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Kerberos Options for DHCPv6
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Abstract

This document defines new four options for the Dynamic Host Configuration Protocol for IPv6 (DHCPv6), options which carry configuration information for Kerberos.

Status of this Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on January 11, 2013.

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1. Introduction

Kerberos Version 5 [RFC4120] is a trusted third-party authentication system. Each organization wishing to use Kerberos establishes its own "realm" and each client is registered as part of that realm. At least one Key Distribution Center (KDC) is required for the operation of a Kerberos realm.

When a client wishes to communicate with, and be authenticated to, a Kerberos application server (also a client of the KDC), the client identifies itself, and its realm, to the KDC and acquires a credential from the KDC. The client then presents the credential to the Kerberos application server which can use the credential to authenticate the client. The client needs to know at least one IP address for a KDC in order to initiate this process.

One example of the application of this protocol is as follows. A student might want to use a shared, public workstation, one that is not configured for Kerberos. If there is a mechanism for the workstation to obtain a realm name and IP address for a KDC, then a student need only input a user-id and pass phrase to be able to use Kerberos.

The Kerberos V5 specification [RFC4120] defines the use of DNS SRV records [RFC2782] for KDC discovery. Some systems, such as industrial systems, do not use DNS. Such systems already have their own name spaces and their own name resolution systems, including pre-configured mapping tables for devices, and do not use Fully Qualified Domain Names. However, many of these systems do use DHCP.

Adding a DNS server to such systems may decrease the reliability of the system and increase the management cost (see Appendix A). In such an environment, another mechanism is needed to provide an IP address for the KDC. For the PacketCable Architecture [PCARCH], RFC 3634 [RFC3634] defines the KDC Server Address sub-option for the DHCPv4 CableLabs Client Configuration option. However, a mechanism is still needed to provide a realm name and an IPv6 address, one which does not depend on any external architecture.

This document defines a Kerberos option for DHCPv6 which provides a realm name and/or a list of KDC IP addresses. This option does not replace or modify any of the existing methods for obtaining this information.

2. Conventions used in this 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 [RFC2119].

It is assumed that the readers are familiar with the terms and concepts described in DHCPv6 [RFC3315].

3. Kerberos Options

This document defines four DHCP configuration parameters for Kerberos.

Kerberos Principal Name Option

Kerberos Realm Name Option

Kerberos Default Realm Name Option

Kerberos KDC Option

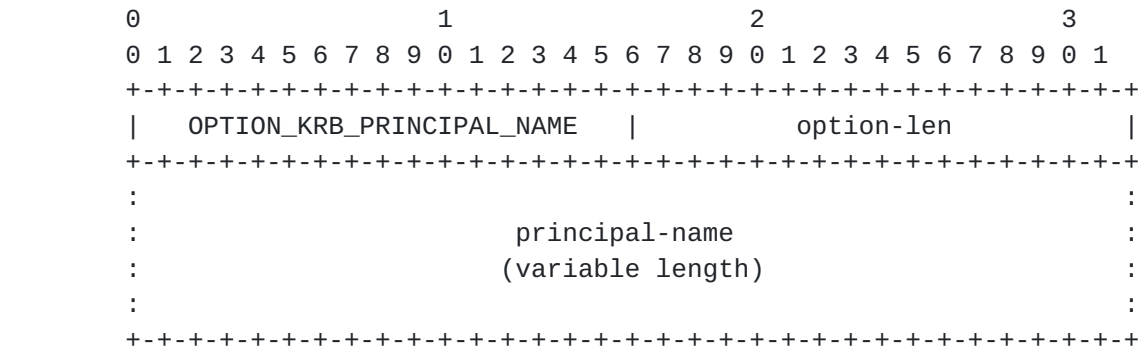
This section describes the format of each option, and the usage of each field in that option.

With the exception of the Kerberos KDC Option, none of these options may appear more than once in a DHCPv6 message.

3.1. Kerberos Principal Name Option

The Kerberos Principal Name Option carries the name of a Kerberos principal. This is sent by the client to the DHCPv6 server which MAY use it to select a specific set of configuration parameters, either for a client or for a Kerberos application server.

The format of the Kerberos Principal Name option is:

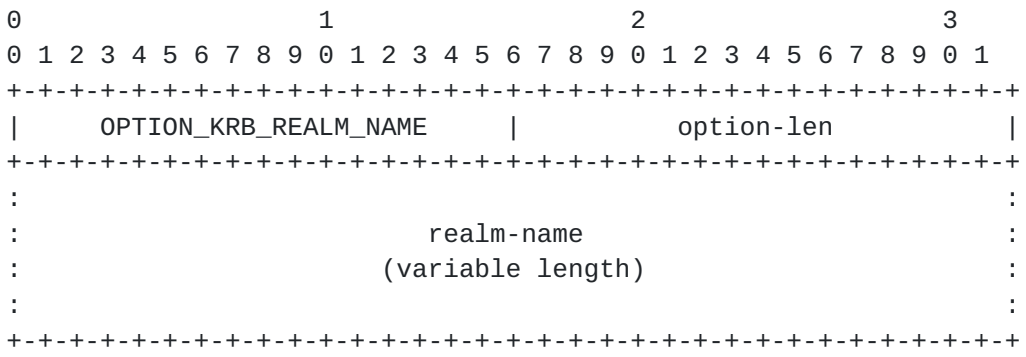


- option-code (16-bit): OPTION_KRB_PRINCIPAL_NAME (TBD by IANA)
- option-len (16-bit): length of the principal-name field.
- principal-name (variable): a client principal name. The encoding of the principal-name field MUST conform to the definition of "PrincipalName" in section 5.2.2 of RFC 4120 [RFC4120].

3.2. Kerberos Realm Name Option

The Kerberos Realm Name Option carries a Kerberos realm name. A DHCPv6 client uses this option to specify to a DHCPv6 server which realm the client wants to access.

The format of the Kerberos Realm Name option is:



- option-code (16-bit): OPTION_KRB_REALM_NAME (TBD by IANA)
- option-len (16-bit): the length of the realm-name field in octets.
- realm-name (variable): a realm-name. The encoding of the realm-name field MUST conform to the definition of "Realm" in section 5.2.2 of RFC 4120 [RFC4120].

3.3. Kerberos Default Realm Name Option

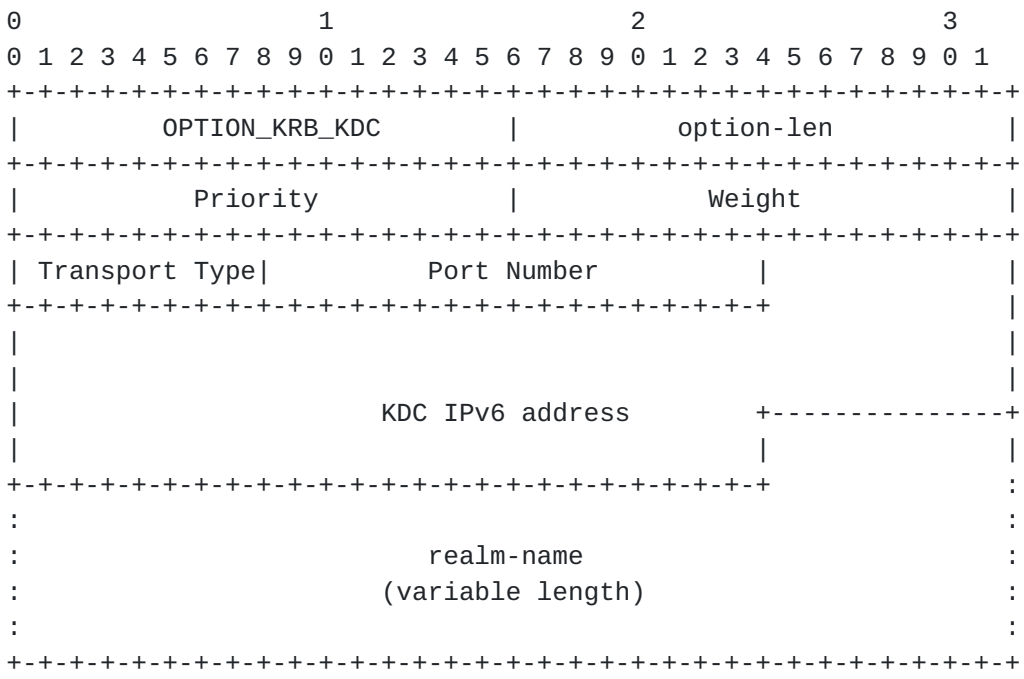
The Kerberos Default Realm Name Option is used to specify a default realm name for the Kerberos system. A DHCPv6 server uses this option to specify the default realm name to both clients and Kerberos application servers.

The option-code of this option is OPTION_KRB_DEFAULT_REALM_NAME. The format and usage of the option-len and realm-name fields are identical to those for the Kerberos Realm Name Option.

3.4. Kerberos KDC Option

The Kerberos KDC Option is used to provide configuration information about a KDC.

The format of the Kerberos KDC Option is:



- option-code (16-bit): OPTION_KRB_KDC (TBD by IANA)

- option-len (16-bit): 23 + the length of the realm-name field in octets.

- Priority (16-bit): see the description of Weight field.

- Weight (16-bit): the Priority and Weight fields provide a hint to the client as to which KDC to select. The usage of the Priority and Weight values MUST follow the specification for DNS SRV [RFC2782].

- Transport Type (8-bit): The Transport Type specifies the transport protocol used for Kerberos. Kerberos [RFC4120] defines UDP and TCP transports. Exchanges over TCP are further described in [RFC5021] while the transport of Kerberos over TLS is described in [RFC6251].

The transport type is defined in below.

Value	Transport Type
0	Reserved
1	UDP
2	TCP
3	TLS

4-254	Unassigned
255	Reserved

- Port Number (16-bit): the port number on which the KDC listens.

- KDC IPv6 address (128-bit): the IPv6 address of the KDC.

- realm-name (variable): the name of the realm for which the specified KDC provides service. The encoding of the realm- name field MUST conform to the definition of "Realm" in section 5.2.2 of RFC 4120 [RFC4120].

4. Client and Server Operation

This section describes the operations of client and server. It assumes that the client has been configured with a principal name.

If a client requires a realm name, the client MUST send a DHCPv6 Option Request option (ORO) specifying the Kerberos Default Realm Name Option. The DHCPv6 server responds with a Reply message containing a Kerberos Default Realm Name Option.

If a client requires configuration parameters for a KDC, the client MUST send a DHCPv6 ORO specifying the Kerberos KDC Option. The client MAY send a Kerberos Principal Name Option. The client MAY send a Kerberos Realm Name Option.

The DHCPv6 server replies with one or more sets of configuration parameters for a Kerberos KDC. If the client has specified either a Kerberos Principal Name Option or a Kerberos Realm Name Option, then the DHCPv6 server MAY use those parameters to select a specific sets of configuration parameters.

Where the server replies with more than one set of configuration paramers, the usage of priority and weight fields by the client MUST follow the specification for DNS SRV [RFC2782].

The client MAY include other options with data values as hints to the DHCPv6 server about parameter values the client would like to have returned; this is specified in section 18.1.5 of RFC 3315 [RFC3315].

4.1. KDC discovery for a client

When a client implements both the DNS method defined by section 7.2.3.2 of [RFC4120] and the DHCP method defined by this document, the choice of method is determined by local policy. The administrator of the realm MUST define the method as part of the configuration of the client before the client is installed.

When no criteria have been specified and the client could get the Kerberos information from either the DNS server or the DHCPv6 server, then the information from DNS SHOULD be preferred.

5. IANA Considerations

IANA is requested to assign four option codes from the "DHCPv6 Options Codes" registry for the following:

OPTION_KRB_PRINCIPAL_NAME

OPTION_KRB_REALM_NAME

OPTION_KRB_DEFAULT_REALM_NAME

OPTION_KRB_KDC

IANA is requested to create a sub-registry of Kerberos Message Transport Type, under the Kerberos Parameters Registry. The initial entries are described in section 3.4.

The assignment of future entries is by "IETF Consensus" policy as described in BCP 26 [RFC5226]. The RFC specifies the symbolic name of such entries which are assigned numeric codes by IANA once publication is approved.

6. Security Considerations

The security considerations in RFC 3315 [RFC3315] apply.

DHCPv6 messages can be modified in transit. If an adversary modifies the response from a DHCPv6 server or injects its own response, a client may be led into contacting a malicious KDC. Both cases are categorized as a Denial of Service (DoS) attack. However, a malicious KDC does not know the shared key and so is unable to proceed any further with the exchange. If a client receives a response from such a KDC, the client can use the shared key to detect that the message originates from a malicious KDC.

A shared, unconfigured workstation may obtain its KDC information, and default realm, via DHCPv6. Such a workstation may not have a host or other service key, and thus be unable to validate the Ticket-Granting Ticket issued by the KDC. A modified DHCPv6 response would then result in the workstation talking to a malicious KDC and be unable to detect that has happened. This in turn could allow access by unauthorized users.

To minimize potential vulnerabilities, a client SHOULD use DHCPv6 authentication as defined in section 21 of RFC 3315 [RFC3315].

Kerberos information may be manually configured into the client before requesting information from DHCPv6. Manual configuration of the device SHOULD be preferred to configuration via the DHCPv6 server.

7. Acknowledgments

The authors are very grateful to Nobuo Okabe and Shigeya Suzuki. They contributed the explanation as to why DNS is inappropriate for some industry networks; this is included as an appendix to this document. Ted Lemon made many suggestions to improve DHCP aspects of this specification. Ken'ichi Kamada and Yukiyo Akisada contributed to the initial work on this document. Tom Petch helped to improve the readability of this document. The authors also thank Jeffrey Hutzelman, Kazunori Miyazawa, Kensuke Hosoya, Nicolas Williams, Nobumichi Ozoe, Sam Hartman, and Stephen Farrell. They made valuable comments and suggestions.

8. References

8.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC2782] Gulbrandsen, A., Vixie, P., and L. Esibov, "A DNS RR for specifying the location of services (DNS SRV)", RFC 2782, February 2000.

[RFC3315] Droms, R., Bound, J., Volz, B., Lemon, T., Perkins, C., and M. Carney, "Dynamic Host Configuration Protocol for IPv6 (DHCPv6)", RFC 3315, July 2003.

[RFC4120] Neuman, C., Yu, T., Hartman, S., and K. Raeburn, "The Kerberos Network Authentication Service (V5)", RFC 4120, July 2005.

[RFC5021] Josefsson, S., "Extended Kerberos Version 5 Key Distribution Center (KDC) Exchanges over TCP", RFC 5021, August 2007.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 5226, May 2008.

8.2. Informative References

[PCARCH] CableLabs, "PacketCable 1.0 Architecture Framework Technical Report", December 1999, <http://www.packetcable.com/downloads/specs/pkt-tr-arch-v01-991201.pdf>.

[RFC3634] Luehrs, K., Woundy, R., Bevilacqua, J., and N. Davoust, "Key Distribution Center (KDC) Server Address Sub-option for the Dynamic Host Configuration Protocol (DHCP) CableLabs Client Configuration (CCC) Option", RFC 3634, December 2003.

[RFC6251] Josefsson, S., "Using Kerberos Version 5 over the Transport Layer Security (TLS) Protocol", RFC 6251, May 2011.

Appendix A. Why DNS is not acceptable in some environments

1. Summary

- This appendix gives reasons why DHCP-based KDC discovery is more appropriate for industrial systems than DNS-based KDC discovery (as described in RFC4120 - the "RFC4120-way").

- Industrial systems have their own name spaces and naming systems which are not based on FQDN and DNS.

- DHCP-based KDC discovery is more efficient because reducing the number of servers reduces the number of messages, improves reliability and reduces management cost.

2. Background (what are industrial systems?)

Industrial systems are
used to control plants, factories, buildings, etc.
They may incorporate a large number of devices, i.e. sensors and
actuators, commonly referred to as field devices.

These field devices have the following characteristics:
1) Though physically large, they have limited resources,
   e.g. processing capability, memory size,
   footprint, power consumption and user interface.
2) They are controlled, as an I/O, by an administrative
   device, usually referred to as a controller, using a legacy
   communication technology.
3) Since they are on I/O buses, not networks,
   the security of the communications has not been considered.

3. High-level goals

3.1. IP and security can enhance industrial systems.

Our goal is to introduce the latest IP-based networking technology
into field devices, something which will enhance the entire
system.
1) Network architecture (= IP technology) can enhance
   the systems, including the field devices.
2) The field devices will be connected to a network and
   not be I/O devices anymore, and so will require security.

3.2. Auto-configuration benefits industrial systems.

Auto-configuration of large systems, such as
industrial systems is important when introducing new technology or
capabilities:

1) It reduces the engineering cost when installing/configuring
a large number of field devices over a large area.
The size of a plant, the size of an industrial system and
the number of field devices are growing.

- A large process automation system has
about 20,000 field devices over a 2*2km area

References:
- http://www.process-worldwide.com/fachartikel/pw_fachartikel_2699276.html

- A distributed process automation systems has
about 30,000 field devices on 26 distributed sites
over a 30*30km area.

References:
- http://www.mikrocentrum.nl/FilesPage/3462/Presentatie%20C3-1.pdf
- http://www.nam.nl/home/Framework?siteId=nam-en&FC2=/nam-en/html/iwgen/algemeen/zzz_lhn.html&FC3=/nam-en/html/iwgen/algemeen/over_de_nam.html

- A large building automation system has
170,000 control points for 16,500 field devices in
729,000 sq. meters (7.8 million sq. ft.) building complex.

References:
- http://www.echelon.com/company/press/2003/echelon_mori.htm

2) It reduces the chance of human error.

3) It makes disaster-recovery easier.

3.3. Security mechanisms for resource-limited devices are needed.

Kerberos-based security is suitable for resource-limited devices,
i.e. field devices, since it avoids
public key cryptography (except when using PKINIT).

4. Some industrial systems do not use DNS.

Field devices have used multiple technologies (see Section 6) but do not use DNS because they already have their own namespaces and naming systems (even though IP is in use, in part).

For example, "tag" is the common logical identifier for process automation systems and Device ID is the common logical identifier for building automation systems.
(You may think those names are not so abstracted, though....)

5. KDC discovery with DHCP is more suitable than with DNS.

If Kerberos is introduced into field devices, auto-configuration could be achieved by:
1) Learning DNS address(es) from DHCP
2) Learning KDC address(es) from DNS, using the RFC4120-way.
However, DNS will be used by the Kerberos-related part only; most applications will not use DNS.

If DHCP can advertise KDC-related information, then:
1) the number of messages handled by the field devices is reduced, reducing the footprint of the field devices.
2) the number of servers is reduced, reducing the management cost of the systems.

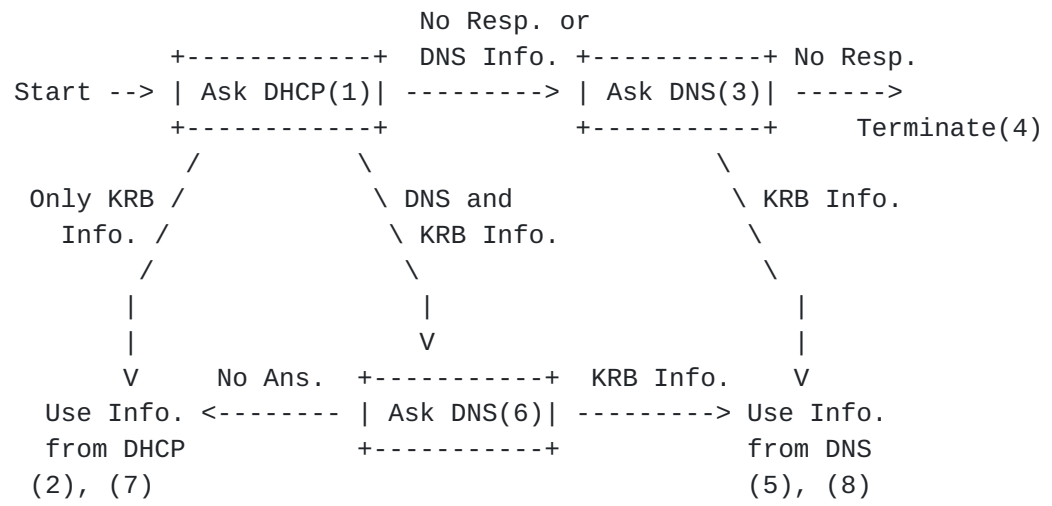
6. References

Field devices have used many technologies.
For example:
- FOUNDATION Fieldbus (http://www.fieldbus.org/)
- PROFIBUS (http://www.profibus.com/)
- BACnet (http://www.bacnet.org/)
- LonWorks (http://www.echelon.co.jp/products/lonworks.html)
- Modbus (http://www.modbus.org/)

Wikipedia also provides information about the communications technology of field devices:
- http://en.wikipedia.org/wiki/Fieldbus
- http://en.wikipedia.org/wiki/BACnet
- http://en.wikipedia.org/wiki/LonWorks

Appendix B. An example of the operation of the client

When no criteria have been specified and the client could get the Kerberos information from either the DNS server or the DHCPv6 server, then the information from DNS should be preferred. The following is the guideline for the client in such an environment.



Abbreviations:
Resp.: Response
Info.: Information
KRB : Kerberos

1) Initially, the client requests both DNS and Kerberos information from the DHCPv6 server.

2) If the DHCPv6 server replies with Kerberos information and not with DNS information, then the client uses that information.

3) If the DHCPv6 server does not reply or replies with only DNS information, then the client requests Kerberos information from the DNS server.

4) If the client gets no response or no Kerberos information from the DNS server, then the client terminates the process.

5) If the client gets Kerberos information from the DNS server, then the client uses that information.

6) If, as the result of (1), the DHCPv6 server replies with both DNS and Kerberos information, then the client requests Kerberos information from the DNS server.

7) If the client gets no response from the DNS server, then the client uses the Kerberos information from the DHCPv6 server.

8) If, as the result of (6), the DNS server replies with Kerberos information, then the client uses the information from the DNS server and not that from the DHCPv6 server.

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