned value (0-65535). 0 (pad) and 65535 (end) are the only codes that do not follow the code, len, value form. Len is a network-order double-octet unsigned value (0-65535). Data contains Len octets.

The first 255 RFC TBD option codes are preassigned for mapping [RFC 2132](#) options into RFC TBD option space. Because the size limit of options within the RFC TBD option space is much higher than that of options within the [RFC 2132](#) option space, RFC TBD implementations MUST use care in responding to [RFC 2132](#) clients. If the data for a mapped [RFC 2132](#) option would exceed the 253 length restriction of [RFC 2132](#) clients, the RFC TBD implementation MUST drop the option from the reply, and SHOULD increment an error count or log a message regarding this event. Note that the creation of multiple instances of [RFC 2132](#) options in order to provide all of the data within the configured RFC TBD option is not workable, since by definition options within the [RFC 2132](#) (and RFC TBD) option space are position-independent, and thus deterministic ordering of data is not possible.

### **[3.7.](#) RFC TBD Default Option Types**

All option types as listed in [Section 3.5](#), and:

- 1) UNICODE string.
- 2) IPv6 addresses(s). Multiple of 16 octets. Encoded within an implementation's configuration table using the text

representation as defined by [Section 2.2 of RFC 2373](#) [6].

- 3) Encapsulated RFC TBD options. For example, New User class, Vendor class-style options. Encapsulated options follow same code, len, value form of RFC TBD options. Overall length specifies limit of encapsulation.
- 4) Mixed-type options. These options are made up of combinations of 3.5/3.7 typed fields. Variable-length typed fields are preceded by a two octet unsigned integer length field. Mixed

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type options are useful for encoding combinations of data (structures).

Example: The following option contains an NVT ASCII string followed by a boolean, followed by a 32bit unsigned integer.

Code	Len	Data
771	17	13  Hello, World!  1   4123782

- 5) BOOLEAN. A single octet value which is explicitly TRUE if non-zero, explicitly FALSE if zero (0). Len is always one.

#### 4. Behavior of [RFC 2132](#) and RFC TBD Client and Server Implementations

##### 4.1 Client Behavior

A DHCP client in the INIT state prefers DHCP replies matching the DHCP option block form ([RFC 2132](#) or RFC TBD) and DHCP protocol version of its DHCPDISCOVER. Option block form is preferred over DHCP protocol version.

DHCP clients SHOULD always indicate the size of response they can accept using the DHCP MTU option.

##### 4.1.1 INIT/INFORM states

A client in one of these states pauses to collect replies (DHCP of any type/version or BOOTP replies) for a tunable polling interval (default: 5 seconds). Retransmissions use the algorithm outlined in [Section 4.1 of RFC 2131](#) [1].

Existing [RFC 2132](#)-form clients require no change in their behavior as specified in [RFC 2131](#) [1].

[RFC 2132](#)-form clients who support a later version of the DHCP protocol include the DHCP version option identifying the version of

DHCP protocol they support. They prefer replies matching their protocol version over older versions of DHCP and BOOTP replies. If a [RFC 2132](#)-form client selects a reply from a down-rev DHCP protocol server (or BOOTP server), then that client MAY update an error count or log this event.

A RFC TBD-form client in one of these states forms the appropriate [RFC 2132](#)-form message (DHCPDISCOVER, DHCPINFORM) and includes the DHCP Option Block Request Option (set to the RFC TBD magic cookie) and the DHCP version option if it supports a version greater than that specified in [RFC 2131](#), and sends this message in the manner appropriate for the message type. A RFC TBD-form client prefers RFC TBD-form responses over [RFC 2132](#)-form responses. Within responses of a certain option form, responses which match the client's DHCP protocol version are preferred over those responses that are down-rev. If no DHCP responses are received, the client MAY choose a BOOTP response if such a response is available.

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In the case of an INIT state client, the DHCPREQUEST used to accept the DHCPPOFFER is formed using the option block form and DHCP protocol version of the selected DHCPPOFFER.

For the duration of the lease, the client MUST form request messages using the option block form and DHCP protocol version of the original DHCPACK (INIT/INFORM) states when verifying existing configuration (INIT-REBOOT DHCPREQUEST), requesting lease extensions (DHCPREQUEST), declining an IP address (DHCPDECLINE), or releasing an IP address (DHCPRELEASE).

In summary, a RFC TBD-form DHCP client will prefer RFC TBD-form replies over [RFC 2132](#)-form replies. Within replies which match the selected option block form, a client will prefer replies which match its DHCP protocol version. All subsequent traffic is done using the option block form and DHCP protocol version of the accepted DHCPPOFFER/DHCPACK.

## **[4.2](#) Server Behavior**

### **[4.2.1](#) Option Block Format-independent Server Behavior**

A server which receives a BOOTP magic cookie it does not understand SHOULD respond with a standard BOOTP reply ONLY if it is explicitly configured to do so. Note that RFC TBD-form requests will appear to [RFC 2131](#) servers as BOOTP requests with an unrecognized magic cookie. In such environments, the [RFC 2131](#) server's ability to respond to BOOTP clients SHOULD be restricted, and RFC TBD servers SHOULD be configured to respond to BOOTP clients.

If a DHCPDISCOVER/DHCPINFORM is received which contains a DHCP protocol version option, a server MUST:

- a) If the DHCP protocol version is down-rev of that supported by the server, the server will format all messages in that earlier version. If the DHCP server does not support the earlier version of the protocol, it MUST drop the request, and MAY update an error counter or log the event.
- b) If the DHCP protocol version is greater than that supported by the server, it MAY either drop the request or respond to the client using messages of the DHCP protocol version supported by the server. This behavior SHOULD be configurable by the administrator. The server SHOULD choose to delay responding to the up-rev client for a configurable number of seconds, in order to give potential higher-rev servers a chance to reply.
- c) If the DHCP protocol version matches that of the server, then the server responds immediately (if possible) to the client with the appropriately formatted reply.

#### **4.2.2 RFC TBD-form Server Behavior**

A RFC TBD-form server can identify a RFC TBD-form client by the

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presence of the DHCP Option Block Request Option with the RFC TBD magic cookie in the option value field in [RFC 2132](#)-form requests or RFC TBD-form requests identified by the RFC TBD-form magic cookie. For the following scenarios, assume a RFC TBD-form server has free resources available for allocation.

- a) If a RFC TBD-form response is requested, it MUST respond with a RFC TBD-form response if it chooses to respond at all.
- b) If a [RFC 2132](#)-form response is requested (no DHCP Option Block Request Option is present) and the RFC TBD-form server is explicitly configured to respond to [RFC 2132](#)-form clients, it MUST respond with a [RFC 2132](#)-form response if it chooses to respond at all.
- c) If a request is received which contains a DHCP Option Block Request Option with a value it does not recognize, the server MUST either drop the request or respond with a [RFC 2132](#)-form response. Its behavior in this situation SHOULD be an administrator-configured option.

A DHCP server MUST NOT use the DHCP Option Block Request Option in the messages it generates for DHCP clients.

## 5. Open Issues

The author would appreciate comments/feedback regarding these issues.

- \* Parameter request option in [RFC 2132](#)-form requests.  
A [RFC 2132](#)-form DISCOVER/REQUEST can only request options from the [RFC 2132](#) name space. One possible solution is for a RFC TBD-form implementation to generate a RFC TBD-form DISCOVER or REQUEST containing the full parameter request list if it receives RFC TBD-form replies. The downside of this approach is the extra DHCP traffic. I propose that RFC TBD-form implementors include a policy mechanism which turns on pure RFC TBD-form and thus disables the [RFC 2132](#)-form request method. Such behavior might be controlled by a [RFC 2132](#)-form option, for example.
- \* RFC TBD-form requests look like BOOTP requests with an unrecognized magic cookie. Disabling BOOTP compatibility in [RFC 2132](#) servers and turning it on in RFC TBD servers (which can appropriately recognize the clients) seems like a reasonable approach.
- \* Relationship between DHCP protocol version and option block format. [Section 4.1.1](#) states that a client will prefer RFC TBD-form replies over [RFC 2132](#)-form replies first, then within the selected option block form, DHCP protocol version. Do people believe that this is the correct ordering? Should clients prefer version over option block form instead?
- \* This document doesn't currently address the addition of new message types. The addition of new message types will change Table 3 and Table 5 of [RFC 2131](#) [1]. Usually, the addition of a

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new message type doesn't require changes to existing implementations. DHCPINFORM is an example of such a message type. Such message types fall into category 3. The addition of message types which require changes to existing implementations fall into category 4.

The addition of new message types does not require a change in the DHCP protocol version, since each additional message implicitly represents a backward compatible DHCP protocol change in most cases.

## 6. Security Considerations

Not Applicable.

## **7. Acknowledgements**

The author would like to gratefully acknowledge the active participation of the following DHCP future panel members: Ralph Droms, Kester Fong, Pratik Gupta, Barr Hibbs, Kim Kinnear, Ted Lemon, Nathan Lane, and Glenn Waters. The author would also like to thank Thomas Narten for his review comments.

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## **11. Expiration**

This document will expire on March 31, 2000.