

Softwire  
Internet-Draft  
Intended status: Standards Track  
Expires: December 15, 2019

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June 13, 2019

RADIUS Attributes for Address plus Port (A+P) based Softwire Mechanisms  
[draft-ietf-softwire-map-radius-25](#)

Abstract

IPv4-over-IPv6 transition mechanisms provide IPv4 connectivity services over IPv6 native networks during the IPv4/IPv6 co-existence period. DHCPv6 options have been defined for configuring clients for Lightweight 4over6, Mapping of Address and Port with Encapsulation, and Mapping of Address and Port using Translation unicast softwire mechanisms, and also multicast softwires. However, in many networks, configuration information is stored in an Authentication, Authorization, and Accounting server which utilizes the RADIUS protocol to provide centralized management for users. When a new transition mechanism is developed, new RADIUS attributes need to be defined correspondingly.

This document defines new RADIUS attributes to carry Address plus Port based softwire configuration parameters from an Authentication, Authorization, and Accounting server to a Broadband Network Gateway. Both unicast and multicast attributes are covered.

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## Table of Contents

<a href="#">1.</a>	<a href="#">Introduction</a>	<a href="#">3</a>
<a href="#">2.</a>	<a href="#">Terminology</a>	<a href="#">5</a>
<a href="#">3.</a>	<a href="#">New RADIUS Attributes</a>	<a href="#">6</a>
<a href="#">3.1.</a>	<a href="#">Softwire46-Configuration Attribute</a>	<a href="#">7</a>
<a href="#">3.1.1.</a>	<a href="#">Softwire46 Attributes</a>	<a href="#">8</a>
<a href="#">3.1.1.1.</a>	<a href="#">Softwire46-MAP-E Attribute</a>	<a href="#">10</a>
<a href="#">3.1.1.2.</a>	<a href="#">Softwire46-MAP-T Attribute</a>	<a href="#">10</a>
<a href="#">3.1.1.3.</a>	<a href="#">Softwire46-Lightweight-4over6 Attribute</a>	<a href="#">11</a>
<a href="#">3.1.2.</a>	<a href="#">Softwire46 Sub-Attributes</a>	<a href="#">11</a>
<a href="#">3.1.3.</a>	<a href="#">Specification of the Softwire46 Sub-Attributes</a>	<a href="#">12</a>
<a href="#">3.1.3.1.</a>	<a href="#">Softwire46-Rule Attribute</a>	<a href="#">12</a>
<a href="#">3.1.3.2.</a>	<a href="#">Softwire46-BR Attribute</a>	<a href="#">13</a>
<a href="#">3.1.3.3.</a>	<a href="#">Softwire46-DMR Attribute</a>	<a href="#">14</a>
<a href="#">3.1.3.4.</a>	<a href="#">Softwire46-V4V6Bind Attribute</a>	<a href="#">14</a>
<a href="#">3.1.3.5.</a>	<a href="#">Softwire46-PORTPARAMS Attribute</a>	<a href="#">15</a>
<a href="#">3.1.4.</a>	<a href="#">Sub-Attributes for Sofwtire46-Rule</a>	<a href="#">16</a>
<a href="#">3.1.4.1.</a>	<a href="#">Rule-IPv6-Prefix Attribute</a>	<a href="#">16</a>
<a href="#">3.1.4.2.</a>	<a href="#">Rule-IPv4-Prefix Attribute</a>	<a href="#">17</a>
<a href="#">3.1.4.3.</a>	<a href="#">EA-Length Attribute</a>	<a href="#">17</a>
<a href="#">3.1.5.</a>	<a href="#">Attributes for Softwire46-v4v6Bind</a>	<a href="#">18</a>
<a href="#">3.1.5.1.</a>	<a href="#">IPv4-Address Attribute</a>	<a href="#">18</a>
<a href="#">3.1.5.2.</a>	<a href="#">Bind-IPv6-Prefix Attribute</a>	<a href="#">18</a>
<a href="#">3.1.6.</a>	<a href="#">Attributes for Softwire46-PORTPARAMS</a>	<a href="#">19</a>
<a href="#">3.1.6.1.</a>	<a href="#">PSID-Offset Attribute</a>	<a href="#">19</a>
<a href="#">3.1.6.2.</a>	<a href="#">PSID-Len Attribute</a>	<a href="#">20</a>
<a href="#">3.1.6.3.</a>	<a href="#">PSID Attribute</a>	<a href="#">20</a>



<a href="#">3.2.</a>	Softwire46-Priority Attribute . . . . .	<a href="#">21</a>
<a href="#">3.2.1.</a>	Softwire46-Option-Code . . . . .	<a href="#">22</a>
<a href="#">3.3.</a>	Softwire46-Multicast Attribute . . . . .	<a href="#">23</a>
<a href="#">3.3.1.</a>	ASM-Prefix64 Attribute . . . . .	<a href="#">24</a>
<a href="#">3.3.2.</a>	SSM-Prefix64 Attribute . . . . .	<a href="#">25</a>
<a href="#">3.3.3.</a>	U-Prefix64 Attribute . . . . .	<a href="#">25</a>
<a href="#">4.</a>	A Sample Configuration Process with RADIUS . . . . .	<a href="#">25</a>
<a href="#">5.</a>	Table of Attributes . . . . .	<a href="#">28</a>
<a href="#">6.</a>	Security Considerations . . . . .	<a href="#">29</a>
<a href="#">7.</a>	IANA Considerations . . . . .	<a href="#">29</a>
<a href="#">7.1.</a>	New RADIUS Attributes . . . . .	<a href="#">30</a>
<a href="#">7.2.</a>	RADIUS Softwire46 Configuration and Multicast Attributes	<a href="#">30</a>
<a href="#">7.3.</a>	Softwire46 Mechanisms and Their Identifying Option Codes	<a href="#">31</a>
<a href="#">8.</a>	Contributing Authors . . . . .	<a href="#">32</a>
<a href="#">9.</a>	Acknowledgements . . . . .	<a href="#">33</a>
<a href="#">10.</a>	References . . . . .	<a href="#">34</a>
<a href="#">10.1.</a>	Normative References . . . . .	<a href="#">34</a>
<a href="#">10.2.</a>	Informative References . . . . .	<a href="#">35</a>
<a href="#">Appendix A.</a>	DHCPv6 to RADIUS Field Mappings . . . . .	<a href="#">37</a>
<a href="#">A.1.</a>	OPTION_S46_RULE (89) to Softwire46-Rule Sub-TLV Field Mappings . . . . .	<a href="#">37</a>
<a href="#">A.2.</a>	OPTION_S46_BR (90) to Softwire46-BR Field Mappings . . . . .	<a href="#">37</a>
<a href="#">A.3.</a>	OPTION_S46_DMR (91) to Softwire46-DMR . . . . .	<a href="#">37</a>
<a href="#">A.4.</a>	OPTION_S46_V4V6BIND (92) to Softwire46-V4V6Bind . . . . .	<a href="#">38</a>
<a href="#">A.5.</a>	OPTION_S46_PORTPARAMS (93) to Softwire46-PORTPARAMS Field Mappings . . . . .	<a href="#">38</a>
<a href="#">A.6.</a>	OPTION_S46_PRIORITY (111) to Softwire46-PORTPARAMS Field Mappings . . . . .	<a href="#">38</a>
<a href="#">A.7.</a>	OPTION_V6_PREFIX64 (113) to Softwire46-Multicast Attribute Field Mappings . . . . .	<a href="#">38</a>
	Authors' Addresses . . . . .	<a href="#">39</a>

## **[1.](#) Introduction**

Providers have started deploying and transitioning to IPv6. Several IPv4 service continuity mechanisms based on the Address plus Port (A+P) [[RFC6346](#)] have been proposed for providing unicast IPv4 over IPv6-only infrastructure, such as Mapping of Address and Port with Encapsulation (MAP-E) [[RFC7597](#)], Mapping of Address and Port using Translation (MAP-T) [[RFC7599](#)], and Lightweight 4over6 [[RFC7596](#)]. Also, [[RFC8114](#)] specifies a generic solution for the delivery of IPv4 multicast services to IPv4 clients over an IPv6 multicast network. For each of these mechanisms, DHCPv6 options have been specified for client configuration.

In many networks, user configuration information is stored in an Authentication, Authorization, and Accounting (AAA) server. AAA servers generally communicate using the Remote Authentication Dial In



User Service (RADIUS) [[RFC2865](#)] protocol. In a fixed broadband network, a Broadband Network Gateway (BNG) acts as the access gateway for users. That is, the BNG acts as both an AAA client to the AAA server, and a DHCPv6 server for DHCPv6 messages sent by clients. Throughout this document, the term BNG describes a device implementing both the AAA client and DHCPv6 server functions.

Since IPv4-in-IPv6 softwire configuration information is stored in an AAA server, and user configuration information is mainly transmitted through DHCPv6 between the BNGs and Customer Premises Equipment (CEs, a.k.a., CPE), new RADIUS attributes are needed to propagate the information from the AAA servers to BNGs so that they can be provided to CEs using the existing DHCPv6 options.

The RADIUS attributes defined in this document provide configuration to populate the corresponding DHCPv6 options for unicast and multicast softwire configuration, specifically:

- o "Mapping of Address and Port with Encapsulation (MAP-E)" [[RFC7597](#)] (DHCPv6 options defined in [[RFC7598](#)]).
- o "Mapping of Address and Port using Translation (MAP-T)" [[RFC7599](#)] (DHCPv6 options defined in [[RFC7598](#)]).
- o "Lightweight 4over6: An Extension to the Dual-Stack Lite Architecture" [[RFC7596](#)] (DHCPv6 options defined in [[RFC7598](#)]).
- o "Unified IPv4-in-IPv6 Softwire Customer Premises Equipment (CPE): A DHCPv6-Based Prioritization Mechanism" [[RFC8026](#)].
- o "Delivery of IPv4 Multicast Services to IPv4 Clients over an IPv6 Multicast Network" [[RFC8114](#)] (DHCPv6 options defined in [[RFC8115](#)]).

The contents of the attributes defined in this document have a 1:1 mapping into the fields of the various DHCPv6 options in [[RFC7598](#)], [[RFC8026](#)], and [[RFC8115](#)]. Table 1 shows how the DHCPv6 options map to the corresponding RADIUS attribute. For detailed mappings between each DHCPv6 option field and the corresponding RADIUS Attribute or field, see [Appendix A](#).



DHCPv6 Option	RADIUS Attribute
OPTION_S46_RULE (89)	Softwire46-Rule
OPTION_S46_BR (90)	Softwire46-BR
OPTION_S46_DMR (91)	Softwire46-DMR
OPTION_S46_V4V6BIND (92)	Softwire46-V4V6Bind
OPTION_S46_PORTPARAMS (93)	Softwire46-PORTPARAMS
OPTION_S46_PRIORITY (111)	Softwire46-Priority
OPTION_V6_PREFIX64 (113)	Softwire46-Multicast

Table 1: Mapping between DHCPv6 Options and RADIUS Attributes

A RADIUS attribute for Dual-Stack Lite [[RFC6333](#)] is defined in [[RFC6519](#)].

This document targets deployments where a trusted relationship is in place between the RADIUS client and server.

## 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.

The reader should be familiar with the concepts and terms defined in [[RFC7596](#)], [[RFC7597](#)], [[RFC7599](#)], and [[RFC8026](#)].

The terms "multicast Basic Bridging BroadBand" element (mB4) and "multicast Address Family Transition Router" element (mAFTR) are defined in [[RFC8114](#)].

Softwire46 (S46) is used throughout to denote any of the IPv4-in-IPv6 softwire mechanisms listed above. Additionally, the following abbreviations are used within the document:

- o BNG: Broadband Network Gateway
- o BR: Border Relay
- o CE: Customer Edge
- o DMR: Default Mapping Rule
- o lwAFTR: Lightweight AFTR





- o PSID: Port Set Identifier
- o TLV: Type, Length, Value
- o MAP-E: Mapping of Address and Port with Encapsulation
- o MAP-T: Mapping of Address and Port using Translation

### **3. New RADIUS Attributes**

This section defines the following attributes:

#### **1. Softwire46-Configuration Attribute ([Section 3.1](#)):**

This attribute carries the configuration information for MAP-E, MAP-T, and Lightweight 4over6. The configuration information for each Softwire46 mechanism is carried in the corresponding Softwire46 attributes. Different attributes are required for each Softwire46 mechanism.

#### **2. Softwire46-Priority Attribute ([Section 3.2](#)):**

Depending on the deployment scenario, a client may support several different Softwire46 mechanisms. Therefore, a client may request configuration for more than one Softwire46 mechanism at a time. The Softwire46-Priority Attribute contains information allowing the client to prioritize which mechanism to use, corresponding to OPTION\_S46\_PRIORITY defined in [[RFC8026](#)].

#### **3. Softwire46-Multicast Attribute ([Section 3.3](#)):**

This attribute conveys the IPv6 prefixes to be used in [[RFC8114](#)] to synthesize IPv4-embedded IPv6 addresses. The BNG uses the IPv6 prefixes returned in the RADIUS Softwire46-Multicast Attribute to populate the DHCPv6 PREFIX64 Option [[RFC8115](#)].

All of these attributes are allocated from the RADIUS "Extended Type" code space per [[RFC6929](#)].

All of these attribute designs follow [[RFC6158](#)] and [[RFC6929](#)].

This document adheres to [[RFC8044](#)] for defining the new RADIUS attributes.



### **3.1. Softwire46-Configuration Attribute**

This attribute is of type "tlv", as defined in the RADIUS Protocol Extensions [[RFC6929](#)]. It contains some sub-attributes, with the following requirements:

The Softwire46-Configuration Attribute MUST contain one or more of the following attributes: Softwire46-MAP-E, Softwire46-MAP-T, and/or Softwire46-Lightweight-4over6.

The Softwire46-Configuration Attribute conveys the configuration information for MAP-E, MAP-T, or Lightweight 4over6. The BNG SHALL use the configuration information returned in the RADIUS attribute to populate the DHCPv6 Softwire46 Container Option(s) defined in [Section 5 of \[RFC7598\]](#).

The Softwire46-Configuration Attribute MAY appear in an Access-Accept packet. It MAY also appear in an Access-Request packet to indicate a preferred Softwire46 configuration. However, the server is not required to honor such a preference.

The Softwire46-Configuration Attribute MAY appear in a CoA-Request packet.

The Softwire46-Configuration Attribute MAY appear in an Accounting-Request packet.

The Softwire46-Configuration Attribute MUST NOT appear in any other RADIUS packet.

The Softwire46-Configuration Attribute is structured as follows:



**Type**

241 (To be confirmed by IANA).

**Length**

Indicates the total length, in bytes, of all fields of this attribute, including the Type, Length, Extended-Type, and the entire length of the embedded attributes.

**Extended-Type**

TBD1

**Value**

Contains one or more of the following attributes. Each attribute type may appear at most once:

**Software46-MAP-E**

For configuring MAP-E clients. For the construction of this attribute, refer to [Section 3.1.1.1](#).

**Software46-MAP-T**

For configuring MAP-T clients. For the construction of this attribute, refer to [Section 3.1.1.2](#).

**Software46-Lightweight-4over6**

For configuring Lightweight 4over6 clients. For the construction of this attribute, refer to [Section 3.1.1.3](#).

The Software46-Configuration Attribute is associated with the following identifier: 241.Extended-Type(TBD1).

### **[3.1.1. Software46 Attributes](#)**

The Software46 attributes can only be encapsulated in the Software46-Configuration Attribute. Depending on the deployment scenario, a client might request for more than one transition mechanism at a time. There MUST be at least one Software46 attribute encapsulated in one Software46-Configuration Attribute. There MUST be at most one instance of each type of Software46 attribute encapsulated in one Software46-Configuration Attribute.

There are three types of Software46 attributes, namely:

1. Software46-MAP-E ([Section 3.1.1.1](#))
2. Software46-MAP-T ([Section 3.1.1.2](#))
3. Software46-Lightweight 4over6 ([Section 3.1.1.3](#))



Each type of Softwire46 attribute contains a number of sub-attributes, defined in [Section 3.1.3](#). The hierarchy of the Softwire46 attributes is shown in Figure 1. [Section 3.1.2](#) describes which sub-attributes are mandatory, optional, or not permitted for each defined Softwire46 attribute.

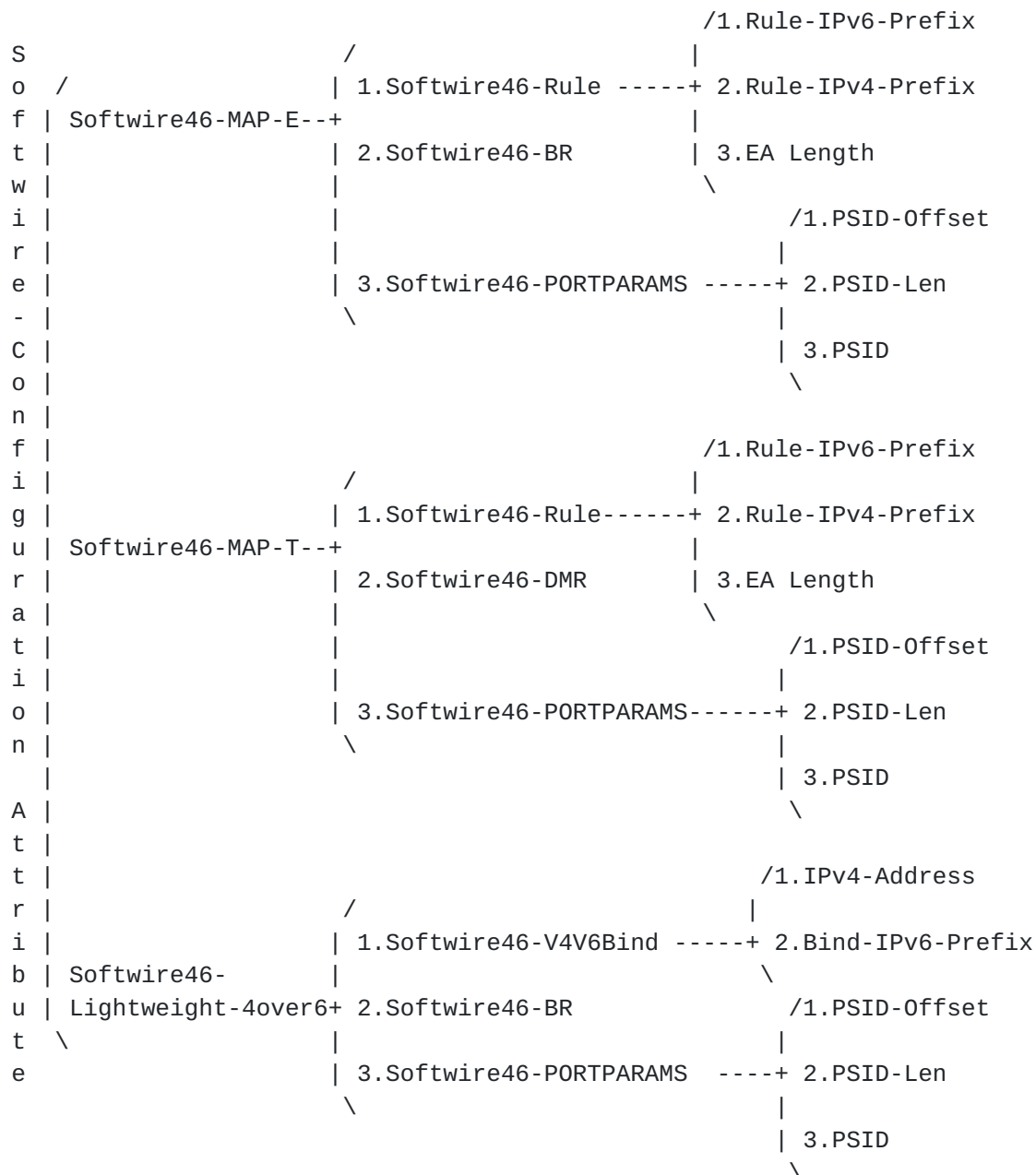


Figure 1: Softwire46 Attributes Hierarchy





#### **3.1.1.1. Software46-MAP-E Attribute**

Software46-MAP-E attribute is designed for carrying the configuration information for MAP-E. The structure of Software46-MAP-E is shown below:

TLV-Type

1

TLV-Length

Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

TLV-Value

Contains a set of sub-attributes, with the following requirements:

It MUST contain Software46-Rule, defined in [Section 3.1.3.1](#).

It MUST contain Software46-BR, defined in [Section 3.1.3.2](#).

It MAY contain Software46-PORTPARAMS, defined in [Section 3.1.3.5](#).

#### **3.1.1.2. Software46-MAP-T Attribute**

Software46-MAP-T attribute is designed for carrying the configuration information for MAP-T. The structure of Software46-MAP-T is shown below:

TLV-Type

2

TLV-Length

Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

TLV-Value

Contains a set of sub-attributes, with the following requirements:

It MUST contain Software46-Rule, defined in [Section 3.1.3.1](#).

It MUST contain Software46-DMR, defined in [Section 3.1.3.3](#).

It MAY contain Software46-PORTPARAMS, defined in [Section 3.1.3.5](#).



### **3.1.1.3. Software46-Lightweight-4over6 Attribute**

Software46-Lightweight-4over6 attribute is designed for carrying the configuration information for Lightweight 4over6. The structure of Software46-Lightweight-4over6 is shown below:

TLV-Type  
3

TLV-Length  
Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

TLV-Value  
Contains a set of sub-attributes as follows:

It MUST contain Software46-BR, defined in [Section 3.1.3.2](#).

It MUST contain Software46-V4V6Bind, defined in [Section 3.1.3.4](#).

It MAY contain Software46-PORTPARAMS, defined in [Section 3.1.3.5](#).

### **3.1.2. Software46 Sub-Attributes**

Table 2 shows which encapsulated sub-attributes are mandatory, optional, or not permitted for each defined Software46 attribute.

Sub-Attributes	MAP-E	MAP-T	Lightweight 4over6
Software46-BR	1+	0	1+
Software46-Rule	1	1	0
Software46-DMR	0	1	0
Software46-V4V6Bind	0	0	1
Software46-PORTPARAMS	0-1	0-1	0-1

Table 2: Software46 Sub-Attributes

The following table defines the meaning of Table 2 entries.



- 0 Not Permitted
- 0-1 Optional, zero or one instance of the attribute may be present.
- 1 Mandatory, only one instance of the attribute must be present.
- 1+ Mandatory, one or more instances of the attribute may be present.

### **[3.1.3.](#) Specification of the Softwire46 Sub-Attributes**

#### **[3.1.3.1.](#) Softwire46-Rule Attribute**

Softwire46-Rule can only be encapsulated in Softwire46-MAP-E ([Section 3.1.1.1](#)) or Softwire46-MAP-T ([Section 3.1.1.2](#)). Depending on the deployment scenario, one Basic Mapping Rule (BMR) and zero or more Forwarding Mapping Rules (FMRs) MUST be included in one Softwire46-MAP-E or Softwire46-MAP-T.

Each type of Softwire46-Rule also contains a number of sub-attributes, including Rule-IPv6-Prefix, Rule-IPv4-Prefix, and EA-Length. The structure of the sub-attributes for Softwire46-Rule is defined in [Section 3.1.4](#).

Defining multiple TLV-types achieves the same design goals as the "Softwire46 Rule Flags" defined in [Section 4.1 of \[RFC7598\]](#). Using TLV-type set to 5 is equivalent to setting the F-flag in the OPTION\_S46\_RULE S46 Rule Flags field.



**TLV-Type**

- 4 Basic Mapping Rule only (not to be used for forwarding)
- 5 Forwarding Permitted Mapping Rule

**TLV-Length**

Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

**Data Type**

The attribute Software46-Rule is of type tlv ([Section 3.13 of \[RFC8044\]](#)).

**TLV-Value**

This field contains a set of attributes as follows:

**Rule-IPv6-Prefix**

This attribute contains the IPv6 prefix for use in the MAP rule. Refer to [Section 3.1.4.1](#).

**Rule-IPv4-Prefix**

This attribute contains the IPv4 prefix for use in the MAP rule. Refer to [Section 3.1.4.2](#).

**EA-Length**

This attribute contains the Embedded-Address (EA) bit length. Refer to [Section 3.1.4.3](#).

**[3.1.3.2](#). Software46-BR Attribute**

Software46-BR can only be encapsulated in Software46-MAP-E ([Section 3.1.1.1](#)) or Software46-Lightweight-4over6 ([Section 3.1.1.3](#)).

There MUST be at least one Software46-BR included in each Software46-MAP-E or Software46-Lightweight-4over6.

The structure of Software46-BR is shown below:





TLV-Type

6

TLV-Length

18 octets

Data Type

The attribute Software46-BR is of type ip6addr ([Section 3.9 of \[RFC8044\]](#)).

TLV-Value

br-ipv6-address. A fixed-length field of 16 octets that specifies the IPv6 address for the Software46 Border Relay (BR).

#### **[3.1.3.3. Software46-DMR Attribute](#)**

Software46-DMR may only appear in Software46-MAP-T ([Section 3.1.1.2](#)). There MUST be exactly one Software46-DMR included in one Software46-MAP-T.

The structure of Software46-DMR is shown below:

TLV-Type

7

TLV-Length

4 + length of dmr-ipv6-prefix specified in octets.

Data Type

The attribute Software46-DMR is of type ipv6pref ([Section 3.10 of \[RFC8044\]](#)).

TLV-Value

A variable-length (dmr-prefix6-len) field specifying the IPv6 prefix (dmr-ipv6-prefix) for the BR. This field is right-padded with zeros to the nearest octet boundary when dmr-prefix6-len is not divisible by 8. Prefixes with length from 0 to 96 are allowed.

#### **[3.1.3.4. Software46-V4V6Bind Attribute](#)**

Software46-V4V6Bind may only be encapsulated in Software46-Lightweight-4over6 ([Section 3.1.1.3](#)). There MUST be exactly one Software46-V4V6Bind included in each Software46-Lightweight-4over6.

The structure of Software46-V4V6Bind is shown below:



TLV-Type

8

TLV-Length

Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

Data Type

The attribute Softwire46-V4V6Bind is of type tlv ([Section 3.13 of \[RFC8044\]](#)).

TLV-Value

This field contains a set of attributes as follows:

IPv4-Address

This attribute contains an IPv4 address, used to specify the full or shared IPv4 address of the CE. Refer to [Section 3.1.5.1](#).

Bind-IPv6-Prefix

This attribute contains an IPv6 prefix used to indicate which configured prefix the Softwire46 CE should use for constructing the softwire. Refer to [Section 3.1.5.2](#).

#### **[3.1.3.5](#). Softwire46-PORTPARAMS Attribute**

Softwire46-PORTPARAMS is optional. It is used to specify port set information for IPv4 address sharing between clients.

Softwire46-PORTPARAMS MAY be included in any of the Softwire46 attributes.

The structure of Softwire46-PORTPARAMS is shown below:



TLV-Type

9

TLV-Length

Indicates the length of this attribute, including the TLV-Type, TLV-Length, and TLV-Value fields.

Data Type

The attribute Software46-PORTPARAMS is of type tlv ([Section 3.13 of \[RFC8044\]](#)).

TLV-Value

This field contains a set of attributes as follows:

PSID-Offset

This attribute specifies the numeric value for the Software46 algorithm's excluded port range/offset bits (a bits). Refer to [Section 3.1.6.1](#).

PSID-Len

This attribute specifies the number of significant bits in the PSID field (also known as 'k'). Refer to [Section 3.1.6.2](#).

PSID

This attribute specifies PSID value. Refer to [Section 3.1.6.3](#).

#### **[3.1.4](#). Sub-Attributes for Software46-Rule**

There are two types of Software46-Rule: the Basic Mapping Rule and the Forwarding Mapping Rule, indicated by the value in the TLV-Type field of Software46-Rule ([Section 3.1.3.1](#)).

Each type of Software46-Rule also contains a number of Sub-attributes as detailed in the following sub-sections.

##### **[3.1.4.1](#). Rule-IPv6-Prefix Attribute**

Rule-IPv6-Prefix is REQUIRED for every Software46-Rule. There MUST be exactly one Rule-IPv6-Prefix encapsulated in each type of Software46-Rule.

Rule-IPv6-Prefix follows the framed IPv6 prefix designed in [\[RFC3162\]](#) and [\[RFC8044\]](#).

The structure of Rule-IPv6-Prefix is shown below:



TLV-Type

10

TLV-Length

4 + length of rule-ipv6-prefix specified in octets.

Data Type

The attribute Rule-IPv6-Prefix is of type ipv6pref ([Section 3.10 of \[RFC8044\]](#)).

TLV-Value

A variable-length field that specifies an IPv6 prefix (rule-ipv6-prefix) appearing in the MAP rule.

#### **[3.1.4.2.](#) Rule-IPv4-Prefix Attribute**

This attribute is used to convey the MAP Rule IPv4 prefix. The structure of Rule-IPv4-Prefix is shown below:

TLV-Type

11

TLV-Length

4 + length of rule-ipv4-prefix specified in octets.

Data Type

The attribute Rule-IPv4-Prefix is of type ipv4pref ([Section 3.11 of \[RFC8044\]](#)).

TLV-Value

A variable-length field that specifies an IPv4 prefix (rule-ipv4-prefix) appearing in the MAP rule.

#### **[3.1.4.3.](#) EA-Length Attribute**

This attribute is used to convey the Embedded-Address (EA) bit length. The structure of EA-Length is shown below:





TLV-Type

12

TLV-Length

6 octets

Data Type

The attribute EA-Length is of type integer ([Section 3.1 of \[RFC8044\]](#)).

TLV-Value

EA-len; 32-bits long. Specifies the Embedded-Address (EA) bit length. Allowed values range from 0 to 48.

### **[3.1.5.](#) Attributes for Software46-v4v6Bind**

#### **[3.1.5.1.](#) IPv4-Address Attribute**

The IPv4-Address MAY be used to specify the full or shared IPv4 address of the CE.

The structure of IPv4-Address is shown below:

TLV-Type

13

TLV-Length

6 octets

Data Type

The attribute IPv4-Address is of type ipv4addr ([Section 3.8 of \[RFC8044\]](#)).

TLV-Value

32-bits long. Specifies the IPv4 address (ipv4-address) to appear in Software46-V4V6Bind ([Section 3.1.3.4](#)).

#### **[3.1.5.2.](#) Bind-IPv6-Prefix Attribute**

The Bind-IPv6-Prefix is used by the CE to identify the correct IPv6 prefix to be used as the tunnel source.

The structure of Bind-IPv6-Prefix is shown below:



TLV-Type

14

TLV-Length

4 + length of bind-ipv6-prefix specified in octets.

Data Type

The attribute Bind-IPv6-Prefix is of type ipv6pref ([Section 3.10 of \[RFC8044\]](#)).

TLV-Value

A variable-length field specifying the IPv6 prefix or address for the Softwire46 CE (bind-ipv6-prefix). This field is right-padded with zeros to the nearest octet boundary when the prefix length is not divisible by 8.

### **[3.1.6.](#) Attributes for Softwire46-PORTPARAMS**

#### **[3.1.6.1.](#) PSID-Offset Attribute**

This attribute is used to convey the Port Set Identifier offset as defined in [\[RFC7597\]](#). This attribute is encoded in 32 bits as per the recommendation in [Appendix A.2.1 of \[RFC6158\]](#).

The structure of PSID-Offset is shown below:

TLV-Type

15

TLV-Length

6 octets

Data Type

The attribute PSID-Offset is of type integer ([Section 3.1 of \[RFC8044\]](#)).

TLV-Value

Contains the PSID-Offset (8-bits) right justified, and the unused bits in this field MUST be set to zero. This field specifies the numeric value for the Softwire46 algorithm's excluded port range/offset bits (a bits), as per [Section 5.1 of \[RFC7597\]](#).

Default values for this field are specific to the Softwire mechanism being implemented and are defined in the relevant specification document.



### **3.1.6.2. PSID-Len Attribute**

This attribute is used to convey the PSID length as defined in [RFC7597]. This attribute is encoded in 32 bits as per the recommendation in [Appendix A.2.1 of \[RFC6158\]](#).

The structure of PSID-Len is shown below:

TLV-Type

16

TLV-Length

6 octets

Data Type

The attribute PSID-Len is of type integer ([Section 3.1 of \[RFC8044\]](#)).

TLV-Value

Contains the PSID-len (8-bits) right justified, and the unused bits in this field MUST be set to zero. This field specifies the number of significant bits in the PSID field (also known as 'k'). When set to 0, the PSID field is to be ignored. After the first 'a' bits, there are k bits in the port number representing the value of the PSID. Subsequently, the address sharing ratio would be  $2^k$ .

### **3.1.6.3. PSID Attribute**

This attribute is used to convey the PSID as defined in [RFC7597]. This attribute is encoded in 32 bits as per the recommendation in [Appendix A.2.1 of \[RFC6158\]](#).

The structure of PSID is shown below:



TLV-Type  
17

TLV-Length  
6 octets

Data Type  
The attribute PSID is of type integer ([Section 3.1](#)  
[of \[RFC8044\]](#)).

TLV-Value  
Contains the PSID (16-bits) right justified, and the unused bits  
in this field MUST be set to zero.  
The PSID value algorithmically identifies a set of ports  
assigned to a CE. The first k bits on the left of this  
2-octet field is the PSID value. The remaining (16-k) bits  
on the right are padding zeros.

### **[3.2.](#) Software46-Priority Attribute**

The Software46-Priority Attribute includes an ordered list of  
Software46 mechanisms allowing the client to prioritize which  
mechanism to use, corresponding to OPTION\_S46\_PRIORITY defined in  
[\[RFC8026\]](#). The following requirements apply:

The Software46-Priority Attribute MAY appear in an Access-Accept  
packet. It MAY also appear in an Access-Request packet.

The Software46-Priority Attribute MAY appear in a CoA-Request  
packet.

The Software46-Priority Attribute MAY appear in an Accounting-  
Request packet.

The Software46-Priority Attribute MUST NOT appear in any other  
RADIUS packet.

The Softwrie46-Priority Attribute is structured as follows:





**Type**

241 (To be confirmed by IANA)

**Length**

Indicates the length of this attribute,  
including the Type, Length, Extended-Type and Value fields.

**Extended-Type**

TBD5

**TLV-Value**

The attribute includes one or more Software46-Option-Code TLVs:  
A Software46-Priority Attribute MUST contain at least one  
Software46-Option-Code TLV ([Section 3.2.1](#)).

Software46 mechanisms are prioritized in the appearance order  
of the in the Software46-Priority Attribute. That is,  
the first-appearing mechanism is most preferred.

The Software46-Priority Attribute is associated with the following  
identifier: 241.Extended-Type (TBD5).

**[3.2.1](#). Software46-Option-Code**

This attribute is used to convey an option code assigned to a  
Software46 mechanism [[RFC8026](#)]. This attribute is encoded in 32 bits  
as per the recommendation in [Appendix A.2.1 of \[RFC6158\]](#).

The structure of Software46-Option-Code is shown below:

**TLV-Type**

18

**TLV-Length**

6 octets

**Data Type**

The attribute Software46-Option-Code is of type integer  
([Section 3.1 of \[RFC8044\]](#)).

**TLV-Value**

A 32-bit IANA-registered option code representing a Software46  
mechanism (Software46-option-code). The codes and their  
corresponding Software46 mechanisms are listed in [Section 7.3](#).



### **3.3. Software46-Multicast Attribute**

The Software46-Multicast Attribute conveys the IPv6 prefixes to be used to synthesize multicast and unicast IPv4-embedded IPv6 addresses as per [\[RFC8114\]](#). This attribute is of type "tlv" and contains additional TLVs. The following requirements apply:

The BNG SHALL use the IPv6 prefixes returned in the RADIUS Software46-Multicast Attribute to populate the DHCPv6 PREFIX64 Option [\[RFC8115\]](#).

This attribute MAY be used in Access-Request packets as a hint to the RADIUS server. For example, if the BNG is pre-configured for Software46-Multicast, these prefixes may be inserted in the attribute. The RADIUS server MAY ignore the hint sent by the BNG, and it MAY assign a different Software46-Multicast Attribute.

The Software46-Multicast Attribute MAY appear in an Access-Request, Access-Accept, CoA-Request, and Accounting-Request packet.

The Software46-Multicast Attribute MUST NOT appear in any other RADIUS packet.

The Software46-Multicast Attribute MAY contain ASM-Prefix64 ([Section 3.3.1](#)), SSM-Prefix64 ([Section 3.3.2](#)), and U-Prefix64 ([Section 3.3.3](#)).

The Software46-Multicast Attribute MUST include ASM-Prefix64 or SSM-Prefix64, and it MAY include both.

The U-Prefix64 MUST be present when SSM-Prefix64 is present. U-Prefix64 MAY be present when ASM-Prefix64 is present.

The Software46-Multicast Attribute is structured as follows:



**Type**

241 (To be confirmed by IANA)

**Length**

This field indicates the total length in bytes of all fields of this attribute, including the Type, Length, Extended-Type, and the entire length of the embedded attributes.

**Extended-Type**

TBD6

**Value**

This field contains a set of attributes as follows:

**ASM-Prefix64**

This attribute contains the Any-Source Multicast (ASM) IPv6 prefix. Refer to [Section 3.3.1](#).

**SSM-Prefix64**

This attribute contains the Source-Source Multicast (SSM) IPv6 prefix. Refer to [Section 3.3.2](#).

**U-Prefix64**

This attribute contains the IPv4 prefix used for address translation. Refer to [Section 3.3.3](#).

The Software46-Multicast Attribute is associated with the following identifier: 241.Extended-Type(TBD6).

### **[3.3.1](#). ASM-Prefix64 Attribute**

The ASM-Prefix64 attribute is structured as follows:

**TLV-Type**

19

**TLV-Length**

16 octets. The length of asm-prefix64 must be /96 [[RFC8115](#)].

**Data Type**

The attribute ASM-Prefix64 is of type ipv6prefix ([Section 3.10 of \[RFC8044\]](#)).

**TLV-Value**

This field specifies the IPv6 multicast prefix (asm-prefix64) to be used to synthesize the IPv4-embedded IPv6 addresses of the multicast groups in the ASM mode. The conveyed multicast IPv6 prefix MUST belong to the ASM range.



### **3.3.2. SSM-Prefix64 Attribute**

The SSM-Prefix64 attribute is structured as follows:

Type  
20

TLV-Length  
16 octets. The length of ssm-prefix64 must be /96 [[RFC8115](#)].

Data Type  
The attribute SSM-Prefix64 is of type ipv6prefix ([Section 3.10 of \[RFC8044\]](#)).

TLV-Type  
This field specifies the IPv6 multicast prefix (ssm-prefix64) to be used to synthesize the IPv4-embedded IPv6 addresses of the multicast groups in the SSM mode. The conveyed multicast IPv6 prefix MUST belong to the SSM range.

### **3.3.3. U-Prefix64 Attribute**

The structure of U-Prefix64 is shown below:

TLV-Type  
21

TLV-Length  
4 + length of unicast-prefix. As specified in [[RFC6052](#)], the unicast-prefix prefix-length MUST be set to 32, 40, 48, 56, 64, or 96.

Data Type  
The attribute U-Prefix64 is of type ipv6prefix ([Section 3.10 of \[RFC8044\]](#)).

TLV-Value  
This field identifies the IPv6 unicast prefix (u-prefix64) to be used in SSM mode for constructing the IPv4-embedded IPv6 addresses representing the IPv4 multicast sources in the IPv6 domain. It may also be used to extract the IPv4 address from the received multicast data flows.

## **4. A Sample Configuration Process with RADIUS**

Figure 2 illustrates how the RADIUS and DHCPv6 protocols interwork to provide CE with software configuration information.





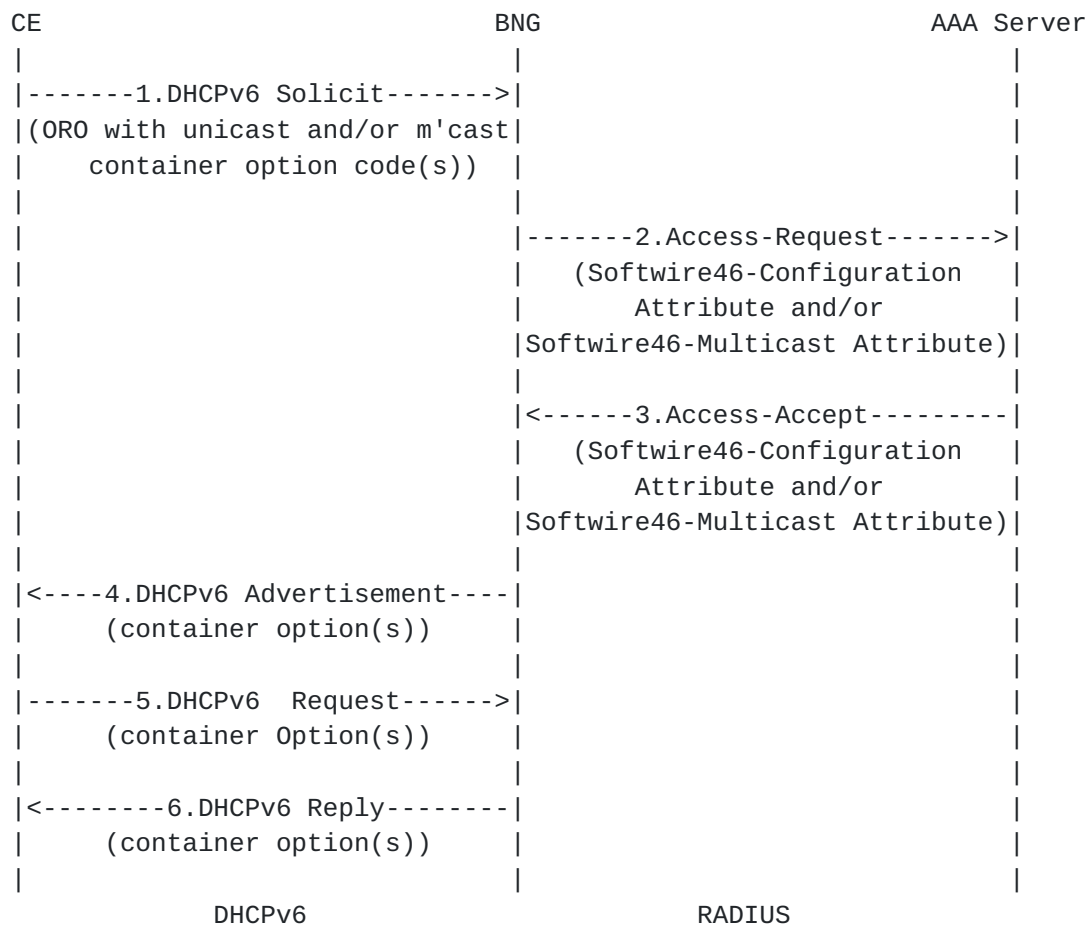


Figure 2: Interaction between DHCPv6 and AAA Server with RADIUS authentication

1. The CE creates a DHCPv6 Solicit message. For unicast softwire configuration, the message includes an `OPTION_REQUEST_OPTION` (6) with the Softwire46 Container option code(s) as defined in [\[RFC7598\]](#). `OPTION_S46_CONT_MAPE` (94) should be included for MAP-E, `OPTION_S46_CONT_MAPT` (95) for MAP-T, and `OPTION_S46_CONT_LW` (96) for Lightweight 4over6. For multicast configuration, the option number for `OPTION_V6_PREFIX64` (113) is included in the client's ORO. The message is sent to the BNG.
2. On receipt of the Solicit message, the BNG constructs a RADIUS Access-Request message containing a User-Name Attribute (1) (containing either a CE MAC address, interface-id, or both), a User-Password Attribute (2) (with a pre-configured shared password between the CE and AAA server as defined in [\[RFC2865\]](#)). The Softwire46-Configuration Attribute and/or Softwire46-Multicast Attribute are also included (as requested by the client). The resulting message is sent to the AAA server.



3. The AAA server authenticates the request. If this is successful, and suitable configuration is available, an Access-Accept message is sent to the BNG containing the requested Software46-Configuration Attribute or Software46-Multicast Attribute. It is the responsibility of the AAA server to ensure the consistency of the provided configuration.
4. The BNG maps the received software configuration into the corresponding fields in the DHCPv6 software configuration option(s). These are included in the DHCPv6 Advertise message which is sent to the CE.
5. The CE sends a DHCPv6 Request message. In the ORO, the option code(s) of any of the required software options that were received in the Advertise message are included.
6. The BNG sends a DHCPv6 Reply message to the client containing the software container option(s) enumerated in the ORO.

The authorization operation could be done independently, after the authentication process. In this case, steps 1-5 are completed as above, then the following steps are performed:

- 6a. When the BNG receives the DHCPv6 Request, it constructs a RADIUS Access-Request message, which contains a Service-Type Attribute (6) with the value "Authorize Only" (17), the corresponding Software46-Configuration Attribute, and a State Attribute obtained from the previous authentication process according to [\[RFC5080\]](#). The resulting message is sent to the AAA server.
- 7a. The AAA checks the authorization request. If it is approved, an Access-Accept message is returned to the BNG with the corresponding Software46-Configuration Attribute.
- 8a. The BNG sends a Reply message to the client containing the software container options enumerated in the ORO.

In addition to the above, the following points need to be considered:

- o In the configuration message flows described above the Message-Authenticator (type 80) [\[RFC2869\]](#) should be used to protect both Access-Request and Access-Accept messages.
- o If the BNG does not receive the corresponding Software46-Configuration Attribute in the Access-Accept message it may fall back to creating the DHCPv6 software configuration options using pre-configured Software46 configuration, if this is present.



- o If the BNG receives an Access-Reject from the AAA server, then Softwire46 configuration must not be supplied to the client.
- o As specified in [\[RFC8415\], Section 18.2.5](#), "Creation and Transmission of Rebind Messages", if the DHCPv6 server to which the DHCPv6 Renew message was sent at time T1 has not responded by time T2, the CE (DHCPv6 client) should enter the Rebind state and attempt to contact any available server. In this situation, a secondary BNG receiving the DHCPv6 message must initiate a new Access-Request message towards the AAA server. The secondary BNG includes the Softwire46-Configuration Attribute in this Access-Request message.
- o For Lightweight 4over6, the CE's binding state needs to be synchronized between the clients and the Lightweight AFTR (lwAFTR)/BR. This can be achieved in two ways: static pre-configuration of the bindings on both the AAA server and lwAFTR, or on-demand whereby the AAA server updates the lwAFTR with the CE's binding state as it is created or deleted.

In some deployments, the DHCP server may use the Accounting-Request to report to a AAA server the softwire configuration returned to a requesting host. It is the responsibility of the DHCP server to ensure the consistency of the configuration provided to requesting hosts. Reported data to a AAA server may be required for various operational purposes (e.g., regulatory).

## 5. Table of Attributes

This document specifies three new RADIUS attributes, and their formats are as follows:

- o Softwire46-Configuration Attribute: 241.TBD1
- o Softwire46-Priority Attribute: 241.TBD5
- o Softwire46-Multicast Attribute: 241.TBD6

Table 3 describes which attributes may be found, in which kinds of packets and in what quantity.



Request	Accept	Reject	Challenge	Acct	CoA-	#	Attribute
				Req	Req		
0-1	0-1	0	0	0-1	0-1	241.TBD1	Softwire46- Configuration
0-1	0-1	0	0	0-1	0-1	241.TBD5	Softwire46- Priority
0-1	0-1	0	0	0-1	0-1	241.TBD6	Softwire46- Multicast

Table 3: Table of Attributes

## 6. Security Considerations

[Section 9 of \[RFC7596\]](#) discusses security issues related to Lightweight 4over6, [Section 10 of \[RFC7597\]](#) discusses security issues related to MAP-E, [Section 13 of \[RFC7599\]](#) discusses security issues related to MAP-T, and [Section 9 of \[RFC8114\]](#) discusses security issues related to the delivery of IPv4 multicast services to IPv4 clients over an IPv6 multicast network.

Generic RADIUS security considerations are discussed in [Section 8 of \[RFC2865\]](#) and [Section 6 of \[RFC5176\]](#) for CoA messages. Known security vulnerabilities of the RADIUS protocol discussed in [Section 7 of \[RFC2607\]](#) and [Section 7 of \[RFC2869\]](#) apply to this specification.

This document targets deployments where a trusted relationship is in place between the RADIUS client and server with communication optionally secured by IPsec or Transport Layer Security (TLS) [\[RFC6614\]](#). The use of IPsec [\[RFC4301\]](#) for providing security when RADIUS is carried in IPv6 is discussed in [\[RFC3162\]](#).

Security considerations for interactions between a Softwire46 CE and the BNG are discussed in [Section 9 of \[RFC7598\]](#) (DHCPv6 options for configuration of softwire46 address and port-mapped clients), [Section 3 of \[RFC8026\]](#) (DHCPv6-based Softwire46 prioritization mechanism), and [Section 5 of \[RFC8115\]](#) (DHCPv6 options for configuration of IPv4-embedded IPv6 prefixes).

## 7. IANA Considerations

IANA is requested to make new code point assignments for RADIUS attributes as described in the following subsections. The assignments should use the RADIUS registry available at <https://www.iana.org/assignments/radius-types/>.





### **7.1. New RADIUS Attributes**

This document requests IANA to assign the Attribute Types defined in this document from the RADIUS namespace as described in the "IANA Considerations" section of [[RFC3575](#)], in accordance with [BCP 26](#) [[RFC8126](#)].

This document requests that IANA register three new RADIUS attributes, from the "Short Extended Space" of [[RFC6929](#)]. The attributes are: Softwire46-Configuration Attribute, Softwire46-Priority Attribute, and Softwire46-Multicast Attribute:

Type	Description	Data Type	Reference
----	-----	-----	-----
241.TBD1	Softwire46-Configuration	tlv	<a href="#">Section 3.1</a>
241.TBD5	Softwire46-Priority	tlv	<a href="#">Section 3.2</a>
241.TBD6	Softwire46-Multicast	tlv	<a href="#">Section 3.3</a>

### **7.2. RADIUS Softwire46 Configuration and Multicast Attributes**

IANA is requested to create a new registry called "RADIUS Softwire46 Configuration and Multicast Attributes".

All attributes in this registry have one or more parent RADIUS attributes in nesting (refer to [[RFC6929](#)]).

This registry must be initially populated with the following values:



Value	Description	Data Type	Reference
-----	-----	-----	-----
0	Reserved		
1	Softwire46-MAP-E	tlv	<a href="#">Section 3.1.1.1</a>
2	Softwire46-MAP-T	tlv	<a href="#">Section 3.1.1.2</a>
3	Softwire46-Lightweight-4over6	tlv	<a href="#">Section 3.1.1.3</a>
4	Softwire46-Rule (BMR)	tlv	<a href="#">Section 3.1.3.1</a>
5	Softwire46-Rule (FMR)	tlv	<a href="#">Section 3.1.3.1</a>
6	Softwire46-BR	ipv6addr	<a href="#">Section 3.1.3.2</a>
7	Softwire46-DMR	ipv6prefix	<a href="#">Section 3.1.3.3</a>
8	Softwire46-V4V6Bind	tlv	<a href="#">Section 3.1.3.4</a>
9	Softwire46-PORTPARAMS	tlv	<a href="#">Section 3.1.3.5</a>
10	Rule-IPv6-Prefix	ipv6prefix	<a href="#">Section 3.1.4.1</a>
11	Rule-IPv4-Prefix	ipv4prefix	<a href="#">Section 3.1.4.2</a>
12	EA-Length	integer	<a href="#">Section 3.1.4.3</a>
13	IPv4-Address	ipv4addr	<a href="#">Section 3.1.5.1</a>
14	Bind-IPv6-Prefix	ipv6prefix	<a href="#">Section 3.1.5.2</a>
15	PSID-Offset	integer	<a href="#">Section 3.1.6.1</a>
16	PSID-Len	integer	<a href="#">Section 3.1.6.2</a>
17	PSID	integer	<a href="#">Section 3.1.6.3</a>
18	Softwire46-Option-Code	integer	<a href="#">Section 3.2.1</a>
19	ASM-Prefix64	ipv6prefix	<a href="#">Section 3.3.1</a>
20	SSM-Prefix64	ipv6prefix	<a href="#">Section 3.3.2</a>
21	U-Prefix64	ipv6prefix	<a href="#">Section 3.3.3</a>
22-255	Unassigned		

The registration procedure for this registry is Standards Action as defined in [\[RFC8126\]](#).

### **7.3. Softwire46 Mechanisms and Their Identifying Option Codes**

The Softwire46-Priority Attribute conveys an ordered list of option codes assigned to Softwire46 mechanisms, for which IANA is requested to create and maintain a new registry entitled "Option Codes Permitted in the Softwire46-Priority Attribute".

Table 4 shows the initial version of allowed option codes, and the Softwire46 mechanisms that they represent. The option code for DS-Lite is derived from the IANA allocated RADIUS Attribute Type value for DS-Lite [\[RFC6519\]](#). The option codes for MAP-E, MAP-T, and Lightweight 4over6 are the TLV-Type values for the MAP-E, MAP-T, and Lightweight 4over6 attributes defined in [Section 3.1.1](#).



Option Code	Softwire46 Mechanism	Reference
1	MAP-E	<a href="#">RFC7597</a>
2	MAP-T	<a href="#">RFC7599</a>
3	Lightweight 4over6	<a href="#">RFC7596</a>
144	DS-Lite	<a href="#">RFC6519</a>

Table 4: Option Codes to S46 Mechanisms

Additional option codes may be added to this list in the future using the IETF Review process described in [Section 4.8 of \[RFC8126\]](#).

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## **9. Acknowledgements**

The authors would like to thank the valuable comments made by Peter Lothberg, Wojciech Dec, Ian Farrer, Suresh Krishnan, Qian Wang, Wei Meng, Cui Wang, Alan Dekok, Stefan Winter, and Yu Tianpeng to this document.

This document was merged with [[I-D.sun-softwire-lw4over6-radext](#)] and [[I-D.wang-radext-multicast-radius-ext](#)], thanks to everyone who contributed to this document.

This document was produced using the xml2rfc tool [[RFC7991](#)].

Many thanks to Al Morton, Bernie Volz, Joel Halpern, and Donald Eastlake for the review.





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## **Appendix A. DHCPv6 to RADIUS Field Mappings**

The following sections detail the mappings between the software DHCPv6 option fields and the relevant RADIUS attributes as defined in this document.

### **A.1. OPTION\_S46\_RULE (89) to Software46-Rule Sub-TLV Field Mappings**

OPTION_S46_RULE Field	Software46-Rule Name	TLV Subfield
flags	N/A	TLV-type (TBD7, TBD8)
ea-len	EA-Length	EA-len
prefix4-len	Rule-IPv4-Prefix	Prefix-Length
ipv4-prefix	Rule-IPv4-Prefix	rule-ipv4-prefix
prefix6-len	Rule-IPv6-Prefix	Prefix-Length
ipv6-prefix	Rule-IPv6-Prefix	rule-ipv6-prefix

### **A.2. OPTION\_S46\_BR (90) to Software46-BR Field Mappings**

OPTION_S46_BR Field	Software46-BR Subfield
br-ipv6-address	br-ipv6-address

### **A.3. OPTION\_S46\_DMR (91) to Software46-DMR**

OPTION_S46_BR Field	Software46-DMR Subfield
dmr-prefix6-len	dmr-prefix6-len
dmr-ipv6-prefix	dmr-ipv6-prefix





**A.4. OPTION\_S46\_V4V6BIND (92) to Softwire46-V4V6Bind**

OPTION_S46_V4V6BIND Field	Softwire46-V4V6Bind Name	TLV Subfield
ipv4-address	IPv4-Address	ipv4-address
bindprefix6-len	Bind-IPv6-Prefix	Prefix-Length
bind-ipv6-prefix	Bind-IPv6-Prefix	bind-ipv6-prefix

**A.5. OPTION\_S46\_PORTPARAMS (93) to Softwire46-PORTPARAMS Field Mappings**

OPTION_S46_PORTPARAMS Field	Softwire46-PORTPARAMS Name	TLV Subfield
offset	PSID-Offset	PSID-Offset
PSID-len	PSID-Len	PSID-len
PSID	PSID	PSID

**A.6. OPTION\_S46\_PRIORITY (111) to Softwire46-PORTPARAMS Field Mappings**

OPTION_S46_PRIORITY Field	Softwire46-Priority Attribute Subfield
s46-option-code	Softwire46-option-code

**A.7. OPTION\_V6\_PREFIX64 (113) to Softwire46-Multicast Attribute Field Mappings**

OPTION_V6_PREFIX64 Field	Softwire46-Multicast Attribute TLV Name	TLV Subfield
asm-length	ASM-Prefix64	Prefix-Length
ASM_mPrefix64	ASM-Prefix64	asm-prefix64
ssm-length	SSM-Prefix64	Prefix-Length
SSM_mPrefix64	SSM-Prefix64	ssm-prefix64
unicast-length	U-Prefix64	Prefix-Length
uPrefix64	U-Prefix64	u-prefix64



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