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M. Boucadair
Orange
I. Farrer
Deutsche Telekom

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Unified IPv4-in-IPv6 Softwire CPE
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Abstract

In IPv6-only provider networks, transporting IPv4 packets encapsulated in IPv6 is a common solution to the problem of IPv4 service continuity. A number of differing functional approaches have been developed for this, each having their own specific characteristics. As these approaches share a similar functional architecture and use the same data plane mechanisms, this memo describes a specification whereby a single CPE can interwork with all of the standardized and proposed approaches to providing encapsulated IPv4 in IPv6 services.

Requirements Language

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].

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 October 23, 2016.

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1. Introduction

IPv4 service continuity is one of the major technical challenges which must be considered during IPv6 migration. Over the past few years, a number of different approaches have been developed to assist with this problem (e.g., [RFC6333], [RFC7596], or [RFC7597]). These approaches, referred to as 'S46 mechanisms' in this document, exist in order to meet the particular deployment, scaling, addressing and

other requirements of different service provider's networks.

A common feature shared between all of the differing modes is the integration of softwire tunnel end-point functionality into the CPE router. Due to this inherent data plane similarity, a single CPE may

be capable of supporting several different approaches. Users may also wish to configure a specific mode of operation.

A service provider's network may also have more than one S46 mechanism enabled in order to support a diverse CPE population with differing client functionality, such as during a migration between mechanisms, or where services require specific supporting softwire architectures.

For softwire based services to be successfully established, it is essential that the customer end-node, the service provider end-node and provisioning systems are able to indicate their capabilities and preferred mode of operation.

A number of DHCPv6 options for the provisioning of softwires have been standardized:

RFC6334 Defines DHCPv6 option 64 for configuring Basic Bridging BroadBand (B4, [RFC6333]) elements with the IPv6 address of the Address Family Transition Router (AFTR, [RFC6333]).

RFC7341 Defines DHCPv6 option 88 for configuring the address of a DHCPv4 over DHCPv6 server, which can then be used by a softwire client for obtaining further configuration.

RFC7598 Defines DHCPv6 options 94, 95 and 96 for provisioning Mapping of Address and Port with Encapsulation (MAP-E, [RFC7597]), Mapping of Address and Port using Translation (MAP-T, [RFC7599]), and Lightweight 4over6 [RFC7596] respectively.

This document describes a DHCPv6 based prioritisation method whereby a CPE which supports several S46 mechanisms and receives configuration for more than one can prioritise which mechanism to use. The method requires no server side logic to be implemented and only uses a simple S46 mechanism prioritization to be implemented in the CPE.

The prioritisation method as described here does not provide

redundancy between S46 mechanisms for the client. I.e. If the highest priority S46 mechanism which has been provisioned to the client is not available for any reason, the means for identifying this and falling back to the S46 mechanism with the next highest priority is not in the scope of this document.

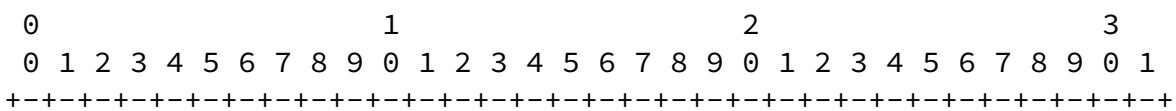
1.1. Rationale

The following rationale has been adopted for this document:

(1) Simplify solution migration paths: Define unified CPE behavior, allowing for smooth migration between the different s46 mechanisms.
(2) Deterministic CPE co-existence behavior: Specify the behavior when several S46 mechanisms co-exist in the CPE.
(3) Deterministic service provider co-existence behavior: Specify the behavior when several modes co-exist in the service providers network.
(4) Re-usability: Maximize the re-use of existing functional blocks including tunnel end-points, port restricted NAPT44, forwarding behavior, etc.
(5) Solution agnostic: Adopt neutral terminology and avoid (as far as possible) overloading the document with solution-specific terms.
(6) Flexibility: Allow operators to compile CPE software only for the mode(s) necessary for their chosen deployment context(s).
(7) Simplicity: Provide a model that allows operators to only implement the specific mode(s) that they require without the additional complexity of unneeded modes.

1.2. S46 Priority Option

The S46 Priority Option is used to convey a priority order of IPv4 service continuity mechanisms. Figure 1 shows the format of the S46 Priority Option.



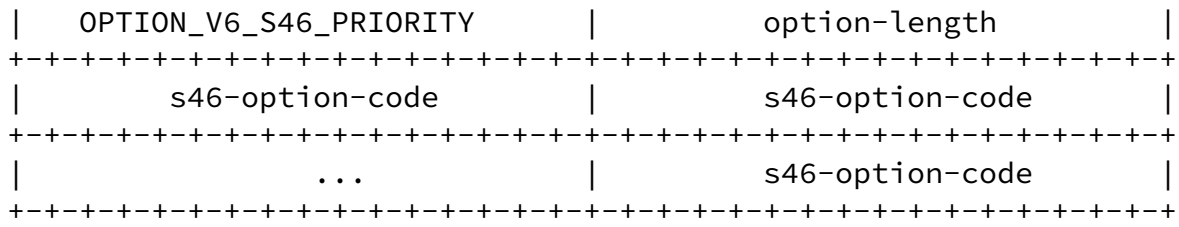


Figure 1: S46 Priority Option

- option-code: OPTION_V6_S46_PRIORITY (TBD)
- option-length: variable-length
- s46-option-code: 16-bits long IANA registered option code of the DHCPv6 option which is used to identify the softwire mechanism. S46 mechanism are prioritized in the appearance order in the S46 Priority Option.

Each defined s46_option_code MUST NOT appear more than once within the list of S46 option codes. The option MUST contain at least one s46-option-code.

1.3. Client Behavior

Clients MAY request option OPTION_V6_S46_PRIORITY, as defined in [RFC3315], Sections 17.1.1, 18.1.1, 18.1.3, 18.1.4, 18.1.5, and 22.7. As a convenience to the reader, we mention here that the client includes requested option codes in the Option Request Option.

Upon receipt of a DHCPv6 Advertise message from the server containing OPTION_V6_S46_PRIORITY the client performs the following steps:

1. Check the contents of the DHCPv6 message for options containing valid S46 mechanism configuration. A candidate list of possible S46 mechanisms is created from these option codes.
2. Check the contents of OPTION_V6_S46_PRIORITY for the DHCPv6 option codes contained in the included s46-option-code fields. From this, an S46 mechanism priority list is created, ordered from highest to lowest following the appearance order.
3. Sequentially check the priority list against the candidate list until a match is found.
4. When a match is found, the client SHOULD configure the resulting S46 mechanism. Configuration for other S46 mechanisms MUST be discarded.

In the event that no match is found between the priority list and the candidate list, the client MAY proceed with configuring one or more of the provisioned S46 softwire mechanism(s). In this case, which mechanism(s) are chosen by the client is implementation-specific and not defined here.

In the event that the client receives OPTION_V6_S46_PRIORITY with the following errors, it MUST be discarded:

- No s46-option-code field is included.
- Multiple s46-option-code fields with the same value are included.

If an invalid OPTION_V6_S46_PRIORITY option is received, the client MAY proceed with configuring the provisioned S46 mechanisms as if OPTION_V6_S46_PRIORITY had not been received.

In the event that a client receives an OPTION_V6_S46_PRIORITY option containing a value in s46-option-code representing an S46 mechanism which the client has not implemented, this is not considered an error.

1.4. Server Behavior

Sections 17.2.2 and 18.2 of [RFC3315] govern server operation in regards to option assignment. As a convenience to the reader, we mention here that the server will send option foo only if configured with specific values for foo and if the client requested it.

Option OPTION_V6_S46_PRIORITY is a singleton. Servers MUST NOT send more than one instance of the OPTION_V6_S46_PRIORITY option.

1.5. S46 Mechanisms and their Identifying Option Codes

The following table shows the currently defined option codes and the S46 mechanisms which they represent. This list is complete at the time of writing, but should not be considered definitive as new S46

mechanisms may be defined in the future.

Option Code	S46 Mechanism	Reference
64	DS-Lite	[RFC6334]
88	DHCPv4 over DHCPv6	[RFC7341]
94	MAP-E	[RFC7598]
95	MAP-T	[RFC7598]
96	Lightweight 4over6	[RFC7598]

Table 1: DHCPv6 Option to S46 Mechanism Mappings

2. Operator Deployment Considerations for Deploying Multiple Sotfwire Mechanisms

The following sub-sections describe some considerations for operators who are planning on implementing multiple sofwire mechanisms in their network (e.g., during a migration between mechanisms).

2.1. Client Address Planning

As an operator's available IPv4 resources are likely to be limited, it may be desirable to use a common range of IPv4 addresses across all of the active Softwire mechanisms. However, this is likely to result in difficulties in routing ingress IPv4 traffic to the correct BR/AFTR instance which is actively serving a given CE. For example, a client which is configured to use MAP-E may send it's traffic to the MAP-E BR, but on the return path, the ingress IP traffic gets routed to a MAP-T BR. The resulting translated packet that gets forwarded to the MAP-E client will be dropped.

Therefore, operators are advised to use separate IPv4 pools for each of the different mechanisms to simplify planning and IPv4 routing.

For IPv6 planning there is less of a constraint as the BR/AFTR elements for the different mechanisms can contain configuration for overlapping client's IPv6 addresses, providing only one mechanism is actively serving a given client at a time. However, the IPv6 address that is used as the tunnel concentrator's endpoint (BR/AFTR address)

needs to be different for each mechanisms to ensure correct operation.

2.2. Backwards Compatability with Existing Softwire Clients

Deployed clients which can support mutliple softwire mechanisms, but do not implement the prioritisation mechanism described here may require additional planning. In this scenario, the CPE would request configuration for all of the supported softwire mechanisms in its DHCPv6 ORO message, but would not request OPTION_V6_S46_PRIORITY. By default, the DHCPv6 server will respond with configuration for all of the requested mechanisms which could result in unpredictable and unwanted client configuration.

In this scenario, it may be necessary for the operator to implement logic within the DHCPv6 server to identify such clients and only provision them with configuration for a single softwire mechanism. It should be noted that this can lead to complextity and reduced scalability in the DHCPv6 server implementation due to the addition DHCPv6 message processing overhead.

3. Security Considerations

Security considerations discussed in [RFC6334] and [RFC7598] apply for this document.

Misbehaving intermediate nodes may alter the content of the S46 Priority Option. This may lead to setting a different IPv4 service continuity mechanism than the one initially preferred by the network side.

4. IANA Considerations

IANA is kindly requested to allocate the following DHCPv6 option code:

TBD for OPTION_V6_S46_PRIORITY

All values should be added to the DHCPv6 option code space defined in Section 24.3 of [RFC3315].

5. Acknowledgements

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6. References

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6.2. Informative References

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Authors' Addresses

Mohamed Boucadair
Orange
Rennes
France

Email: mohamed.boucadair@orange.com

Ian Farrer
Deutsche Telekom
Germany

Email: ian.farrer@telekom.de