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RFC 9463
DHCP and Router Advertisement Options for the Discovery of Network-designated Resolvers (DNR)

Abstract

This document specifies new DHCP and IPv6 Router Advertisement options to discover encrypted DNS resolvers (e.g., DNS over HTTPS, DNS over TLS, and DNS over QUIC). Particularly, it allows a host to learn an Authentication Domain Name together with a list of IP addresses and a set of service parameters to reach such encrypted DNS resolvers.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9463.

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1. Introduction

This document focuses on the discovery of encrypted DNS resolvers that are using protocols such as DNS over HTTPS (DoH) [RFC8484], DNS over TLS (DoT) [RFC7858], or DNS over QUIC (DoQ) [RFC9250] in local networks.

In particular, this document specifies how a local encrypted DNS resolver can be discovered by connected hosts by means of DHCPv4 [RFC2132], DHCPv6 [RFC8415], and IPv6 Router Advertisement (RA) options [RFC4861]. These options are designed to convey the following information: the DNS Authentication Domain Name (ADN), a list of IP addresses, and a set of service parameters. This procedure is called Discovery of Network-designated Resolvers (DNR).

The options defined in this document can be deployed in a variety of deployments (e.g., local networks with Customer Premises Equipment (CPEs) that may or may not be managed by an Internet Service Provider (ISP), or local networks with or without DNS forwarders). Providing an inventory of such deployments is beyond the scope of this document.

Resolver selection considerations are out of scope. Likewise, policies (including any interactions with users) are out of scope.

2. Terminology

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

This document makes use of the terms defined in [RFC8499]. The following additional terms are used:

Authentication Domain Name (ADN): Refers to a domain name that is used by a DNS client to authenticate a DNS resolver.

ADN-only mode: Refers to a DNS discovery mode where only the ADN of the DNS resolver is retrieved. See Section 3.1.6.

Do53: Refers to unencrypted DNS.

DNR: Refers to the procedure called Discovery of Network-designated Resolvers.

Encrypted DNS: Refers to a scheme where DNS exchanges are transported over an encrypted channel. Examples include DoT, DoH, and DoQ.

Encrypted DNS resolver: Refers to a DNS resolver that supports any encrypted DNS scheme.

Encrypted DNS options: Refers to the options defined in Sections 4, 5, and 6.

DHCP: Refers to both DHCPv4 and DHCPv6.

3. Overview

This document describes how a DNS client can discover local encrypted DNS resolvers using DHCP (Sections 4 and 5) and Neighbor Discovery protocol (Section 6) Encrypted DNS options.

These options configure an ADN, a list of IP addresses, and a set of service parameters of the encrypted DNS resolver. More information about the design of these options is provided in the following subsections.

3.1. Configuration Data for Encrypted DNS

3.1.1. ADN as Reference Identifier for DNS Authentication

In order to allow for a PKIX-based authentication of the encrypted DNS resolver to the DNS client, the Encrypted DNS options are designed to always include an ADN. This ADN is presented as a reference identifier for DNS authentication purposes. This design accommodates the current best practices for issuing certificates as per Section 1.7.2 of [RFC6125]:

> Some certification authorities issue server certificates based on IP addresses, but preliminary evidence indicates that such certificates are a very small percentage (less than 1%) of issued certificates.

3.1.2. Avoiding Dependency on External Resolvers

To avoid adding a dependency on another server to resolve the ADN, the Encrypted DNS options return the IP address(es) to locate an encrypted DNS resolver. These encrypted DNS resolvers may be hosted on the same IP address or distinct IP addresses. Such a decision is deployment specific.

In order to optimize the size of discovery messages when all DNS resolvers terminate on the same IP address, early draft versions of this document considered relying upon the discovery mechanisms specified in [RFC2132], [RFC3646], and [RFC8106] to retrieve a list of IP addresses to reach their DNS resolvers. Nevertheless, this approach requires a client that supports more than one encrypted DNS protocol (e.g., DoH and DoT) to probe that list of IP addresses. To avoid such probing, the options defined in Sections 4, 5, and 6 associate an encrypted DNS protocol with an IP address. No probing is required in such a design.

3.1.3. Single vs. Multiple IP Addresses

A list of IP addresses to reach an encrypted DNS resolver may be returned in an Encrypted DNS option to accommodate current deployments relying upon primary and backup resolvers. Also, DNR can be used in contexts where other DNS redundancy schemes (e.g., anycast as discussed in BCP 126 [RFC4786]) are used.

Whether one or more IP addresses are returned in an Encrypted DNS option is deployment specific. For example, a router embedding a recursive server or a forwarder has to include one single IP address pointing to one of its LAN-facing interfaces. Typically, this IP address can be a private IPv4 address, a Link-Local address, an IPv6 Unique Local Address (ULA), or a Global Unicast Address (GUA).

If multiple IP addresses are to be returned in an Encrypted DNS option, these addresses are returned, ordered by preference, for use by the client.

3.1.4. Why Not Separate Options for the ADN and IP Addresses?

A single option is used to convey both the ADN and IP addresses. Otherwise, a means to correlate an IP address conveyed in an option with an ADN conveyed in another option will be required if, for example, more than one ADN is supported by the network.

3.1.5. Service Parameters

Because distinct encrypted DNS protocols (e.g., DoT, DoH, and DoQ) may be provisioned by a network and some of these protocols may make use of customized port numbers instead of default port numbers, the Encrypted DNS options are designed to return a set of service parameters. These parameters are encoded following the same rules for encoding SvcParams using the wire format specified in Section 2.2 of [RFC9460]. This encoding approach may increase

the size of the options, but it has the merit of relying upon an existing IANA registry and, thus, accommodating new encrypted DNS protocols and service parameters that may be defined in the future.

The following service parameters **MUST** be supported by a DNR implementation:

alpn: Used to indicate the set of supported protocols (Section 7.1 of [RFC9460]).

port: Used to indicate the target port number for the encrypted DNS connection (Section 7.2 of [RFC9460]).

In addition, the following service parameter is **RECOMMENDED** to be supported by a DNR implementation:

dohpath: Used to supply a relative DoH URI Template (Section 5.1 of [RFC9461]).

3.1.6. ADN-Only Mode

The provisioning mode in which an ADN, a list of IP addresses, and a set of service parameters of the encrypted DNS resolver are supplied to a host **SHOULD** be used because the Encrypted DNS options are self-contained and do not require any additional DNS queries. The reader may refer to [RFC7969] for an overview of advanced capabilities that are supported by DHCP servers to populate configuration data (e.g., issue DNS queries).

In contexts where putting additional complexity on requesting hosts is acceptable, returning an ADN only can be considered. The supplied ADN will be passed to a local resolution library (a DNS client, typically), which will then issue Service Binding (SVCB) queries [RFC9461]. These SVCB queries can be sent to the discovered encrypted DNS resolver itself or to the network-designated Do53 resolver. Note that this mode may be subject to active attacks, which can be mitigated by DNSSEC.

> How an ADN is passed to a local resolution library is implementation specific.

3.1.7. Ordering of Encrypted DNS Options

The DHCP options defined in Sections 4 and 5 follow the option ordering guidelines in Section 17 of [RFC7227].

Likewise, the RA option (Section 6) adheres to the recommendations in Section 9 of [RFC4861].

3.1.8. DNR Validation Checks

On receipt of an Encrypted DNS option, the DHCP client (or IPv6 host) makes the following validation checks:

- The ADN is present and encoded as per Section 10 of [RFC8415].

- If additional data is supplied:
  - The service parameters are encoded following the rules specified in Section 2.2 of [RFC9460].
  - The option includes at least one valid IP address.
  - The service parameters do not include "ipv4hint" or "ipv6hint" parameters.

If any of the checks fail, the receiver discards the received Encrypted DNS option.

3.1.9. DNR Information Using Other Provisioning Mechanisms

The provisioning mechanisms specified in this document may not be available in specific networks (e.g., some cellular networks exclusively use Protocol Configuration Options (PCOs) [TS. 24008]) or may not be suitable in some contexts (e.g., where secure discovery is needed). Other mechanisms may be considered in these contexts for the provisioning of encrypted DNS resolvers. It is **RECOMMENDED** that at least the following DNR information be made available to a requesting host:

- A service priority whenever the discovery mechanism does not rely on implicit ordering if multiple instances of the encrypted DNS are used.
- An ADN. This parameter is mandatory.
- A list of IP addresses to locate the encrypted DNS resolver.
- A set of service parameters.

3.2. Handling Configuration Data Conflicts

If encrypted DNS resolvers are discovered by a host using both RA and DHCP, the rules discussed in Section 5.3.1 of [RFC8106] **MUST** be followed.

DHCP/RA options to discover encrypted DNS resolvers (including DoH URI Templates) takes precedence over Discovery of Designated Resolvers (DDR) [RFC9462], since DDR uses Do53 to an external DNS resolver, which is susceptible to both internal and external attacks whereas DHCP/RA is typically protected using the mechanisms discussed in Section 7.1.

If a client learns both Do53 and encrypted DNS resolvers from the same network, and absent explicit configuration otherwise, it is **RECOMMENDED** that the client use the encrypted DNS resolvers for that network. If the client cannot establish an authenticated and encrypted connection with the encrypted DNS resolver, it may fall back to using the Do53 resolver.

3.3. Validating Discovered Resolvers

This section describes a set of validation checks to confirm that an encrypted DNS resolver matches what is provided using DNR (e.g., DHCP or RA). Such validation checks do not intend to validate the security of the DNR provisioning mechanisms or the user's trust relationship to the network.

If the local DNS client supports one of the discovered encrypted DNS protocols identified by Application-Layer Protocol Negotiation (ALPN) protocol identifiers (or another service parameter that indicates some other protocol disambiguation mechanism), the DNS client establishes an encrypted DNS session following the service priority of the discovered encrypted resolvers.

The DNS client verifies the connection based on PKIX validation [RFC5280] of the DNS resolver certificate and uses the validation techniques as described in [RFC6125] to compare the ADN conveyed in the Encrypted DNS options to the certificate provided (see Section 8.1 of [RFC8310] for more details). The DNS client uses the default system or application PKI trust anchors unless configured otherwise to use explicit trust anchors. ALPN-related considerations can be found in Section 7.1 of [RFC9460]. Operational considerations related to checking the revocation status of the certificate of an encrypted DNS resolver are discussed in Section 10 of [RFC8484].

3.4. Multihoming Considerations

Devices may be connected to multiple networks, each providing their own DNS configuration using the discovery mechanisms specified in this document. Nevertheless, discussing DNS selection of multi-interfaced devices is beyond the scope of this specification. Such considerations fall under the generic issue of handling multiple provisioning sources and should not be processed in each option separately, as per the recommendation in Section 12 of [RFC7227].

The reader may refer to [RFC6731] for a discussion of DNS selection issues and an example of DNS resolver selection for multi-interfaced devices. Also, the reader may refer to [Local-DNS-Authority] for a discussion on how DNR and Provisioning Domain (PvD) key "dnsZones" (Section 4.3 of [RFC8801]) can be used in "split DNS" environments (Section 6 of [RFC8499]).

4. DHCPv6 Encrypted DNS Option

4.1. Option Format

The format of the DHCPv6 Encrypted DNS option is shown in Figure 1.

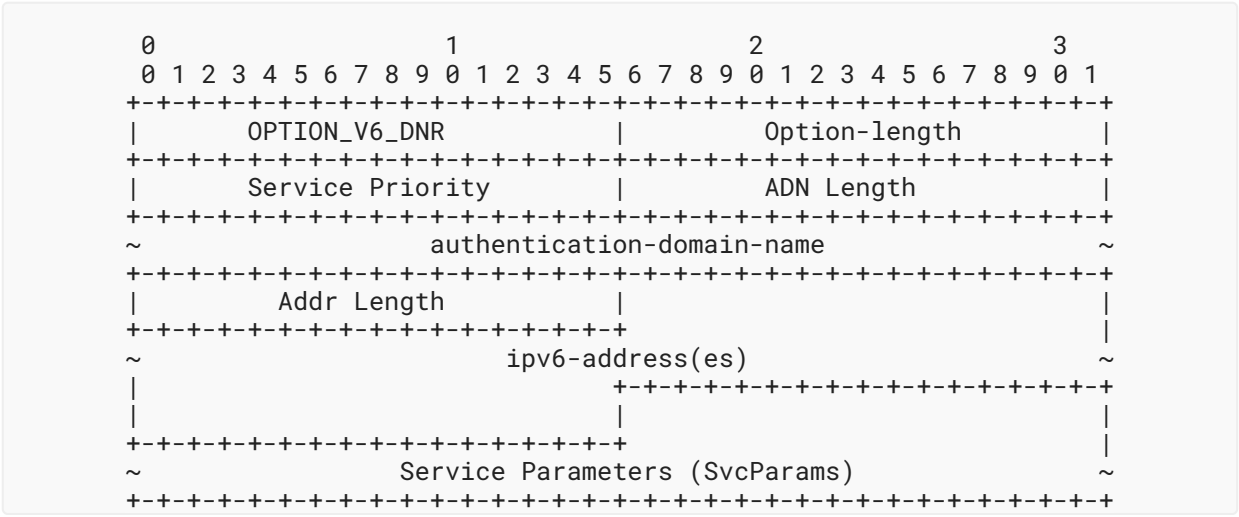

Figure 1: DHCPv6 Encrypted DNS Option

The fields of the option shown in Figure 1 are as follows:

Option-code: OPTION_V6_DNR (144; see Section 9.1).

Option-length: Length of the enclosed data in octets. The option length is ('ADN Length' + 4) when only an ADN is included in the option.

Service Priority: The priority of this OPTION_V6_DNR instance compared to other instances. This 16-bit unsigned integer is interpreted following the rules specified in Section 2.4.1 of [RFC9460].

ADN Length: Length of the authentication-domain-name field in octets.

authentication-domain-name (variable length): A Fully Qualified Domain Name (FQDN) of the encrypted DNS resolver. This field is formatted as specified in Section 10 of [RFC8415].

An example of the authentication-domain-name encoding is shown in Figure 2. This example conveys the FQDN "doh1.example.com.", and the resulting ADN Length field is 18.

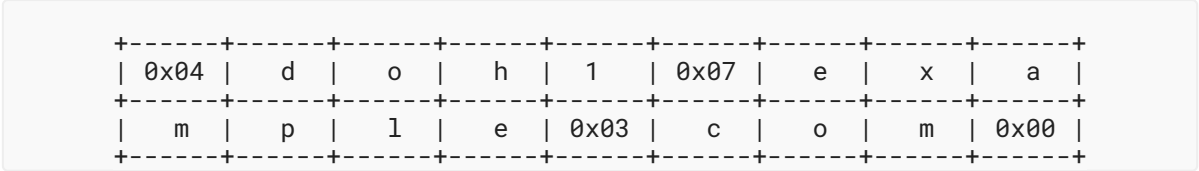

Figure 2: An Example of the DNS authentication-domain-name Encoding

Addr Length: Length of enclosed IPv6 addresses in octets. When present, it **MUST** be a multiple of 16.

ipv6-address(es) (variable length): Indicates one or more IPv6 addresses to reach the encrypted DNS resolver. An address can be a Link-Local address, a ULA, or a GUA. The format of this field is shown in Figure 3.

Figure 3: Format of the ipv6-address(es) Field

Service Parameters (SvcParams) (variable length): Specifies a set of service parameters that are encoded following the rules in Section 2.2 of [RFC9460]. Service parameters may include, for example, a list of ALPN protocol identifiers or alternate port numbers. This field **SHOULD** include at least the "alpn" SvcParam. The "alpn" SvcParam may not be required in contexts such as a variant of DNS over the Constrained Application Protocol (CoAP) where messages are encrypted using Object Security for Constrained RESTful Environments (OSCORE) [RFC8613]. The service parameters **MUST NOT** include "ipv4hint" or "ipv6hint" SvcParams, as they are superseded by the included IP addresses.

If no port service parameter is included, this indicates that default port numbers should be used. As a reminder, the default port number is 853 for DoT, 443 for DoH, and 853 for DoQ.

The length of this field is ('Option-length' - 6 - 'ADN Length' - 'Addr Length').

Note that the "Addr Length", "ipv6-address(es)", and "Service Parameters (SvcParams)" fields are not present if the ADN-only mode is used (Section 3.1.6).

4.2. DHCPv6 Client Behavior

To discover an encrypted DNS resolver, the DHCPv6 client **MUST** include OPTION_V6_DNR in an Option Request Option (ORO), per Sections 18.2.1, 18.2.2, 18.2.4, 18.2.5, 18.2.6, and 21.7 of [RFC8415].

The DHCPv6 client **MUST** be prepared to receive multiple instances of the OPTION_V6_DNR option; each option is to be treated as a separate encrypted DNS resolver. These instances **MUST** be processed following their service priority (i.e., a smaller service priority value indicates a higher preference).

The DHCPv6 client **MUST** silently discard any OPTION_V6_DNR that fails to pass the validation steps defined in Section 3.1.8.

The DHCPv6 client **MUST** silently discard multicast and host loopback addresses conveyed in OPTION_V6_DNR.

5. DHCPv4 Encrypted DNS Option

5.1. Option Format

The format of the DHCPv4 Encrypted DNS option is illustrated in Figure 4.

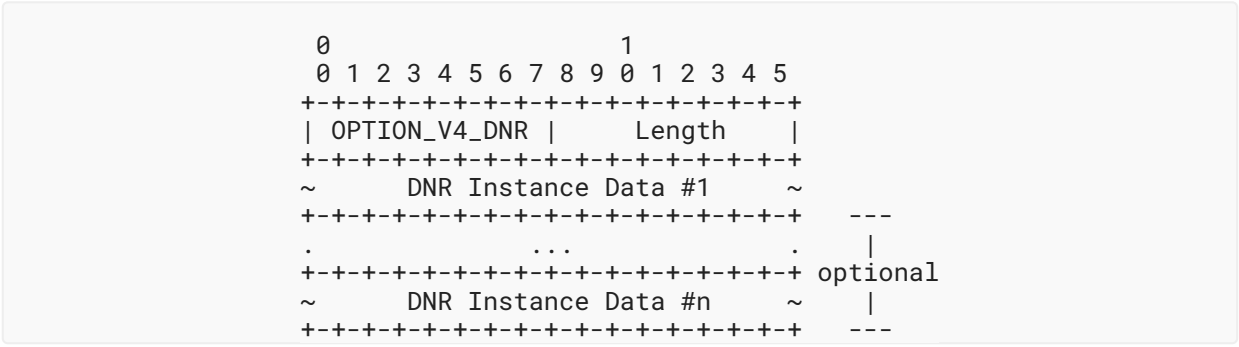

Figure 4: DHCPv4 Encrypted DNS Option

The fields of the option shown in Figure 4 are as follows:

Code: OPTION_V4_DNR (162; see Section 9.2).

Length: Indicates the length of the enclosed data in octets.

DNR Instance Data: Includes the configuration data of an encrypted DNS resolver. The format of this field is shown in Figure 5.

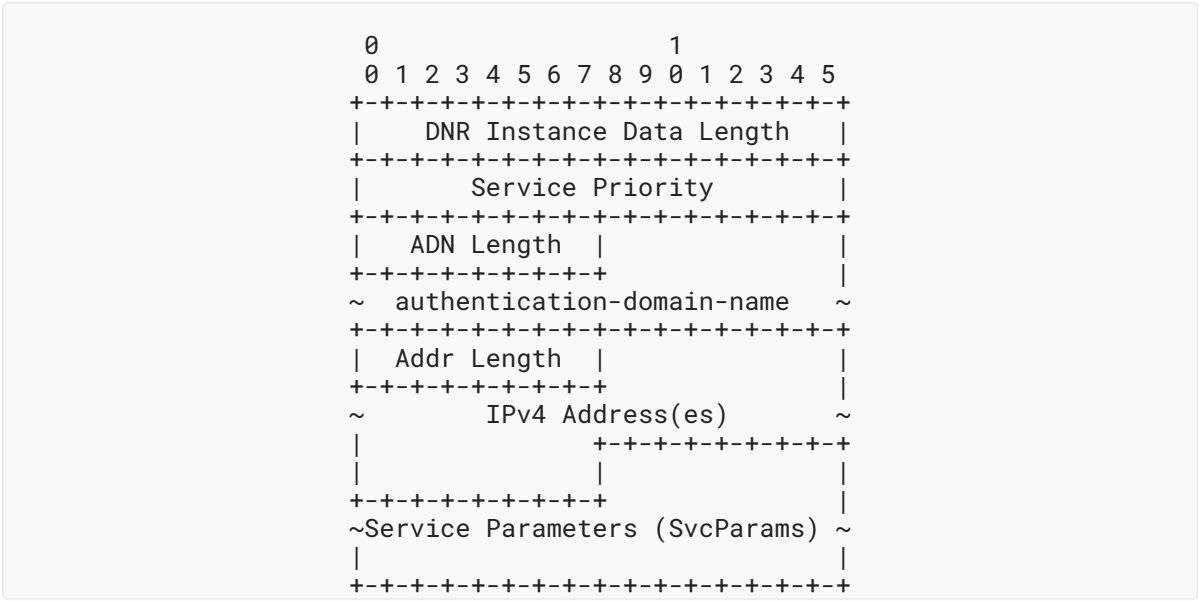

Figure 5: DNR Instance Data Format

When several encrypted DNS resolvers are to be included, the "DNR Instance Data" field is repeated.

The fields shown in Figure 5 are as follows:

DNR Instance Data Length: Length of all following data in octets. This field is set to ('ADN Length' + 3) when only an ADN is provided for a DNR instance.

Service Priority: The priority of this instance compared to other DNR instances. This 16-bit unsigned integer is interpreted following the rules specified in Section 2.4.1 of [RFC9460].

ADN Length: Length of the authentication-domain-name field in octets.

authentication-domain-name (variable length): The ADN of the encrypted DNS resolver. This field is formatted as specified in Section 10 of [RFC8415]. An example is provided in Figure 2.

Addr Length: Length of included IPv4 addresses in octets. When present, it **MUST** be a multiple of 4.

IPv4 Address(es) (variable length): Indicates one or more IPv4 addresses to reach the encrypted DNS resolver. Both private and public IPv4 addresses can be included in this field. The format of this field is shown in Figure 6. This format assumes that an IPv4 address is encoded as a1.a2.a3.a4.

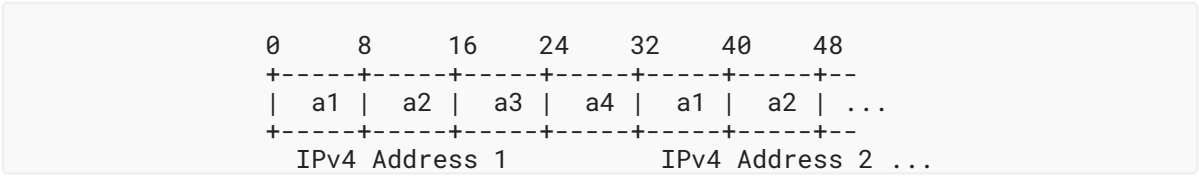

Figure 6: Format of the IPv4 Address(es) Field

Service Parameters (SvcParams) (variable length): Specifies a set of service parameters that are encoded following the rules in Section 2.2 of [RFC9460]. Service parameters may include, for example, a list of ALPN protocol identifiers or alternate port numbers. This field **SHOULD** include at least the "alpn" SvcParam. The "alpn" SvcParam may not be required in contexts such as a variant of DNS over CoAP where messages are encrypted using OSCORE. The service parameters **MUST NOT** include "ipv4hint" or "ipv6hint" SvcParams, as they are superseded by the included IP addresses.

If no port service parameter is included, this indicates that default port numbers should be used.

The length of this field is ('DNR Instance Data Length' - 4 - 'ADN Length' - 'Addr Length').

Note that the "Addr Length", "IPv4 Address(es)", and "Service Parameters (SvcParams)" fields are not present if the ADN-only mode is used (Section 3.1.6).

OPTION_V4_DNR is a concatenation-requiring option. As such, the mechanism specified in [RFC3396] **MUST** be used if OPTION_V4_DNR exceeds the maximum DHCPv4 option size of 255 octets.

5.2. DHCPv4 Client Behavior

To discover an encrypted DNS resolver, the DHCPv4 client requests the encrypted DNS resolver by including OPTION_V4_DNR in a Parameter Request List option [RFC2132].

The DHCPv4 client **MUST** be prepared to receive multiple "DNR Instance Data" field entries in the OPTION_V4_DNR option; each instance is to be treated as a separate encrypted DNS resolver. These instances **MUST** be processed following their service priority (i.e., a smaller service priority value indicates a higher preference).

The DHCPv4 client **MUST** silently discard any OPTION_V4_DNR that fails to pass the validation steps defined in Section 3.1.8.

The DHCPv4 client **MUST** silently discard multicast and host loopback addresses conveyed in OPTION_V4_DNR.

6. IPv6 RA Encrypted DNS Option

6.1. Option Format

This section defines a new Neighbor Discovery option [RFC4861]: the IPv6 RA Encrypted DNS option. This option is useful in contexts similar to those discussed in Section 1.1 of [RFC8106].

The format of the IPv6 RA Encrypted DNS option is illustrated in Figure 7.

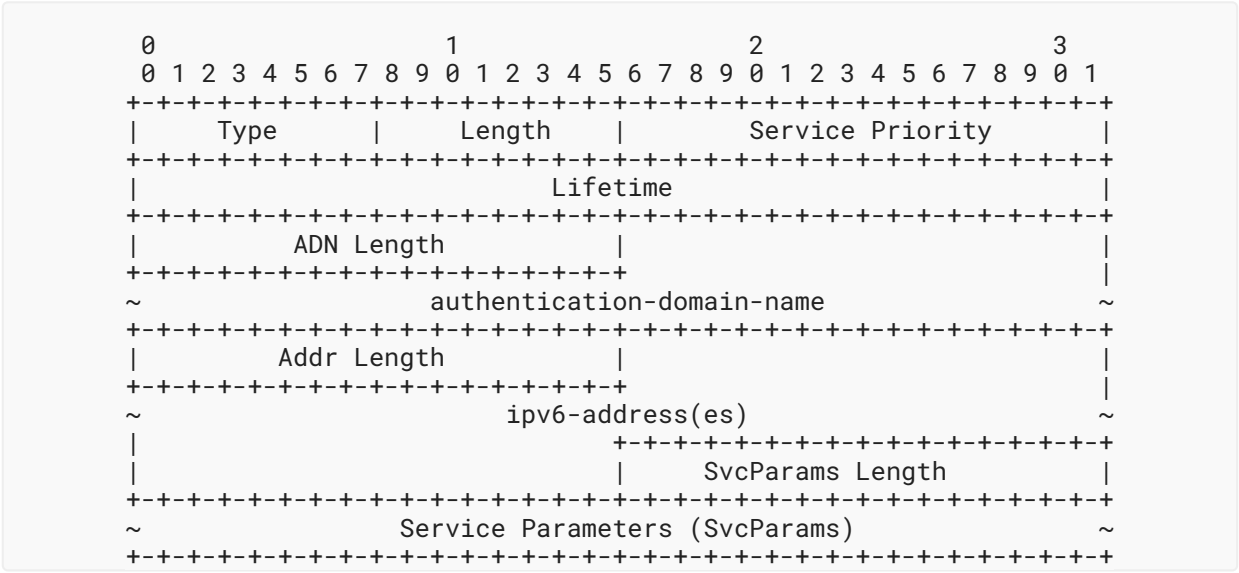

Figure 7: RA Encrypted DNS Option

The fields of the option shown in Figure 7 are as follows:

Type: 8-bit identifier of the Encrypted DNS option as assigned by IANA (144; see Section 9.3).

Length: 8-bit unsigned integer. The length of the option (including the Type and Length fields) is in units of 8 octets.

Service Priority: 16-bit unsigned integer. The priority of this Encrypted DNS option instance compared to other instances. This field is interpreted following the rules specified in Section 2.4.1 of [RFC9460].

Lifetime: 32-bit unsigned integer. This represents the maximum time in seconds (relative to the time the packet is received) over which the discovered ADN is valid.

The value of Lifetime **SHOULD** by default be at least 3 * MaxRtrAdvInterval, where MaxRtrAdvInterval is the maximum RA interval as defined in [RFC4861].

A value of all one bits (0xffffffff) represents infinity.

A value of zero means that this ADN **MUST** no longer be used.

ADN Length: 16-bit unsigned integer. This field indicates the length of the authentication-domain-name field in octets.

authentication-domain-name (variable length): The ADN of the encrypted DNS resolver. This field is formatted as specified in Section 10 of [RFC8415].

Addr Length: 16-bit unsigned integer. This field indicates the length of enclosed IPv6 addresses in octets. When present, it **MUST** be a multiple of 16.

ipv6-address(es) (variable length): One or more IPv6 addresses of the encrypted DNS resolver. An address can be a Link-Local address, a ULA, or a GUA.

All of the addresses share the same Lifetime value. As also discussed in [RFC8106], if it is desirable to have different Lifetime values per IP address, multiple Encrypted DNS options may be used.

The format of this field is shown in Figure 3.

SvcParams Length: 16-bit unsigned integer. This field indicates the length of the "Service Parameters (SvcParams)" field in octets.

Service Parameters (SvcParams) (variable length): Specifies a set of service parameters that are encoded following the rules in Section 2.2 of [RFC9460]. Service parameters may include, for example, a list of ALPN protocol identifiers or alternate port numbers. This field **SHOULD** include at least the "alpn" SvcParam. The "alpn" SvcParam may not be required in contexts such as a variant of DNS over CoAP where messages are encrypted using OSCORE. The service parameters **MUST NOT** include "ipv4hint" or "ipv6hint" SvcParams, as they are superseded by the included IP addresses.

If no port service parameter is included, this indicates that default port numbers should be used.

Note that the "Addr Length", "ipv6-address(es)", and "Service Parameters (SvcParams)" fields are not present if the ADN-only mode is used (Section 3.1.6).

The option **MUST** be padded with zeros so that the full enclosed data is a multiple of 8 octets (Section 4.6 of [RFC4861]).

6.2. IPv6 Host Behavior

The procedure for DNS configuration is the same as it is with any other Neighbor Discovery option [RFC4861]. In addition, the host follows the same procedure as the procedure described in Section 5.3.1 of [RFC8106] for processing received Encrypted DNS options, with the formatting requirements listed in Section 6.1 and the validation checks listed in Section 3.1.8 substituted for length and field validations.

The host **MUST** be prepared to receive multiple Encrypted DNS options in RAs. These instances **MUST** be processed following their service priority (i.e., a smaller service priority value indicates a higher preference).

The host **MUST** silently discard multicast and host loopback addresses conveyed in the Encrypted DNS options.

7. Security Considerations

7.1. Spoofing Attacks

DHCP/RA messages are not encrypted or protected against modification within the LAN. Unless spoofing attacks are mitigated as described below, the content of DHCP and RA messages can be spoofed or modified by active attackers, such as compromised devices within the local network. An active attacker (Section 3.3 of [RFC3552]) can spoof the DHCP/RA response to provide the attacker's encrypted DNS resolver. Note that such an attacker can launch other attacks as discussed in Section 22 of [RFC8415]. The attacker can get a domain name with a domain-validated public certificate from a Certificate Authority (CA) and host an encrypted DNS resolver.

Attacks of spoofed or modified DHCP responses and RA messages by attackers within the local network may be mitigated by making use of the following mechanisms:

DHCPv6-Shield [RFC7610]: The network access node (e.g., a border router, a CPE, an Access Point (AP)) discards DHCP response messages received from any local endpoint.

RA-Guard [RFC7113]: The network access node discards RA messages received from any local endpoint.

Source Address Validation Improvement (SAVI) solution for DHCP [RFC7513]: The network access node filters packets with forged source IP addresses.

The above mechanisms would ensure that the endpoint receives the correct configuration information of the encrypted DNS resolvers selected by the DHCP server (or RA sender), but these mechanisms cannot provide any information about the DHCP server or the entity hosting the DHCP server (or RA sender).

Encrypted DNS sessions with rogue resolvers that spoof the IP address of a DNS resolver will fail because the DNS client will fail to authenticate that rogue resolver based upon PKIX authentication [RFC6125], particularly the ADN in the Encrypted DNS option. DNS clients that ignore authentication failures and accept spoofed certificates will be subject to attacks (e.g., attacks that redirect to malicious resolvers or intercept sensitive data).

7.2. Deletion Attacks

If the DHCP responses or RAs are dropped by the attacker, the client can fall back to using a preconfigured encrypted DNS resolver. However, the use of policies to select resolvers is beyond the scope of this document.

Note that deletion attacks are not specific to DHCP/RA.

7.3. Passive Attacks

A passive attacker (Section 3.2 of [RFC3552]) can determine that a host is using DHCP/RA to discover an encrypted DNS resolver and can infer that the host is capable of using DoH/DoT/DoQ to encrypt DNS messages. However, a passive attacker cannot spoof or modify DHCP/RA messages.

7.4. Wireless Security - Authentication Attacks

Wireless LANs (WLANs), frequently deployed in local networks (e.g., home networks), are vulnerable to various attacks (e.g., [Evil-Twin], [Krack], [Dragonblood]). Because of these attacks, only cryptographically authenticated communications are trusted on WLANs. This means that any information (e.g., regarding NTP servers, DNS resolvers, or domain search lists) provided by such networks via DHCP, DHCPv6, or RA is untrusted because DHCP and RA messages are not authenticated.

If the pre-shared key (PSK) is the same for all clients that connect to the same WLAN (e.g., Wi-Fi Protected Access Pre-Shared Key (WPA-PSK)), the shared key will be available to all nodes, including attackers. As such, it is possible to mount an active on-path attack. On-path attacks are possible within local networks because this form of WLAN authentication lacks peer entity authentication.

This leads to the need for provisioning unique credentials for different clients. Endpoints can be provisioned with unique credentials (username and password, typically) provided by the local network administrator to mutually authenticate to the local WLAN AP (e.g., 802.1x Wireless User Authentication on OpenWrt [dot1x], EAP-pwd [RFC8146] ("EAP" stands for "Extensible Authentication Protocol")). Not all endpoint devices (e.g., Internet of Things (IoT) devices) support 802.1x supplicants and need an alternate mechanism to connect to the local network. To address this limitation, unique PSKs can be created for each such device and WPA-PSK is used (e.g., [IPSK]).

8. Privacy Considerations

Privacy considerations that are also specific to DNR provisioning mechanisms are discussed in Section 23 of [RFC8415] and in [RFC7824]. Anonymity profiles for DHCP clients are discussed in [RFC7844]. The mechanisms defined in this document can be used to infer that a DHCP client or IPv6 host supports Encrypted DNS options, but these mechanisms do not explicitly reveal whether local DNS clients are able to consume these options or infer their encryption capabilities. Other than that, this document does not expose more privacy information compared to Do53 discovery options.

As discussed in [RFC9076], the use of encrypted DNS does not reduce the data available in the DNS resolver. For example, the reader may refer to Section 8 of [RFC8484] or Section 7 of [RFC9250] for a discussion on specific privacy considerations for encrypted DNS.

9. IANA Considerations

9.1. DHCPv6 Option

IANA has assigned the following new DHCPv6 Option Code in the "Option Codes" registry maintained at [DHCPV6].

Value	Description	Client ORO	Singleton Option	Reference
144	OPTION_V6_DNR	Yes	No	RFC 9463

Table 1: DHCPv6 Encrypted DNS Option

9.2. DHCPv4 Option

IANA has assigned the following new DHCP Option Code in the "BOOTP Vendor Extensions and DHCP Options" registry maintained at [BOOTP].

Tag	Name	Data Length	Meaning	Reference
162	OPTION_V4_DNR	N	Encrypted DNS Server	RFC 9463

Table 2: DHCPv4 Encrypted DNS Option

9.3. Neighbor Discovery Option

IANA has assigned the following new IPv6 Neighbor Discovery Option type in the "IPv6 Neighbor Discovery Option Formats" subregistry under the "Internet Control Message Protocol version 6 (ICMPv6) Parameters" registry maintained at [ND].

Type	Description	Reference
144	Encrypted DNS Option	RFC 9463

Table 3: Neighbor Discovery Encrypted DNS Option

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