

Workgroup: DNSOP  
Internet-Draft: draft-homburg-dnsop-codcp-01  
Published: 7 July 2023  
Intended Status: Standards Track  
Expires: 8 January 2024  
Authors: P.C. Homburg

## Control Options For DNS Client Proxies

### Abstract

The introduction of many new transport protocols for DNS in recent years (DoT, DoH, DoQ) significantly increases the complexity of DNS stub resolvers that want to support these protocols. A practical way forward is to have a DNS client proxy in the host operating system. This allows applications to communicate using Do53 and still get the privacy benefit from using more secure protocols over the internet. However, such a setup leaves the application with no control over which transport the proxy uses. This document introduces EDNS(0) options that allow a stub resolver to request certain transport and allow the proxy to report capabilities and actual transports that are available.

### Status of This Memo

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

Internet-Drafts are working documents of the Internet Engineering Task Force (IETF). Note that other groups may also distribute working documents as Internet-Drafts. The list of current Internet-Drafts is at <https://datatracker.ietf.org/drafts/current/>.

Internet-Drafts are draft documents valid for a maximum of six months and may be updated, replaced, or obsoleted by other documents at any time. It is inappropriate to use Internet-Drafts as reference material or to cite them other than as "work in progress."

This Internet-Draft will expire on 8 January 2024.

### Copyright Notice

Copyright (c) 2023 IETF Trust and the persons identified as the document authors. All rights reserved.

This document is subject to BCP 78 and the IETF Trust's Legal Provisions Relating to IETF Documents (<https://trustee.ietf.org/license-info>) in effect on the date of publication of this document. Please review these documents carefully, as they describe your rights and restrictions with respect

to this document. Code Components extracted from this document must include Revised BSD License text as described in Section 4.e of the Trust Legal Provisions and are provided without warranty as described in the Revised BSD License.

## Table of Contents

- [1. Discussion Venues](#)
- [2. Definitions](#)
- [3. Introduction](#)
- [4. Key Words](#)
- [5. Description](#)
- [6. PROXY CONTROL OPTION](#)
  - [6.1. Security Constraints Sub-option](#)
  - [6.2. Transport Priority Sub-option](#)
  - [6.3. SVC Parameter](#)
  - [6.4. Domain Name](#)
  - [6.5. Interface Name](#)
- [7. PROXY SCOPE OPTION](#)
- [8. TRUST ANCHOR OPTION](#)
- [9. Protocol Specification](#)
  - [9.1. Client Processing](#)
    - [9.1.1. Probing](#)
    - [9.1.2. Trust Anchor](#)
  - [9.2. Server Processing](#)
- [10. Connection Between Stub Resolver And Proxy](#)
- [11. Security Considerations](#)
- [12. IANA Considerations](#)
- [13. Acknowledgements](#)
- [14. Normative References](#)
- [15. Informative References](#)
- [Appendix A. Change history](#)
- [Author's Address](#)

### 1. Discussion Venues

This note is to be removed before publishing as an RFC. Source for this draft and an issue tracker can be found at <https://github.com/NLnetLabs/draft-homburg-dnsop-codc> .

### 2. Definitions

**Do53** The original, plain text DNS transport as described in [RFC1034][RFC1035]. Typically, UDP is used, with the DNS server listening on port 53. Sometimes, for example, for large responses, TCP is used, also on port 53.

**DoH** DNS over HTTPS as described in [RFC8484].

**DoT** DNS over TLS as described in [RFC7858]

**DoQ**

DNS over QUIC ([[RFC9000](#)]) as described in [I-D.ietf-dprive-dnsquic], not to be confused with DNS over HTTP/3 which also uses QUIC

**EDNS(0) Option** An option as described in [[RFC6891](#)]

**h2** This TLS ALPN identifies HTTP/2 as described in [[RFC7540](#)]

**h3** This TLS ALPN identifies HTTP/3, which is HTTP over QUIC and is described in I.D.ietf-quic-http (expired draft)

**Interface Name** A name that identifies a network interface as described in [[RFC3493](#)]. In addition, an interface index converted to a decimal number is also considered an interface name.

**PKIX** Public-Key Infrastructure using X.509. See [[RFC5280](#)]

### 3. Introduction

The introduction of many new transport protocols for DNS in recent years (DoT, DoH, DoQ) significantly increases the complexity of DNS stub resolvers that want to support these protocols. In addition, for short-lived applications, the overhead of setting a DoH connection is quite high if the application only needs to send a few DNS requests.

A practical way forward is to have a DNS client proxy in the host operating system. A local proxy may provide some benefit to short-lived applications by caching results. In particular if the system uses a so called 'public DNS resolver'. In general we assume that the cache is tagged according to the source of a reply and the transport it is received on.

This allows applications to communicate using Do53 and still get the privacy benefits from using more secure protocols over the internet. However, such a setup leaves the application with no control over which transport the proxy uses. This document introduces EDNS(0) options that allow a stub resolver to request certain transports and allow the proxy to report capabilities and actual transports that are available.

With respect to DNSSEC, we assume that an application that needs DNSSEC validation, for example, for DANE validation or SSHFP, will perform the DNSSEC validation within the application itself and does not trust the proxy. The proxy can of course do DNSSEC validation as well. Important however, is that an untrusted proxy cannot provide an application with a traditional (unsigned) trust anchor.

For the transport configuration we expect three levels of details. The first is a choice between requiring authenticated encryption,

also allowing unauthenticated encryption or doing opportunistic encryption on an best effort basis. The second level is where the application also specifies the names and/or IP addresses of upstream resolvers. The third level is where the application also specifies which transports (Do53, DoT, DoH, DoQ) are allowed to be used. A final transport parameter is the outgoing interface that is to be used.

For authentication we can have a mix of PKIX and DANE. Options are one of the two and not the other, both or one of the two.

In a response, the proxy reports the interface, resolver, and transport used.

As described in [Section 3](#) of [[RFC5625](#)], some simple DNS proxies may just forward DNS packets without handling of EDNS(0) options. So what could happen is that an application sends a privacy sensitive request to local proxy, expecting the proxy upstream connection to be encrypted. However, a simple proxy may just forward the request unencrypted to another proxy, for example, one in a CPE that does implement the protocol described in this document. So what could happen is that the request travels unencrypted over a local lan, or if proxies deeper in the network support this protocol, even further without the application noticing that something is wrong.

To handle this case, we introduce an option where the proxy reports whether the connection between the stub resolver and the proxy is host-local, link-local, or site-local or global.

In the ideal case, the host operating system provides applications with a secure way to access a DNSSEC trust anchor that is maintained according to [[RFC5011](#)]. However in situations where this is not the case, an application can fall back to [[RFC7958](#)]. However, for short lived processes, there is considerable overhead in issuing two HTTP(S) requests to data.iana.org to obtain the trust anchor XML file and the signature over the trust anchor. For this reason, it makes sense to let the proxy cache this information.

#### 4. Key Words

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.

#### 5. Description

This document introduces three new EDNS(0) options, and one new response code. This first option, called PROXY CONTROL Option,

specifies which transports a proxy should use to connect to a recursive resolver.

The second option, called PROXY SCOPE Option, reports the IP address scope of the connection between the application's stub resolver and the proxy.

Finally, the TRUST ANCHOR Option, provides the application with a DNSSEC trust anchor signed by IANA.

The BADPROXYPOLICY error is returned the proxy cannot meet the requirements in a PROXY CONTROL Option or the option is malformed.

## 6. PROXY CONTROL OPTION

```
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
0: |                               OPTION-CODE                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
2: |                               OPTION-LENGTH                             |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
4: ~                               Type-Length-Value (TLV) Sub-Options       ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

where

### OPTION-CODE

To be decided (TBD1)

### OPTION-LENGTH

Length of this option excluding the OPTION-CODE and OPTION-LENGTH fields

The remainder is filled with a collection of TLV sub-options defined next. All sub-options have the following format:

```
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
0: |                               SUB-OPTION-CODE                             |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
2: |                               SUB-OPTION-LENGTH                             |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
4: ~                               Sub-Option Data                             ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

where

**SUB-OPTION-CODE**

16-bit identifier for the sub-option

**SUB-OPTION-LENGTH**

Length of this sub-option excluding the SUB-OPTION-CODE and SUB-OPTION-LENGTH fields

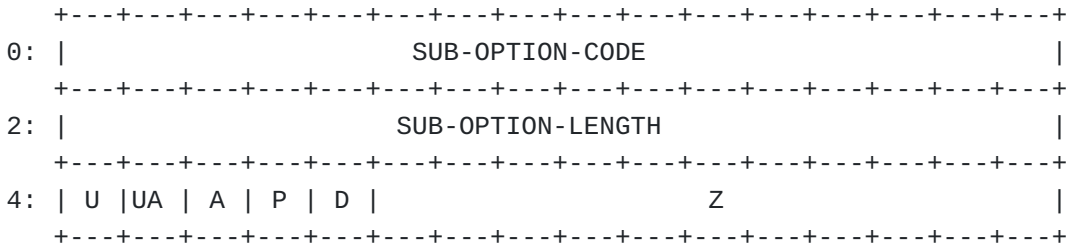
**Sub-Option Data**

Sub-option specific data

Associated with this option is a new error, BADPROXYPOLICY. When a proxy cannot meet the requirements in a PROXY CONTROL Option or the option is malformed, it returns this error.

If the proxy returns a BADPROXYPOLICY error, the proxy MAY include a PROXY CONTROL Option that lists what the proxy can do. For example, if authenticated encryption is not possible, but unauthenticated is, then the proxy may include an option show that.

**6.1. Security Constraints Sub-option**



where

**SUB-OPTION-CODE**

To be decided

**SUB-OPTION-LENGTH**

2 (this sub-option defines a 16-bit flags field)

**U**

force the use of unencrypted communication (Do53)

**UA**

require encryption, authentication is allowed but not required

**A**

require authenticated encryption

**P**

authenticate using a PKIX certificate

**D**

authenticate using DANE

**Z**

reserved, MUST be zero when sending, MUST be ignored when received

This sub-option gives the security constraints of the DNS transports that are used by the client proxy. The U, UA, and A flags are mutually exclusive. If more than one flag is set, the proxy SHOULD return a BADPROXYPOLICY error. There are four possibilities:

**U = 0, UA = 0, A = 0** An effort is made to reach authenticated encryption, if that fails, unauthenticated encryption is tried. If that also fails, the proxy resorts to an unencrypted transport. It is an error if either or both of the P or D flags is set and the proxy SHOULD return a BADPROXYPOLICY error if that is the case.

**U = 1, UA = 0, A = 0** The proxy tries only unencrypted transports. It is an error if either or both of the P or D flags is set and the proxy SHOULD return a BADPROXYPOLICY error if that is the case.

**U = 0, UA = 1, A = 0** An effort is made to reach authenticated encryption, if that fails, unauthenticated encryption is tried. It is an error if either or both of the P or D flags is set and the proxy SHOULD return a BADPROXYPOLICY error if that is the case.

**U = 0, UA = 0, A = 1** The proxy only tries authenticated encryption. The P and D flags can be used to control which authentication mechanism has to be used.

The P and D flags allow the application to require a specific authentication mechanism (PKIX or DANE). The meaning of the flags is the following:

**P = 0, D = 0** At least one of the two mechanisms has to validate for authenticated encryption to succeed.

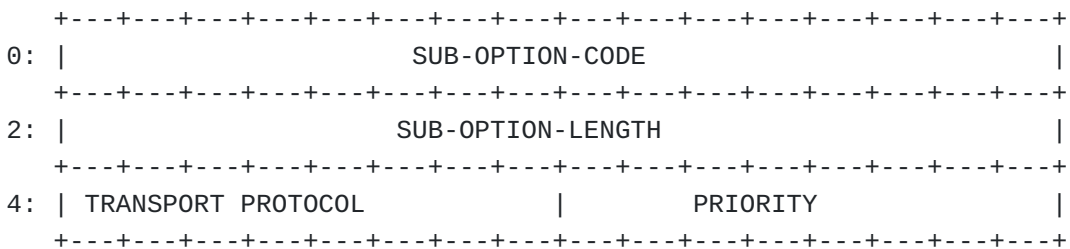
**P = 1, D = 0** PKIX validation has to succeed, the status of DANE validation is ignored.

**P = 0, D = 1** A DANE record has to be present and be DNSSEC valid. A DANE record has a Certificate Usage Field. For some values of this field (the values zero and one), DANE requires PKIX validation. In those cases, PKIX validation is also required according to the DANE specifications. For the values two and three, DANE does not require PKIX and because the P flag is zero, the result of PKIX validation has to be ignored.

**P = 1, D = 1** Both PKIX and DANE are required together. For PKIX, this means that PKIX validation has to succeed. For DANE it means that a DANE record has to be present and be DNSSEC valid. Validation using the DANE record has to succeed.

Note that these two flags can only be used in combination with the A flag. The proxy SHOULD return a BADPROXYPOLICY error if either or both of the P or D flags is set and the A flag is clear.

## 6.2. Transport Priority Sub-option



where



**SUB-OPTION-CODE**

To be decided

**SUB-OPTION-LENGTH**

2

**TRANSPORT PROTOCOL**

A DNS transport protocol identifier. The value 0 is used to specify any transport implemented by server.

**PRIORITY**

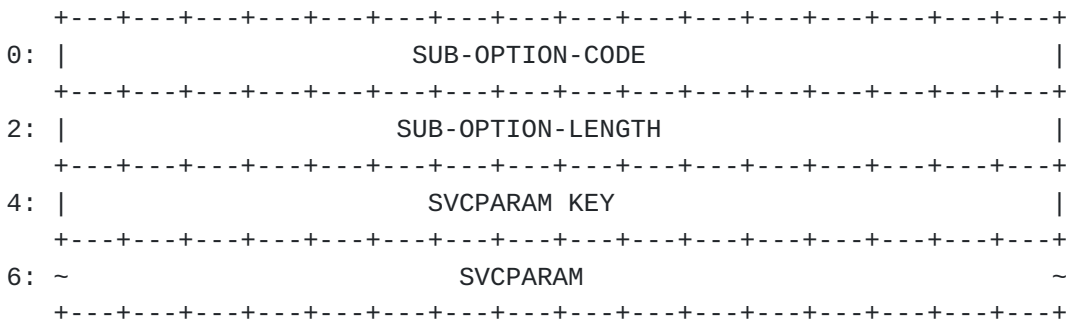
The priority of this transport relative to other transports. The value 0 indicates the highest priority and 254 the lowest. The value 255 is defined to mean that this protocol MUST NOT be used.

Priorities are taken over all Proxy Control options in a DNS request. This allows the application to specify an explicit order (or the lack of order) among different upstream resolvers.

For protocol 0 (the default list), all protocols that are explicitly listed in a Proxy Control option are excluded from the default list. In other words, when processing the default list, all explicitly listed protocols are excluded.

If this sub option is not present in a Proxy Control option, then the proxy should assume protocol 0 at priority 128.

**6.3. SVC Parameter**



where

**SUB-OPTION-CODE**

To be decided

**SUB-OPTION-LENGTH**

Length of this sub-option excluding the SUB-OPTION-CODE and SUB-OPTION-LENGTH fields

**SVCPARAM KEY**

Key of Svc parameters as defined in [ref]

## SvcParam

Svc parameter value

This document take the meaning of SvcParamKeys 'alpn', 'port', and 'dohpath' from [draft-ietf-add-svcb-dns] with the exception that 'alpn' does not have to be present (i.e., the 'MUST be present' requirement does not apply)

Other relevant SvcParamKeys from [draft-ietf-dnsop-svcb-https] are 'mandatory', 'ech', 'ipv4hint' and 'ipv6hint'.

Instead of defining new sub-options to store IPv4 and IPv6 address, this document re-uses the ipv4hints and ipv6hints. However the semantics are redefined to be that these option and not hints, be are the actual addresses that are to be used.

### 6.4. Domain Name

```
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
0: |                               SUB-OPTION-CODE                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
2: |                               SUB-OPTION-LENGTH                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
4: ~                               DOMAIN NAME                               ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

where

#### **SUB-OPTION-CODE**

To be decided

#### **SUB-OPTION-LENGTH**

Length of this sub-option excluding the SUB-OPTION-CODE and SUB-OPTION-LENGTH fields

#### **DOMAIN NAME**

domain name for authentication or resolving IP addresses. The domain name is encoded in uncompressed DNS wire format.

If the option contains a domain name but no IP addresses (ipv4hints or ipv6hints) then the proxy is expected to resolve the name to addresses. If only addresses are specified then the proxy assumes that no name is known (though a PKIX certificate may include an address literal in the subjectAltName). If both a name and addresses are specified then the proxy will use the specified addresses to reach the upstream resolver and use the name for authentication.

The the option contains neither a domain name nor any IP addresses then the application requests the resolvers known to the proxy.

## 6.5. Interface Name

```
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
0: |                               SUB-OPTION-CODE                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
2: |                               SUB-OPTION-LENGTH                             |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
4: ~                               INTERFACE NAME                               ~
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

where

### **SUB-OPTION-CODE**

To be decided

### **SUB-OPTION-LENGTH**

Length of this sub-option excluding the SUB-OPTION-CODE and SUB-OPTION-LENGTH fields

### **INTERFACE NAME**

name of outgoing interface for transport connections

An application may want to specify a DNS resolver that is reachable through an IPv6 link-local address. IPv6 link-local addresses are special in that they require a zone to be specified, either explicitly or implicitly. Typically for a link-local address that appears as a source or destination address, the zone is implicitly the zone of the link the packet travels on. For packets that travel between hosts, there is no good way to explicitly specify the zone of a link-local address because two different hosts do not agree on zone names. However, if the proxy is on the same host as the application, then the zone identifier for the link-local address can be specified in the Interface field. For this purpose an interface name can also be an interface index expressed as a decimal string.

## 7. PROXY SCOPE OPTION

```
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
0: |                               OPTION-CODE                               |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
2: |                               OPTION-LENGTH                             |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
4: |                               Scope                                       |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
```

**OPTION-CODE**

To be decided (TBD2)

**OPTION-LENGTH**

Length of this option excluding the OPTION-CODE and OPTION-LENGTH fields

**Scope**

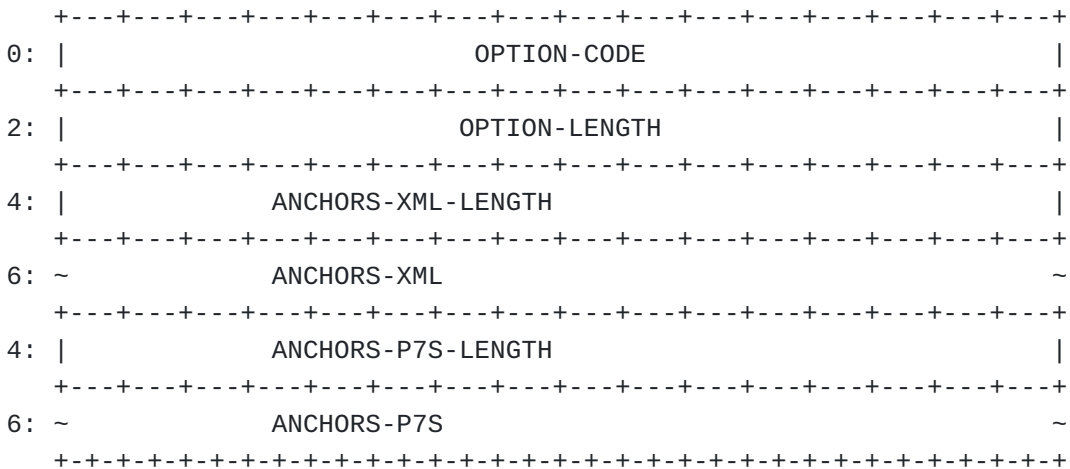
Scope of the source address of a request. Scope can have the following values:

Value	Scope
0	Undefined
1	Host local
2	Link local
3	Site local
4	Global

Table 1

The purpose of this option is to deal with proxies that forward DNS traffic without first removing any EDNS(0) options. The option requests the DNS proxy that processes the option to report the scope of the source address.

**8. TRUST ANCHOR OPTION**



where

**OPTION-CODE**

To be decided (TBD3)

**OPTION-LENGTH**

Length of this option excluding the OPTION-CODE and OPTION-LENGTH fields

**ANCHORS-XML-LENGTH**

Length of ANCHORS-XML in network byte order

**ANCHORS-XML**

Trust anchors in XML format

**ANCHORS-P7S-LENGTH**

Length of ANCHORS-P7S in network byte order

**ANCHORS-P7S**

Signature in p7s format

This option provides DNSSEC trust anchors as described in [[RFC7958](#)].

## 9. Protocol Specification

### 9.1. Client Processing

A stub resolver that wishes to use the PROXY CONTROL Option includes the option in all outgoing DNS requests that require privacy. The option should be initialized according to the needs of the application. In addition the PROXY SCOPE Option can be added. In requests, the Scope field is set to undefined.

If the stub resolver receives a reply without a PROXY CONTROL Option included in the reply, then stub resolver has to assume that traffic will have Do53 levels of privacy. Similarly, a lack of a PROXY SCOPE Option implies a global scope.

If the stub resolver receives a BADPROXYPOLICY error then the proxy was unable to meet the requirements of the PROXY CONTROL Option.

#### 9.1.1. Probing

In cases where the stub resolver expects a local DNS proxy, or where the stub resolver has (a limited) fall back to more private transports, or when the security policy of the application is such that is better to fail than send queries over Do53, the stub resolver first sends a probing query to verify that the proxy supports the PROXY CONTROL and PROXY SCOPE Options.

This request queries "resolver.arpa" for SOA records. The proxy MUST implement this as a Special Use Domain Name. The actual response is not important. The important part is that the proxy returns PROXY CONTROL and PROXY SCOPE Options as described in this document or sets the response code to BADPROXYPOLICY if it cannot meet specified policy.

### 9.1.2. Trust Anchor

In the ideal case, the host operating system provides applications with a secure way to access a DNSSEC trust anchor that is maintained according to [[RFC5011](#)]. However in situations where this is not the case, an application can fall back to [[RFC7958](#)]. However, for short lived processes, there is considerable overhead in issuing two HTTP(S) requests to data.iana.org to obtain the trust anchor XML file and the signature over the trust anchor. For this reason, it makes sense to let the proxy cache this information.

If the local operating system does not provide a DNSSEC trust anchor, then the application can ask the proxy. The stub resolver adds the TRUST ANCHOR Option with ANCHORS-XML-LENGTH and ANCHORS-P7S-LENGTH set to zero. If the proxy returns both an ANCHORS-XML and an ANCHORS-P7S, then the application verifies the trust anchor using the trust anchor certificate (which needs to come with the application).

### 9.2. Server Processing

Proxies are encouraged to cache options that appear in requests under the assumption that a stub resolver will send multiple requests. If a proxy caches DNS responses then the proxy MUST tag cached responses with the properties of the DNS transport. When responding to later requests, the proxy returns a cached entry only if the parameters of the DNS transport match what is specified in the request.

When a proxy receives a new set of requirements, the proxy compiles a list of addresses to connect to and a list of transports to try per address. The proxy SHOULD prefer more private transports over less private ones.

If the proxy cannot obtain a connection to a recursive resolver in a way that matches the provided policy, then the proxy sets the BADPROXYPOLICY response code in the reply.

The proxy MUST implement "resolver.arpa" as a locally served zone. Proxies SHOULD respond to all queries with NODATA unless other behavior is specified in a different document.

If the proxy successfully connects to a recursive resolver and receives a reply, or the query is for a special use domain name that is handled internally in the proxy, then the proxy add a PROXY CONTROL Options dat details the connection to the recursive resolver (i.e., the U, UA, or A flag depending on encryption and authentication, P and or D for authenticated connections, A53, AT, AH2, AH3, or AQ depending on the transport (or none of those for a future transport). Furthermore the proxy includes the address it connected to, the Domain Name if known, any Service Parameters and the outgoing interface name if known.

If the proxy finds a PROXY SCOPE Option, then it calculates the scope from the source address. The proxy adds a PROXY SCOPE Option to a reply and sets the value of Scope to the actual scope of the source address of the request.

If the request contains a TRUST ANCHOR Option, then the proxy tries to fetch the trust anchor XML and p7s files if it does not have them already. If fetching one or both fails then the proxy sets the corresponding length to zero. It is not clear how long the proxy can cache this information. [RFC7958] Does not describe how long these documents can be cache. A simple solution is to take the Expires header in the HTTP reply. The proxy adds a TRUST ANCHOR Option to the reply.

## **10. Connection Between Stub Resolver And Proxy**

Absent other configuration, a stub resolver that implements this standard SHOULD connect to the proxy using Do53 and as remote address either ::1 or 127.0.0.1. In particular, the stub resolver SHOULD avoid using name servers listed in files such as /etc/resolv.conf.

The reason for this is to simplify the integration of local DNS proxies in existing environments. If the stub resolver ignores /etc/resolv.conf then the proxy can use that information to connect to recursive resolvers.

If no DNS server is responding to queries sent using Do53 to ::1 and 127.0.0.1, or if the response indicates that this standard is not supported, then the stub resolver MAY fall back to traditional configuration methods, such as /etc/resolv.conf. However, in that case the stub resolver MUST make sure that doing so does not violate the policy set by the application.

## **11. Security Considerations**

A privacy sensitive application SHOULD first issue a SOA query for resolver.arpa to verify that the local proxy supports the options documented in the document. If the proxy does not support this document then the application can refrain from sending queries that reveal privacy sensitive names.

By setting the interface name, an application can select an outgoing interface on the proxy. Proxies should make sure that a query receives from a process that is authorized to do so. By default, a proxy SHOULD allow only process on the same host to use this feature. If an unauthorized process includes an option with the interface name set, then the proxy SHOULD return the BADPROXYPOLICY error.

## 12. IANA Considerations

IANA has assigned the following DNS EDNS0 option codes:

Value	Name	Status	Reference
TBD1	PROXY CONTROL	Standard	RFC xxxx
TBD2	PROXY SCOPE	Standard	RFC xxxx
TBD3	TRUST ANCHOR	Standard	RFC xxxx

IANA has assigned the following Extended DNS Error code:

INFO-CODE	Name	Purpose	Reference
28	BADPROXYPOLICY	Unable to conform to policy	RFC xxxx

This document requests IANA to create a new registry for Proxy Control Sub Options in the group Domain Name System (DNS) Parameters. Expert review shall be required to add new entries to the registry.

The initial contents of the Proxy Control Sub Options registry shall be:

Value	Name	Description	Reference
0		Reserved	
1	SECCON	Security Constraints	RFC xxxx
2	TRANSPRIO	Transport Priority	RFC xxxx
3	SVCPARAM	SVC Parameter	RFC xxxx
4	DOMAINNAME	Domain Name	RFC xxxx
5	INFNAME	Interface Name	RFC xxxx
6-65535		Unassigned	

Table 2

This document also requests IANA to create a new registry for DNS Transport Protocols in the group Domain Name System (DNS) Parameters. An RFC shall be required to add new entries to the registry.

Value	Name	Description	Reference
0	DEFAULT	default protocols	RFC xxxx
1	Do53	Unencrypted UDP, fallback to TCP	RFC xxxx
2	Do53-UDP	Unencrypted UDP, no fallback to TCP	RFC xxxx
3	Do53-TCP	Unencrypted TCP	RFC xxxx
4	DoT	DNS over TLS	RFC xxxx
5	DoH	DNS over HTTPS	RFC xxxx
6	DoQ	DNS over QUIC	RFC xxxx
7-255		Unassigned	

Table 3



### 13. Acknowledgements

Many thanks to Yorgos Thessalonikefs and Willem Toorop for their feedback.

### 14. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <<https://www.rfc-editor.org/info/rfc2119>>.
- [RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <<https://www.rfc-editor.org/info/rfc8174>>.

### 15. Informative References

- [RFC1034] Mockapetris, P., "Domain names - concepts and facilities", STD 13, RFC 1034, DOI 10.17487/RFC1034, November 1987, <<https://www.rfc-editor.org/info/rfc1034>>.
- [RFC1035] Mockapetris, P., "Domain names - implementation and specification", STD 13, RFC 1035, DOI 10.17487/RFC1035, November 1987, <<https://www.rfc-editor.org/info/rfc1035>>.
- [RFC3493] Gilligan, R., Thomson, S., Bound, J., McCann, J., and W. Stevens, "Basic Socket Interface Extensions for IPv6", RFC 3493, DOI 10.17487/RFC3493, February 2003, <<https://www.rfc-editor.org/info/rfc3493>>.
- [RFC5011] StJohns, M., "Automated Updates of DNS Security (DNSSEC) Trust Anchors", STD 74, RFC 5011, DOI 10.17487/RFC5011, September 2007, <<https://www.rfc-editor.org/info/rfc5011>>.
- [RFC5280] Cooper, D., Santesson, S., Farrell, S., Boeyen, S., Housley, R., and W. Polk, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 5280, DOI 10.17487/RFC5280, May 2008, <<https://www.rfc-editor.org/info/rfc5280>>.
- [RFC5625] Bellis, R., "DNS Proxy Implementation Guidelines", BCP 152, RFC 5625, DOI 10.17487/RFC5625, August 2009, <<https://www.rfc-editor.org/info/rfc5625>>.
- [RFC6891] Damas, J., Graff, M., and P. Vixie, "Extension Mechanisms for DNS (EDNS(0))", STD 75, RFC 6891, DOI 10.17487/RFC6891, April 2013, <<https://www.rfc-editor.org/info/rfc6891>>.

**[RFC7540]**

Belshe, M., Peon, R., and M. Thomson, Ed., "Hypertext Transfer Protocol Version 2 (HTTP/2)", RFC 7540, DOI 10.17487/RFC7540, May 2015, <<https://www.rfc-editor.org/info/rfc7540>>.

**[RFC7858]**

Hu, Z., Zhu, L., Heidemann, J., Mankin, A., Wessels, D., and P. Hoffman, "Specification for DNS over Transport Layer Security (TLS)", RFC 7858, DOI 10.17487/RFC7858, May 2016, <<https://www.rfc-editor.org/info/rfc7858>>.

**[RFC7958]**

Abley, J., Schlyter, J., Bailey, G., and P. Hoffman, "DNSSEC Trust Anchor Publication for the Root Zone", RFC 7958, DOI 10.17487/RFC7958, August 2016, <<https://www.rfc-editor.org/info/rfc7958>>.

**[RFC8484]**

Hoffman, P. and P. McManus, "DNS Queries over HTTPS (DoH)", RFC 8484, DOI 10.17487/RFC8484, October 2018, <<https://www.rfc-editor.org/info/rfc8484>>.

**[RFC9000]**

Iyengar, J., Ed. and M. Thomson, Ed., "QUIC: A UDP-Based Multiplexed and Secure Transport", RFC 9000, DOI 10.17487/RFC9000, May 2021, <<https://www.rfc-editor.org/info/rfc9000>>.

**Appendix A. Change history**

(This section to be removed by the RFC editor.)

\*draft-homburg-dnsop-codcp-01

-Moved draft to a separate git repository (<https://github.com/NLnetLabs/draft-homburg-dnsop-codc>)

\*draft-homburg-dnsop-codcp-00

-Renamed to draft-homburg-dnsop-codcp  
-IANA section with allocated code point for BADPROXYPOLICY  
-Proxy Control Option rewritten to be TLV-based  
-Two new registries for sub-options and for DNS transports

\*draft-homburg-add-codcp-00

-Initial version

**Author's Address**

Philip Homburg

Email: [philip@nlnetlabs.nl](mailto:philip@nlnetlabs.nl)