Network
Internet-Draft
Intended status: Standards Track
Expires: January 19, 2019

T. Pauly
Apple Inc.
P. Wouters
Red Hat

July 18, 2018

Split DNS Configuration for IKEv2
draft-ietf-ipsecme-split-dns-10

Abstract

This document defines two Configuration Payload Attribute Types for the IKEv2 protocol that add support for private DNS domains. These domains are intended to be resolved using DNS servers reachable through an IPsec connection, while leaving all other DNS resolution unchanged. This approach of resolving a subset of domains using non-public DNS servers is referred to as "Split DNS".

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 January 19, 2019.

Table of Contents

1. Introduction

Split DNS is a common configuration for secure tunnels, such as Virtual Private Networks in which host machines private to an organization can only be resolved using internal DNS resolvers [RFC2775]. In such configurations, it is often desirable to only resolve hosts within a set of private domains using the tunnel, while letting resolutions for public hosts be handled by a device's default DNS configuration.

The Internet Key Exchange protocol version 2 [RFC7296] negotiates configuration parameters using Configuration Payload Attribute Types. This document defines two Configuration Payload Attribute Types that add support for trusted Split DNS domains.

The INTERNAL_DNS_DOMAIN attribute type is used to convey one or more DNS domains that SHOULD be resolved only using the provided DNS nameserver IP addresses, causing these requests to use the IPsec connection.

The INTERNAL_DNSSEC_TA attribute type is used to convey DNSSEC trust anchors for those domains.

When only a subset of traffic is routed into a private network using an IPsec SA, these Configuration Payload options can be used to define which private domains are intended to be resolved through the IPsec connection without affecting the client's global DNS resolution.

For the purposes of this document, DNS resolution servers accessible through an IPsec connection will be referred to as "internal DNS servers", and other DNS servers will be referred to as "external DNS servers".

A client using these configuration payloads will be able to request and receive Split DNS configurations using the INTERNAL_DNS_DOMAIN and INTERNAL_DNSSEC_TA configuration attributes. The client device can use the internal DNS server(s) for any DNS queries within the assigned domains. DNS queries for other domains SHOULD be sent to the regular external DNS server.

1.1. Requirements Language

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 captials, as shown here.

2. Background

Split DNS is a common configuration for enterprise VPN deployments, in which only one or a few private DNS domains are accessible and resolvable via an IPsec based VPN connection.

Other tunnel-establishment protocols already support the assignment of Split DNS domains. For example, there are proprietary extensions to IKEv1 that allow a server to assign Split DNS domains to a client. However, the IKEv2 standard does not include a method to configure this option. This document defines a standard way to negotiate this option for IKEv2.

3. Protocol Exchange

In order to negotiate which domains are considered internal to an IKEv2 tunnel, initiators indicate support for Split DNS in their CFG_REQUEST payloads, and responders assign internal domains (and DNSSEC trust anchors) in their CFG_REPLY payloads. When Split DNS

has been negotiated, the existing DNS server configuration attributes will be interpreted as internal DNS servers that can resolve hostnames within the internal domains.

3.1. Configuration Request

To indicate support for Split DNS, an initiator includes one more INTERNAL_DNS_DOMAIN attributes as defined in Section 4 as part of the CFG_REQUEST payload. If an INTERNAL_DNS_DOMAIN attribute is included in the CFG_REQUEST, the initiator SHOULD also include one or more INTERNAL_IP4_DNS and INTERNAL_IP6_DNS attributes in the CFG_REQUEST.

The INTERNAL_DNS_DOMAIN attribute sent by the initiator is usually empty but MAY contain a suggested domain name.

The absence of INTERNAL_DNS_DOMAIN attributes in the CFG_REQUEST payload indicates that the initiator does not support or is unwilling to accept Split DNS configuration.

To indicate support for DNSSEC, an initiator includes one or more INTERNAL_DNSSEC_TA attributes as defined in Section 4 as part of the CFG_REQUEST payload. If an INTERNAL_DNSSEC_TA attribute is included in the CFG_REQUEST, the initiator SHOULD also include one or more INTERNAL_DNS_DOMAIN attributes in the CFG_REQUEST. If the initiator includes an INTERNAL_DNSSEC_TA attribute, but does not inclue an INTERNAL_DNS_DOMAIN attribute, the responder MAY still respond with both INTERNAL_DNSSEC_TA and INTERNAL_DNS_DOMAIN attributes.

An initiator MAY convey its current DNSSEC trust anchors for the domain specified in the INTERNAL_DNS_DOMAIN attribute. If it does not wish to convey this information, it MUST use a length of 0.

The absence of INTERNAL_DNSSEC_TA attributes in the CFG_REQUEST payload indicates that the initiator does not support or is unwilling to accept DNSSEC trust anchor configuration.

3.2. Configuration Reply

Responders MAY send one or more INTERNAL_DNS_DOMAIN attributes in their CFG_REPLY payload. If an INTERNAL_DNS_DOMAIN attribute is included in the CFG_REPLY, the responder MUST also include one or both of the INTERNAL_IP4_DNS and INTERNAL_IP6_DNS attributes in the CFG_REPLY. These DNS server configurations are necessary to define which servers can receive queries for hostnames in internal domains. If the CFG_REQUEST included an INTERNAL_DNS_DOMAIN attribute, but the CFG_REPLY does not include an INTERNAL_DNS_DOMAIN attribute, the initiator SHOULD behave as if Split DNS configurations are not supported by the server.

Each INTERNAL_DNS_DOMAIN represents a domain that the DNS servers address listed in INTERNAL_IP4_DNS and INTERNAL_IP6_DNS can resolve.

If the CFG_REQUEST included INTERNAL_DNS_DOMAIN attributes with non-zero lengths, the content MAY be ignored or be interpreted as a suggestion by the responder.

For each DNS domain specified in an INTERNAL_DNS_DOMAIN attribute, one or more INTERNAL_DNSSEC_TA attributes MAY be included by the responder. This attribute lists the corresponding internal DNSSEC trust anchor in the DNS presentation format of a DS record as specified in [RFC4034]. The INTERNAL_DNSSEC_TA attribute MUST immediately follow the INTERNAL_DNS_DOMAIN attribute that it applies to.

3.3. Mapping DNS Servers to Domains

All DNS servers provided in the CFG_REPLY MUST support resolving hostnames within all INTERNAL_DNS_DOMAIN domains. In other words, the INTERNAL_DNS_DOMAIN attributes in a CFG_REPLY payload form a single list of Split DNS domains that applies to the entire list of INTERNAL_IP4_DNS and INTERNAL_IP6_DNS attributes.

3.4. Example Exchanges

3.4.1. Simple Case

In this example exchange, the initiator requests INTERNAL_IP4_DNS and INTERNAL_DNS_DOMAIN attributes in the CFG_REQUEST, but does not specify any value for either. This indicates that it supports Split DNS, but has no preference for which DNS requests will be routed through the tunnel.

The responder replies with two DNS server addresses, and two internal domains, "example.com" and "city.other.com".

Any subsequent DNS queries from the initiator for domains such as "www.example.com" SHOULD use 198.51.100.2 or 198.51.100.4 to resolve.

```
CP(CFG_REQUEST) =
  INTERNAL_IP4_ADDRESS()
  INTERNAL_IP4_DNS()
  INTERNAL_DNS_DOMAIN()

CP(CFG_REPLY) =
  INTERNAL_IP4_ADDRESS(198.51.100.234)
  INTERNAL_IP4_DNS(198.51.100.2)
  INTERNAL_IP4_DNS(198.51.100.4)
  INTERNAL_DNS_DOMAIN(example.com)
  INTERNAL_DNS_DOMAIN(city.other.com)
```

3.4.2. Requesting Domains and DNSSEC trust anchors

In this example exchange, the initiator requests INTERNAL_IP4_DNS, INTERNAL_DNS_DOMAIN and INTERNAL_DNSSEC_TA attributes in the CFG_REQUEST.

Any subsequent DNS queries from the initiator for domains such as "www.example.com" or "city.other.com" would be DNSSEC validated using the DNSSEC trust anchor received in the CFG_REPLY.

In this example, the initiator has no existing DNSSEC trust anchors would the requested domain. the "example.com" dommain has DNSSEC trust anchors that are returned, while the "other.com" domain has no DNSSEC trust anchors.

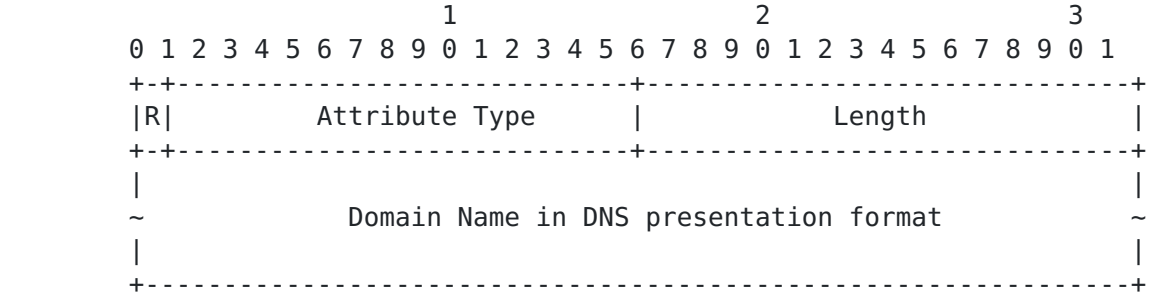
```
CP(CFG_REQUEST) =
  INTERNAL_IP4_ADDRESS()
  INTERNAL_IP4_DNS()
  INTERNAL_DNS_DOMAIN()
  INTERNAL_DNSSEC_TA()

CP(CFG_REPLY) =
  INTERNAL_IP4_ADDRESS(198.51.100.234)
  INTERNAL_IP4_DNS(198.51.100.2)
  INTERNAL_IP4_DNS(198.51.100.4)
  INTERNAL_DNS_DOMAIN(example.com)
  INTERNAL_DNSSEC_TA(43547,8,1,B6225AB2CC613E0DCA7962BDC2342EA4...)
  INTERNAL_DNSSEC_TA(31406,8,2,F78CF3344F72137235098ECBBD08947C...)
  INTERNAL_DNS_DOMAIN(city.other.com)
```

4. Payload Formats

All multi-octet fields representing integers are laid out in big endian order (also known as "most significant byte first", or "network byte order").

4.1. INTERNAL_DNS_DOMAIN Configuration Attribute Type Request and Reply



- Reserved (1 bit) - Defined in IKEv2 RFC [RFC7296].

- Attribute Type (15 bits) set to value 25 for INTERNAL_DNS_DOMAIN.

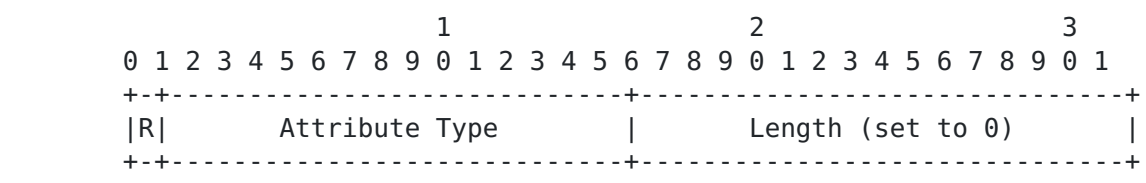
- Length (2 octets) - Length of domain name.

- Domain Name (0 or more octets) - A Fully Qualified Domain Name used for Split DNS rules, such as "example.com", in DNS presentation format and optionally using IDNA [RFC5890] for Internationalized Domain Names. Implementors need to be careful that this value is not null-terminated.

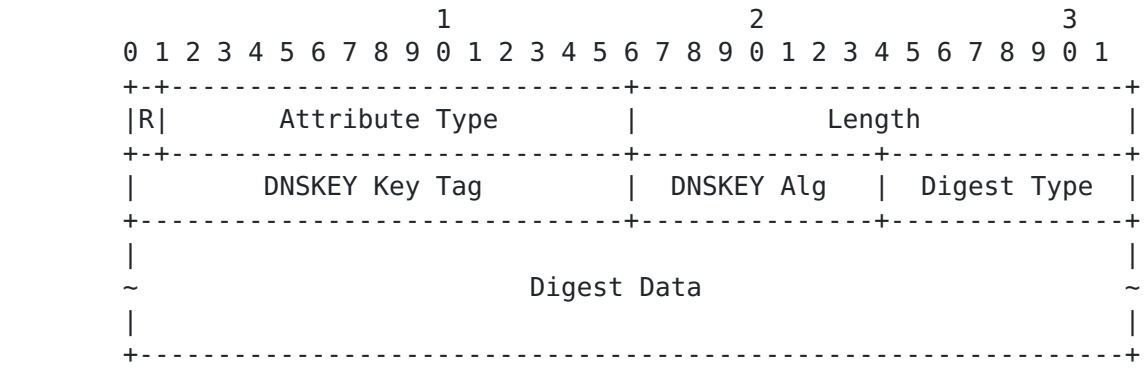
4.2. INTERNAL_DNSSEC_TA Configuration Attribute

An INTERNAL_DNSSEC_TA Configuration Attribute can either be empty, or it can contain one Trust Anchor by containing a non-zero Length with a DNSKEY Key Tag, DNSKEY Algorithm, Digest Type and Digest Data fields.

An empty INTERNAL_DNSSEC_TA CFG attribute:



A non-empty INTERNAL_DNSSEC_TA CFG attribute:



- Reserved (1 bit) - Defined in IKEv2 RFC [RFC7296].

- Attribute Type (15 bits) set to value 26 for INTERNAL_DNSSEC_TA.

- Length (0 or 2 octets) - Length of DNSSEC Trust Anchor data (4 octets plus the length of the Digest Data).

- DNSKEY Key Tag value (0 or 2 octets) - Delegation Signer (DS) Key Tag as specified in [RFC4034] Section 5.1.

- DNSKEY Algorithm (0 or 1 octet) - DNSKEY algorithm value from the IANA DNS Security Algorithm Numbers Registry.

- Digest Type (0 or 1 octet) - DS algorithm value from the IANA Delegation Signer (DS) Resource Record (RR) Type Digest Algorithms Registry.

- Digest Data (0 or more octets) - The DNSKEY digest as specified in [RFC4034] Section 5.1 in presentation format.

INTERNAL_DNSSEC_TA payloads MUST immediately follow an INTERNAL_DNS_DOMAIN payload. As the INTERNAL_DNSSEC_TA format itself does not contain the domain name, it relies on the preceding INTERNAL_DNS_DOMAIN to provide the domain for which it specifies the trust anchor.

5. INTERNAL_DNS_DOMAIN Usage Guidelines

If a CFG_REPLY payload contains no INTERNAL_DNS_DOMAIN attributes, the client MAY use the provided INTERNAL_IP4_DNS or INTERNAL_IP6_DNS servers as the default DNS server(s) for all queries.

If a client is configured by local policy to only accept a limited number of INTERNAL_DNS_DOMAIN values, the client MUST ignore any other INTERNAL_DNS_DOMAIN values.

For each INTERNAL_DNS_DOMAIN entry in a CFG_REPLY payload that is not prohibited by local policy, the client MUST use the provided INTERNAL_IP4_DNS or INTERNAL_IP6_DNS DNS servers as the only resolvers for the listed domains and its sub-domains and it MUST NOT attempt to resolve the provided DNS domains using its external DNS servers.

If the initiator host is configured to block DNS answers containing IP addresses from special IP address ranges such as those of [RFC1918], the initiator SHOULD allow the DNS domains listed in the INTERNAL_DNS_DOMAIN attributes to contain those Special IP addresses.

If a CFG_REPLY contains one or more INTERNAL_DNS_DOMAIN attributes and its local policy does not forbid these values, the client MUST configure its DNS resolver to resolve those domains and all their subdomains using only the DNS resolver(s) listed in that CFG_REPLY message. If those resolvers fail, those names MUST NOT be resolved using any other DNS resolvers. Other domain names SHOULD be resolved using some other external DNS resolver(s), configured independently from IKE. Queries for these other domains MAY be sent to the internal DNS resolver(s) listed in that CFG_REPLY message, but have no guarantee of being answered. For example, if the INTERNAL_DNS_DOMAIN attribute specifies "example.com", then "example.com", "www.example.com" and "mail.eng.example.com" MUST be resolved using the internal DNS resolver(s), but "anotherexample.com" and "ample.com" SHOULD NOT be resolved using the internal resolver and SHOULD use the system's external DNS resolver(s).

When an IKE SA is terminated, the DNS forwarding MUST be unconfigured. This includes deleting the DNS forwarding rules; flushing all cached data for DNS domains provided by the INTERNAL_DNS_DOMAIN attribute, including negative cache entries; removing any obtained DNSSEC trust anchors from the list of trust anchors; and clearing the outstanding DNS request queue.

INTERNAL_DNS_DOMAIN attributes SHOULD only be used on split tunnel configurations where only a subset of traffic is routed into a private remote network using the IPsec connection. If all traffic is

routed over the IPsec connection, the existing global INTERNAL_IP4_DNS and INTERNAL_IP6_DNS can be used without creating specific DNS exemptions.

6. INTERNAL_DNSSEC_TA Usage Guidelines

DNS records can be used to publish specific records containing trust anchors for applications. The most common record type is the TLSA record specified in [RFC6698]. This DNS record type publishes which CA certificate or EE certificate to expect for a certain host name. These records are protected by DNSSEC and thus can be trusted by the application. Whether to trust TLSA records instead of the traditional WebPKI depends on the local policy of the client. By accepting an INTERNAL_DNSSEC_TA trust anchor via IKE from the remote IKE server, the IPsec client might be allowing the remote IKE server to override the trusted certificates for TLS. Similar override concerns apply to other public key or fingerprint based DNS records, such as OPENPGPKEY, SMIMEA or IPSECKEY records.

Thus, installing an INTERNAL_DNSSEC_TA trust anchor can be seen as the equivalent of installing an Enterprise Certificate Agency (CA) certificate. It allows the remote IKE/IPsec server to modify DNS answers including its DNSSEC cryptographic signatures by overriding existing DNS information with trust anchor conveyed via IKE and (temporarilly) installed on the IKE client. Of specific concern is the overriding of [RFC6698] based TLSA records, which represent a confirmation or override of an existing WebPKI TLS certificate. Other DNS record types that convey cryptographic materials (public keys or fingerprints) are OPENPGPKEY, SMIMEA, SSHP and IPSECKEY records.

IKE clients MUST use a preconfigured whitelist of one or more domain names for which it will allow INTERNAL_DNSSEC_TA updates. This list may be sent in the CFG_REQUEST payload, or may be applied after reception of the CFG_REPLY payload.

IKE clients should take care to only whitelist domains that apply to internal or managed domains, rather than to generic Internet traffic. The DNS root zone (".") MUST NOT be whitelisted. Other generic or public domains, such as top-level domains, similarly SHOULD NOT be whitelisted.

Any updates to this whitelist of domain names MUST happen via explicit human interaction to prevent invisible installation of trust anchors.

IKE clients SHOULD accept any INTERNAL_DNSSEC_TA updates for subdomain names of the whitelisted domain names. For example, if

"example.net" is whitelisted, then INTERNAL_DNSSEC_TA received for "antartica.example.net" SHOULD be accepted.

IKE clients MAY interpret an INTERNAL_DNSSEC_TA for domain that was not preconfigured as an indication that it needs to update its IKE configuration (out of band). The client MUST NOT use such a INTERNAL_DNSSEC_TA to reconfigure its local DNS settings.

IKE clients MUST ignore any received INTERNAL_DNSSEC_TA requests for a FDQN for which it did not receive and accept an INTERNAL_DNS_DOMAIN Configuration Payload.

In most deployment scenario's, the IKE client has an expectation that it is connecting, using a split-network setup, to a specific organisation or enterprise. A recommended policy would be to only accept INTERNAL_DNSSEC_TA directives from that organization's DNS names. However, this might not be possible in all deployment scenarios, such as one where the IKE server is handing out a number of domains that are not within one parent domain.

7. Security Considerations

The use of Split DNS configurations assigned by an IKEv2 responder is predicated on the trust established during IKE SA authentication. However, if IKEv2 is being negotiated with an anonymous or unknown endpoint (such as for Opportunistic Security [RFC7435]), the initiator MUST ignore Split DNS configurations assigned by the responder.

If a host connected to an authenticated IKE peer is connecting to another IKE peer that attempts to claim the same domain via the INTERNAL_DNS_DOMAIN attribute, the IKE connection SHOULD only process the DNS information if the two connections are part of the same logical entity. Otherwise, the client SHOULD refuse the DNS information and potentially warn the end-user.

If the initiator is using DNSSEC validation for a domain in its public DNS view, and it requests and receives an INTERNAL_DNS_DOMAIN attribute without an INTERNAL_DNSSEC_TA, it will need to reconfigure its DNS resolver to allow for an insecure delegation. It SHOULD NOT accept insecure delegations for domains that are DNSSEC signed in the public DNS view, for which it has not explicitely requested such deletation by specifying the domain specifically using a INTERNAL_DNS_DOMAIN(domain) request.

Deployments that configure INTERNAL_DNS_DOMAIN domains should pay close attention to their use of indirect reference RRtypes such as

CNAME, DNAME, MX or SRV records so that resolving works as intended when all, some, or none of the IPsec connections are established.

The content of INTERNAL_DNS_DOMAIN and INTERNAL_DNSSEC_TA may be passed to another (DNS) program for processing. As with any network input, the content SHOULD be considered untrusted and handled accordingly.

8. IANA Considerations

This document defines two new IKEv2 Configuration Payload Attribute Types, which are allocated from the "IKEv2 Configuration Payload Attribute Types" namespace.

Value	Attribute Type	Multi-Valued	Length	Reference
25	INTERNAL_DNS_DOMAIN	YES	0 or more	[this document]
26	INTERNAL_DNSSEC_TA	YES	0 or more	[this document]

Figure 1

9. References

9.1. Normative References

[RFC1918] Rekhter, Y., Moskowitz, B., Karrenberg, D., de Groot, G., and E. Lear, "Address Allocation for Private Internets", BCP 5, RFC 1918, DOI 10.17487/RFC1918, February 1996, <https://www.rfc-editor.org/info/rfc1918>.

[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>.

[RFC4034] Arends, R., Austein, R., Larson, M., Massey, D., and S. Rose, "Resource Records for the DNS Security Extensions", RFC 4034, DOI 10.17487/RFC4034, March 2005, <https://www.rfc-editor.org/info/rfc4034>.

[RFC5890] Klensin, J., "Internationalized Domain Names for Applications (IDNA): Definitions and Document Framework", RFC 5890, DOI 10.17487/RFC5890, August 2010, <https://www.rfc-editor.org/info/rfc5890>.

[RFC6698] Hoffman, P. and J. Schlyter, "The DNS-Based Authentication of Named Entities (DANE) Transport Layer Security (TLS) Protocol: TLSA", RFC 6698, DOI 10.17487/RFC6698, August 2012, <https://www.rfc-editor.org/info/rfc6698>.

[RFC7296] Kaufman, C., Hoffman, P., Nir, Y., Eronen, P., and T. Kivinen, "Internet Key Exchange Protocol Version 2 (IKEv2)", STD 79, RFC 7296, DOI 10.17487/RFC7296, October 2014, <https://www.rfc-editor.org/info/rfc7296>.

[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>.

9.2. Informative References

[RFC2775] Carpenter, B., "Internet Transparency", RFC 2775, DOI 10.17487/RFC2775, February 2000, <https://www.rfc-editor.org/info/rfc2775>.

[RFC7435] Dukhovni, V., "Opportunistic Security: Some Protection Most of the Time", RFC 7435, DOI 10.17487/RFC7435, December 2014, <https://www.rfc-editor.org/info/rfc7435>.

Authors' Addresses

Tommy Pauly
Apple Inc.
One Apple Park Way
Cupertino, California 95014
US

Email: tpauly@apple.com

Paul Wouters
Red Hat

Email: pwouters@redhat.com