Softwire
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RADIUS Attribute for Softwire Address plus Port based Mechanisms draft-ietf-softwire-map-radius-12

Abstract

IPv4-over-IPv6 transition mechanisms provide both IPv4 and IPv6 connectivity services simultaneously during the IPv4/IPv6 co-existing period. The Dynamic Host Configuration Protocol for IPv6 (DHCPv6) options have been defined to configure Customer Edge (CE) in MAP-E, MAP-T, and Lightweight 4over6. However, in many networks, the configuration information may be stored in an Authentication Authorization and Accounting (AAA) server, while user configuration information is mainly provided by the Broadband Network Gateway (BNG) through the DHCPv6 protocol. This document defines two new Remote Authentication Dial In User Service (RADIUS) attributes that carry CE configuration information from an AAA server to BNG.

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 November 3, 2017.

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1. Introduction

Recently providers have started to deploy IPv6 and consider how to transit to IPv6. Many transition mechanisms based on the Address plus Port (A+P) [RFC6346] have been proposed for running IPv4 over IPv6-only infrastructure, including MAP-E, MAP-T, and Lightweight 4over6. Mapping of Address and Port with Encapsulation(MAP-E)[RFC7597], Mapping of Address and Port using Translation(MAP-T)[RFC7599] are stateless mechanisms for running IPv4 over IPv6-only infrastructure. Lightweight 4over6[RFC7596] is a hub-and-spoke IPv4-over-IPv6 tunneling mechanism, with complete independence of IPv4 and IPv6 addressing. They provide both IPv4 and IPv6 connectivity services simultaneously during the IPv4/IPv6 co-existing period. MAP-E, MAP-T and Lightweight 4over6 have adopted Dynamic Host Configuration Protocol for IPv6 (DHCPv6) [RFC3315] as auto-configuring protocol. The Customer Edge (CE) uses DHCPv6 options to discover the Border Relay (BR) and get Softwire46 (S46) configurations.

In many networks, user configuration information may be stored in an Authentication, Authorization, and Accounting (AAA) server. Currently the AAA servers communicate using the Remote Authentication Dial In User Service (RADIUS) [RFC2865] protocol. In a fixed line broadband network, a Broadband Network Gateway (BNG) acts as the access gateway of users. The BNG is assumed to embed a DHCPv6 server function that allows it to locally handle any DHCPv6 requests initiated by hosts.

Since the S46 configuration information is stored in an AAA servers and user configuration information is mainly transmitted through DHCPv6 protocol between the BNGs and hosts/CEs, new RADIUS attributes are needed to propagate the information from the AAA servers to BNGs. The RADIUS attributes designed in this document are especially for the MAP-E[RFC7597], MAP-T[RFC7599] and Lightweight 4over6[RFC7596], providing enough information to form the correspondent DHCPv6 configuration options[RFC7598].

2. Terminology

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 [RFC2119].

3. Configuration process with RADIUS

The Figure 1 below illustrates how the RADIUS protocol and DHCPv6 co-operate to provide CE with MAP configuration information. The BNG acts as a RADIUS client and DHCPv6 server.

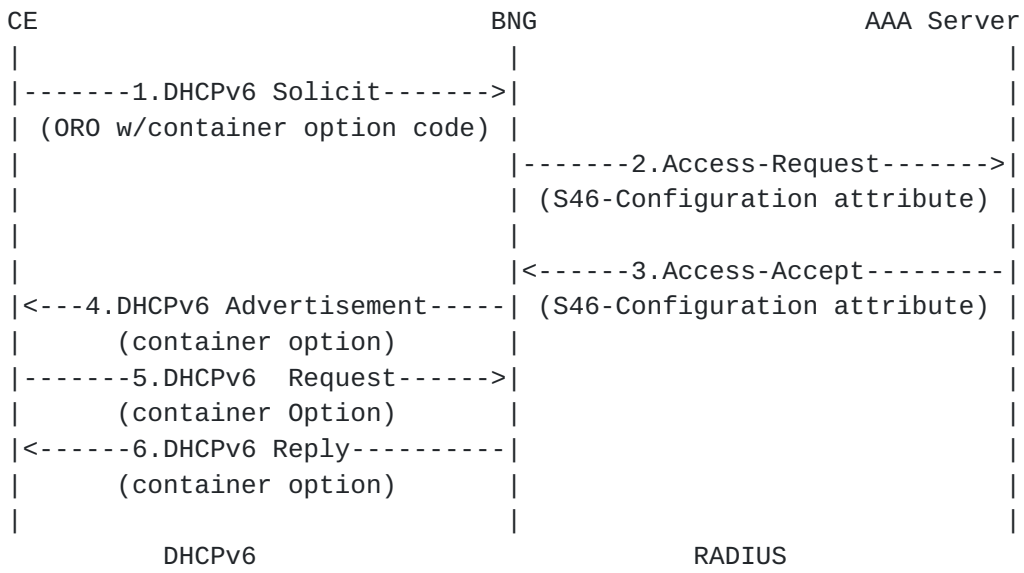


Figure 1: the cooperation between DHCPv6 and RADIUS combining with RADIUS authentication

1. First, the CE MAY initiate a DHCPv6 Solicit message that includes an Option Request option(6) [RFC3315] with the S46 Container option codes as defined in[RFC7598]. As described in [RFC7598], OPTION_S46_CONT_MAPE should be included for MAP-E[RFC7597], OPTION_S46_CONT_MAPT for MAP-T [RFC7599], and OPTION_S46_CONT_LW for Lightweight 4over6 [RFC7596]. Note however, that the ORO (Option Request option) with the S46 Container option code could be optional if the network was planned as being S46-enabled as default.

2. When the BNG receives the Solicit message, it should initiate a radius Access-Request message, in which an User-Name attribute (1) should be filled by a CE MAC address or interface-id or both, to the RADIUS server and a User-password attribute (2) should be filled by the shared password that has been preconfigured on the DHCPv6 server, requesting authentication as defined in [RFC2865] with the corresponding Softwire46-Configuration Attribute, which will be defined in the next Section.

3. If the authentication request is approved by the AAA server, an Access-Accept message MUST be acknowledged with the corresponding Softwire46-Configuration Attribute.

4. After receiving the Access-Accept message with the corresponding Attribute, the BNG SHOULD respond to the DHCPv6 Client (CE) with an Advertisement message.

5. After receiving the Advertise message, the CE MAY request for the corresponding S46 Container option, by including the S46 Container option in the Request message.

6. After receiving the client's Request message, containing the corresponding S46 Container option the BNG SHOULD reply to the CE with the message containing the S46 Container option. The recommended format of the MAC address is defined as Calling-Station-Id (Section 3.20 in [RFC3580] without the SSID (Service Set Identifier) portion.

For Lightweight 4over6 [RFC7596], the subscriber's binding state should be synchronized between the AAA server and lwAFTR. If the bindings are pre-configured statically, in both the AAA server and lwAFTR, an AAA server does not need to configure the lwAFTR anymore. Otherwise, if the bindings are locally created on-demand in an AAA server, it should inform the lwAFTR with the subscriber's binding state, in order to synchronize the binding information of the lwB4 with the lwAFTR.

The authorization operation could also be done independently after the authentication process. In such a scenario, after the authentication operation, the client MAY initiate a DHCPv6 Request message that includes the corresponding S46 Container options. Similar to the above scenario, the ORO with the corresponding S46 Container option code in the initial DHCPv6 request could be optional if the network was planned as being S46-enabled by default. When the BNG receives the DHCPv6 Request, it SHOULD initiate the radius Access-Request message, which MUST contain a Service-Type attribute (6) with the value Authorize Only (17), the corresponding Softwire46-Configuration Attribute, and a State attribute obtained from the previous authentication process according to [RFC5080]. If the authorization request is approved by an AAA server, an Access-Accept message MUST be acknowledged with the corresponding Softwire46-Configuration Attribute. The BNG SHOULD then send the DHCPv6 Reply message containing the S46 Container option.

In both the above-mentioned scenarios, Message-authenticator (type 80) [RFC2869] SHOULD be used to protect both Access-Request and Access-Accept messages.

If the BNG does not receive the corresponding Softwire46-Configuration Attribute in the Access-Accept message it MAY fallback to a pre-configured default S46 configuration, if any. If the BNG does not have any pre-configured default S46 configuration, or if the BNG receives an Access-Reject, then S46 connection cannot be established.

As specified in [RFC3315], section 18.1.4, "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, the secondary BNG receiving the DHCPv6 message MUST initiate a new Access-Request message towards the AAA server. The secondary BNG MAY include the Softwire46-Configuration Attribute in its Access-Request message.

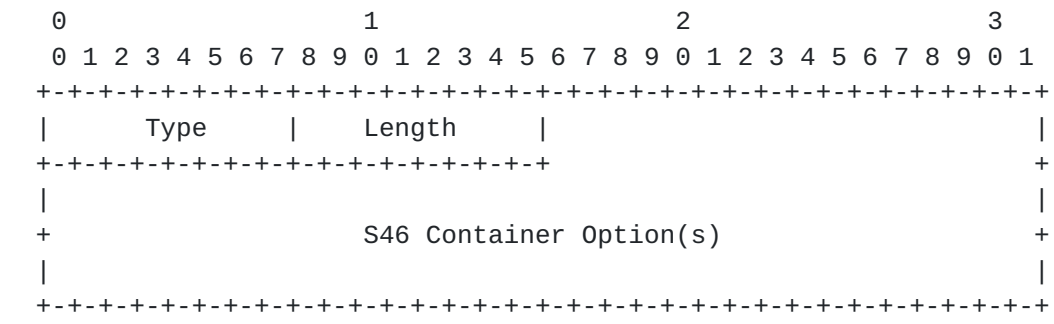
4. Attributes

This section defines the Softwire46-Configuration Attribute and the Softwire46-Priority Attribute. The attribute design follows [RFC6158] and refers to [RFC6929]. The Softwire46-Configuration Attribute carries the configuration information for MAP-E, MAP-T, and Lightweight 4over6. The configuration information for each S46 mechanism is carried in the corresponding S46 Container option. Different sub options are required for each type of S46 Container option. The RADIUS attribute for Dual-Stack Lite [RFC6333] is defined in [RFC6519].

A client may be capable of supporting several different S46 mechanisms. Depending on the deployment scenario, a client might request for more than one S46 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].

4.1. Softwire46-Configuration Attribute

The Softwire46-Configuration Attribute can only encapsulate S46 Container Option(s). The Softwire46-Configuration Attribute is structured as follows:



Type
TBD
Length
2 + the length of the S46 Container option(s) specified in octets
S46 Container Option (s)
A variable field that may contains one or more S46 Container option(s), defined in Section 4.2.

4.2. S46 Container Options

The S46 Container Option can only be encapsulated in the Softwire46-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 S46 Container option encapsulated in one Softwire46-Configuration Attribute. There MUST be at most one instance of each type of S46 Container Option encapsulated in one Softwire46-Configuration Attribute.

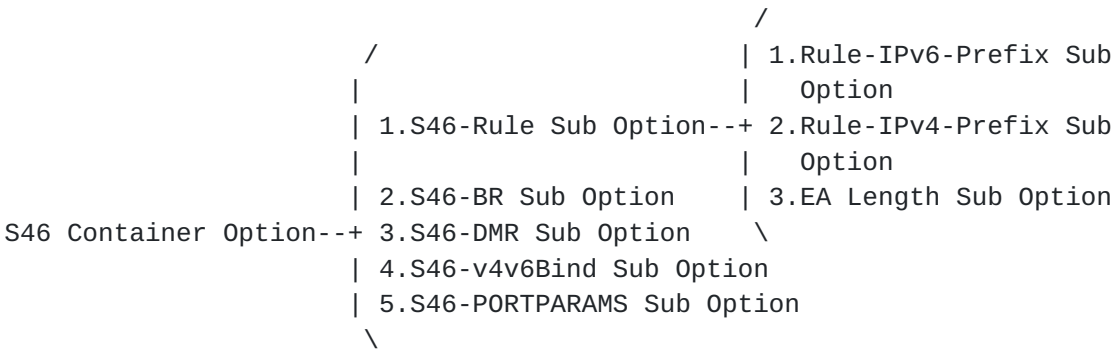
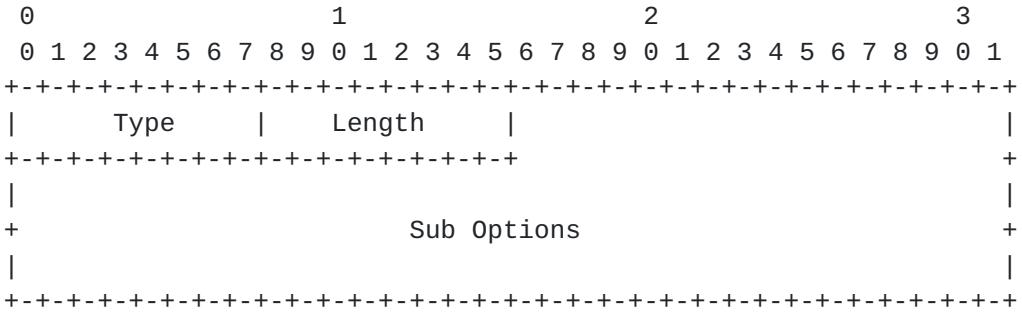


Figure 2: S46 Container Option Hierarchy

There are three types of S46 Container Options, namely MAP-E Container Option, MAP-T Container Option, Lightweight 4over6 Container Option. Each type of S46 Container Option contains a number of sub options, defined in Section 4.3. The hierarchy of the S46 Container Option is shown in Figure 2. Section 4.5 describes which Sub Options are mandatory, optional, or not permitted for each defined S46 Container Option.

There are three types of S46-Rule Sub Options, namely Basic Mapping Rule, Forwarding Mapping Rule, Basic and Forwarding Mapping Rule. Each type of S46-Rule Sub Option also contains a number of Sub Options. The Rule-IPv6-Prefix Sub Option is necessary for every type of S46-Rule Sub Option. It should appear for once and only once.



Type
TBD1 MAP-E Container Option
TBD2 MAP-T Container Option
TBD3 Lightweight 4over6 Container Option
Length
2 + the length of the Sub Options specified in octets
Sub Option
A variable field that contains necessary sub options defined in Section 4.3 and zero or several optional sub options, defined in Section 4.4.

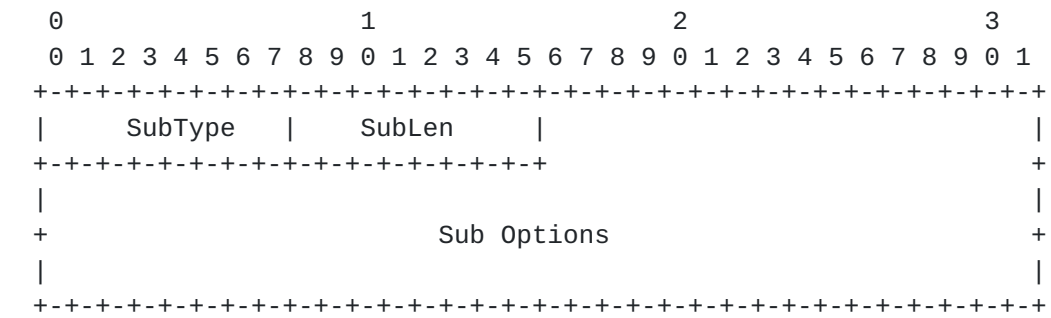
NOTE: The Type values for each S46 Container Option are the same as the S46-option-code values of the corresponding S46 Mechanisms specified in Section 6.1.

4.3. Sub Options for S46 Container Option

4.3.1. S46-Rule Sub Option

The S46-Rule Sub Option can only be encapsulated in the MAP-E Container Option or the MAP-T Container Option. Depending on deployment scenario, one Basic Mapping Rule and zero or more Forwarding Mapping Rules MUST be included in one MAP-E Container Option or MAP-T Container Option.

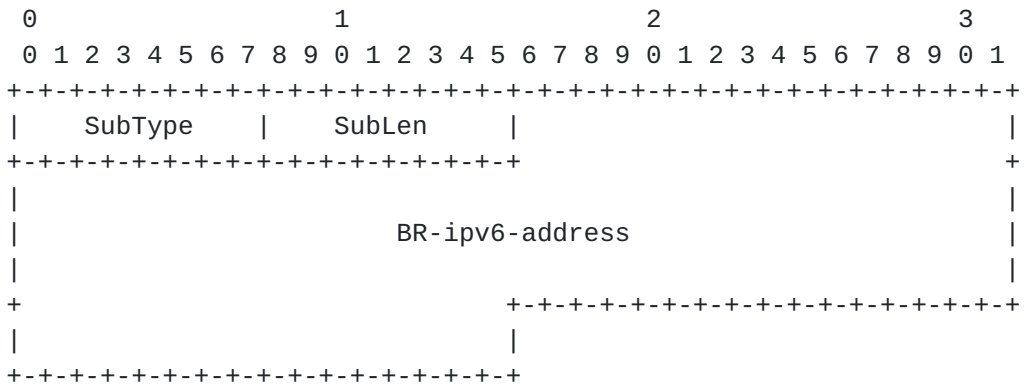
Each type of S46-Rule Sub Option also contains a number of sub options, including Rule-IPv6-Prefix Sub Option, Rule-IPv4-Prefix Sub Option, and EA Length Sub Option. The structure of the sub options for S46-Rule Sub Option is defined in section 4.4.



SubType
1 Basic Mapping Rule (Not Forwarding Mapping Rule)
2 Forwarding Mapping Rule (Not Basic Mapping Rule)
3 Basic & Forwarding Mapping Rule
SubLen
2 + the length of the Sub Options specified in octets
Sub Option
A variable field that contains sub options defined in Section 4.4.

4.3.2. S46-BR Sub Option

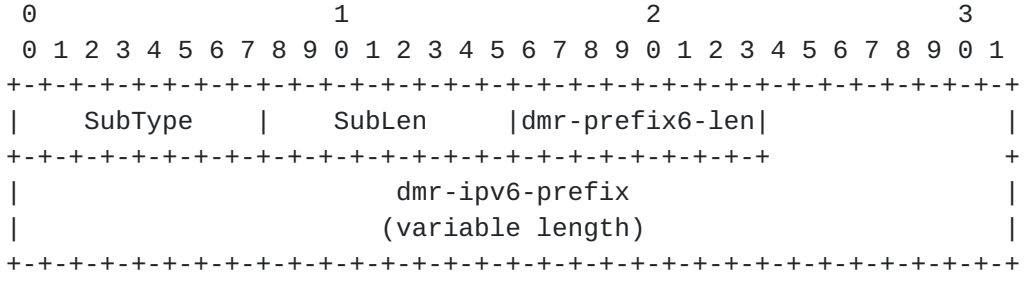
The S46-BR Sub Option an only be encapsulated in the MAP-E Container Option or the Lightweight 4over6 Container Option. There MUST be at least one S46-BR Sub Option included in each MAP-E Container Option or Lightweight 4over6 Container Option.



SubType
4 (SubType number, for the S46-BR sub option)
SubLen
18 (the length of the S46-BR sub option)
BR-ipv6-address
a fixed-length field of 16 octets that specifies the IPv6 address for the S46 BR.

4.3.3. S46-DMR Sub Option

The S46-DMR Sub Option can only appear in the MAP-T Container Option. There MUST be exactly one S46-DMR Sub Option included in one MAP-T Container Option.



SubType
: 5 (SubType number, for the S46-DMR Sub Option)

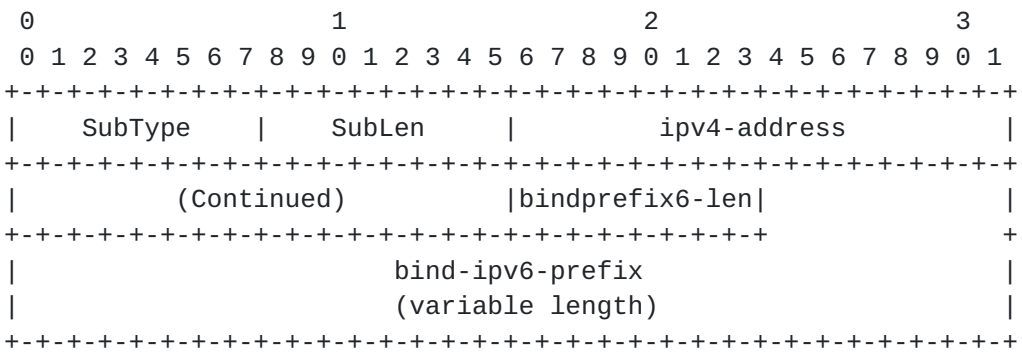
SubLen
: 3 + length of dmr-ipv6-prefix specified in octets

dmr-prefix6-len
: 8 bits long; expresses the bitmask length of the IPv6 prefix specified in the dmr-ipv6-prefix field. Allowed values range from 0 to 96.

dmr-ipv6-prefix
: a variable-length field specifying the IPv6 prefix or address for the BR. This field is right-padded with zeros to the nearest octet boundary when dmr-prefix6-len is not divisible by 8.

4.3.4. S46-V4V6Bind Sub Option

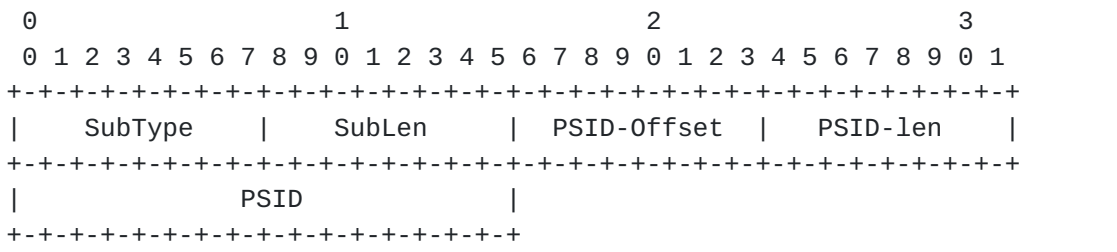
The S46-V4V6Bind Sub Option can only be encapsulated in the Lightweight 4over6 Container Option. There MUST be at most one S46-V4V6Bind Sub Option included in each Lightweight 4over6 Container Option.



SubType
6 (SubType number, for the S46-V4V6Bind sub option)
SubLen
the length of the S46-V4V6Bind sub option expressed in octets
ipv4-address
a 32-bits field that specifies an IPv4 address that appears in the V4V6Bind Option
bindprefix6-len
8 bits long; expresses the bitmask length of the IPv6 prefix specified in the bind-ipv6-prefix field. Allowed values range from 0 to 96.
bind-ipv6-prefix
a variable-length field specifying the IPv6 prefix or address for the S46 CE. This field is right-padded with zeros to the nearest octet boundary when bindprefix6-len is not divisible by 8.

4.3.5. S46-PORTPARAMS Sub Option

The S46-PORTPARAMS Sub Option specifies optional port set information that MAY be provided to CEs. The S46-PORTPARAMS sub option can be included optionally by each type of S46 Container Option.



SubType
7 (SubType number, for the S46-PORTPARAMS Sub Option sub option)
SubLen
6 (the length of the S46-PORTPARAMS Sub Option sub option)
PSID Offset
8 bits long field that specifies the numeric value for the S46 algorithm's excluded port range/ offset bits (a bits), as per Section 5.1 of RFC7597. Allowed values are between 0 and 15. Default values for this field are specific to the Softwire mechanism being implemented and are defined in the relevant specification document.
PSID-len
8 bits long; 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 valid of PSID. Subsequently, the address sharing ratio would be 2 ^k.
PSID (Port-set ID)
Explicit 16-bit (unsigned word) PSID value. The PSID value algorithmically identifies a set of ports assigned to a CE. The first k-bits on the left of this 2-octets field is the PSID value. The remaining (16-k) bits on the right are padding zeros.

4.4. Sub Options for S46-Rule Sub Option

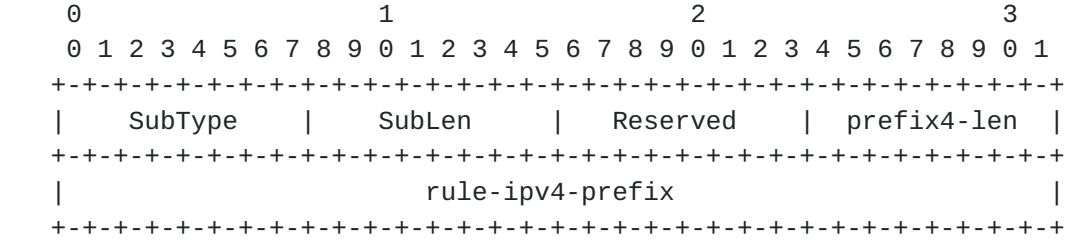
4.4.1. Rule-IPv6-Prefix Sub Option

The Rule-IPv6-Prefix Sub Option is necessary for every S46-RULE sub option. There MUST be exactly one S46-IPv6-Prefix Sub Option encapsulated in each type of S46-Rule Sub Option.

The IPv6 Prefix sub option is followed the framed IPv6 prefix designed in [RFC3162].

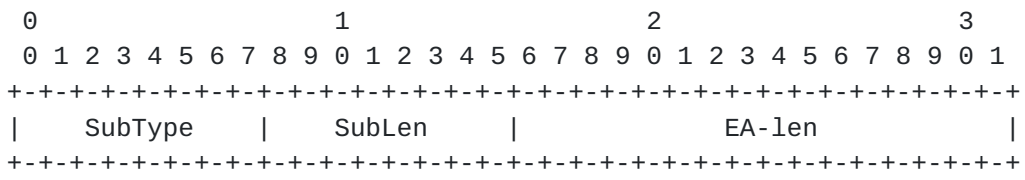
SubType
8 (SubType number, for the Rule-IPv6-Prefix Sub Option)
SubLen
20 (the length of the Rule-IPv6-Prefix Sub Option)
Reserved
Reserved for future usage. It should be set to all zero.
prefix6-len
the length of IPv6 prefix, specified in the rule-ipv6-prefix field, expressed in bits.
rule-ipv6-prefix
a 128-bits field that specifies an IPv6 prefix that appears in a MAP rule.

4.4.2. Rule-IPv4-Prefix Sub Option



SubType
9 (SubType number, for the Rule-IPv4-Prefix sub option)
SubLen
8 (the length of the Rule-IPv4-Prefix sub option)
Reserved
Reserved for future usage. It should be set to all zero
Prefix4-len
the length of IPv4 prefix, specified in the rule-ipv4-prefix field, expressed in bits.
rule-ipv4-prefix
a 32-bits field that specifies an IPv4 prefix that appears in a MAP rule.

4.4.3. EA Length Sub Option



SubType
10 (SubType number, for the EA Length Sub Option)
SubLen
4 (the length of the EA Length Sub Option)
EA-len
16 bits long field that specifies the Embedded-Address (EA) bit length. Allowed values range from 0 to 48.

4.5. Softwire46 Sub Options Encapsulation

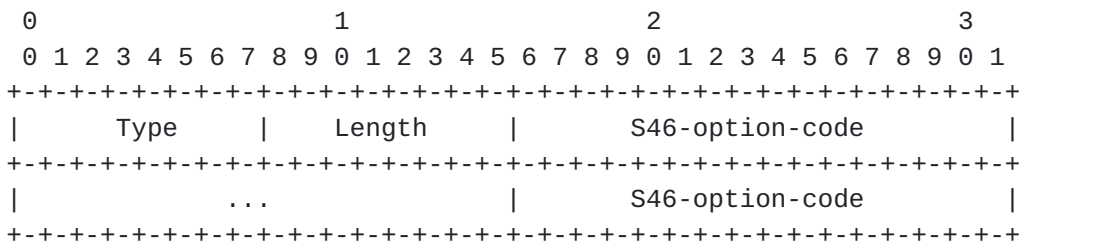
The table below shows which encapsulated Sub Options are mandatory, optional, or not permitted for each defined S46 Container Option.

Sub Option	MAP-E	MAP-T	Lightweight 4over6
S46-BR	M	N/P	M
S46-Rule	M	M	N/P
S46-DMR	N/P	M	N/P
S46-V4V6Bind	N/P	N/P	O
S46-PORTPARAMS	O	O	O

M - Mandatory, O - Optional, N/P - Not Permitted

4.6. Softwire46-Priority Attribute

The S46-Priority Attribute is structured as follows:



Type
TBD
Length
2 + the length of the S46-option-code(s) specified in octets
S46-option-code
16-bit IANA-registered option code of the DHCPv6 option that is used to identify the softwire mechanisms. S46 mechanisms are prioritized in the appearance order of the S46-option-code(s) in the Softwire46-Priority Attribute. A Softwire46-Priority Attribute MUST contain at least one S46-option-code. The option codes of the corresponding S46 mechanisms are listed in Section 6.1.

4.7. Table of attributes

The following table provides a guide to which attributes may be found in which kinds of packets, and in what quantity.

Request	Accept	Reject	Challenge	Accounting Request	#	Attribute
0-1	0-1	0	0	0-1	TBD1	Softwire46-Configuration
0-1	0-1	0	0	0-1	TBD2	Softwire46-Priority
0-1	0-1	0	0	0-1	1	User-Name
0-1	0	0	0	0	2	User-Password
0-1	0-1	0	0	0-1	6	Service-Type
0-1	0-1	0-1	0-1	0-1	80	Message-Authenticator

The following table defines the meaning of the above table entries.

0	This attribute MUST NOT be present in packet.
0+	Zero or more instances of this attribute MAY be present in packet.
0-1	Zero or one instance of this attribute MAY be present in packet.
1	Exactly one instance of this attribute MUST be present in packet.

5. Diameter Considerations

S46 Configuration using Diameter [RFC6733] is specified in [RFC7678].

6. IANA Considerations

This document requires the assignment of two new RADIUS Attribute Type in the "Radius Types" registry (currently located at http://www.iana.org/assignments/radius-types for the following attributes:

- Softwire46-Configuration Attribute TBD1
- Softwire46-Priority Attribute TBD2

IANA should allocate the numbers from the standard RADIUS Attributes space using the "IETF Review" policy [RFC5226].

6.1. S46 Mechanisms and Their Identifying Option Codes

The Softwire46-Priority Attribute defines a 16-bit S46-option-code field, for which IANA is to create and maintain a new registry entitled "Option Codes Permitted in the Softwire46-Priority Attribute". This document requires IANA to register four option codes of the Softwire46 mechanisms permitted to be included in the Softwire46-Priority Attribute. Additional options may be added to this list in the future using the IETF Review process described in Section 4.1 of [RFC5226].

The following table shows the option codes that are required and the S46 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 need to be determined. The option codes for MAP-E, MAP-T, and Lightweight 4over6 should also be used as the option Type values for the MAP-E, MAP-T, and Lightweight 4over6 Container Options defined in Section 4.2.

Option Code	S46 Mechanism	Reference
TBD1	MAP-E	RFC7597
TBD2	MAP-T	RFC7599
TBD3	Lightweight 4over6	RFC7596
144	DS-Lite	RFC6519

Table 1: Option Codes to S46 Mechanisms

7. Security Considerations

Known security vulnerabilities of the RADIUS protocol are discussed in [RFC2607], [RFC2865], and[RFC2869]. Use of IPsec [RFC4301] for providing security when RADIUS is carried in IPv6 is discussed in [RFC3162].

A malicious user may use MAC address spoofing on the shared password that has been preconfigured on the DHCPv6 server to get unauthorized configuration information.

Security considerations for MAP specific between the MAP CE and the BNG are discussed in [RFC7597]. Security considerations for Lightweight 4over6 are discussed in [RFC7596]. Security considerations for DHCPv6-Based S46 Prioritization Mechanism are discussed in [RFC8026]. Furthermore, generic DHCPv6 security mechanisms can be applied DHCPv6 intercommunication between the CE and the BNG.

Security considerations for the Diameter protocol are discussed in [RFC6733].

8. Acknowledgements

The authors would like to thank the valuable comments made by Peter Lothberg, Wojciech Dec, Ian Farrer and Suresh Krishnan for this document. This document was merged with draft-sun-softwire-lw4over6-radext-01, thanks to everyone who contributed to this draft.

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

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9.1. Normative References

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