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RADIUS IP Security Extensions

Status of this Memo

Abstract

The RADIUS Authentication/Authorization protocol defines a mechanism which is used by a Network Access Server (NAS) to authenticate dial-up users. IP Security defines a mechanism of establishing a secure link between two entities over a network.

This document defines a mechanism for RADIUS to inform the NAS of the security policies required for secure communication with a host.

Table of Contents

1.0 Introduction

RADIUS is widely used as a mechanism to send to the NAS connection information. This is particularly important for "login" or tunneled users, where the NAS initiates a connection to a specified host on behalf of the user [1][2]. However the only current security mechanism used to secure the connection is to rely on the source IP address (which is a very weak protection).

The IP Security (IPSEC) protocol suite is used by entities in order to communicate in a secure fashion over an untrusted network. In order for the NAS to be able to establish a secure link with a destination host or network it requires a set of security policies which defines the target as well as the different transforms which are to be used during the communication. These policies need to be pre-configured on the NAS prior to establishing the secure link.

Since particular users can connect to a variety of hosts over the internet, it becomes very difficult to statically configure these policies for every host which dial-up users may connect to. This document defines new RADIUS attributes which are used to "download" security policies for the host which the user may connect to.

1.1 Conventions

The following language conventions are used in the items of specification in this document:

- MUST, SHALL, or MANDATORY -- This item is an absolute requirement of the specification.

- SHOULD or RECOMMEND -- This item should generally be followed for all but exceptional circumstances.

- MAY or OPTIONAL -- This item is truly optional and may be followed or ignored according to the needs of the implementor.

2.0 Operation

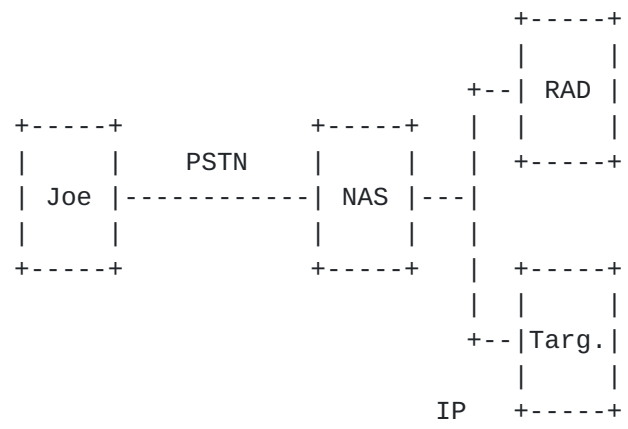
In this section we will examine two possible types of users. In the first example we will describe a login user, and the second will define how a tunneled user would use the extensions used in this document.

2.1 Login User

In this section we will look an at example of a login user. The user, named joe, dials into a NAS which authenticates the user with the assistance of a local RADIUS Server. The user's RADIUS profile is shown below:

```
joe     Password = password
        Service-Type = Login,
        Login-Service = Telnet,
        Login-IP-Host = 10.1.1.1,
        Login-Port = 23
```

As the user's profile depicts, once the user is authenticated the NAS will create a telnet session to target host 10.1.1.1 on behalf of the user. In this case the NAS is used as a terminal server and sends all of the user's asynchronous data to the target encapsulated within a telnet session.



As stated above IPSEC is a mechanism used by the NAS and the target to establish a secure telnet connection for the user. Traditionally the NAS must have security policies defined locally which state that all communication with the target host for the user must be secured, and more importantly how secure the communication must be.

2.2 Tunneled User

Document [3] defines a protocol which is used by a NAS to "tunnel" all

PPP data from the user to a destination host. This encapsulation is

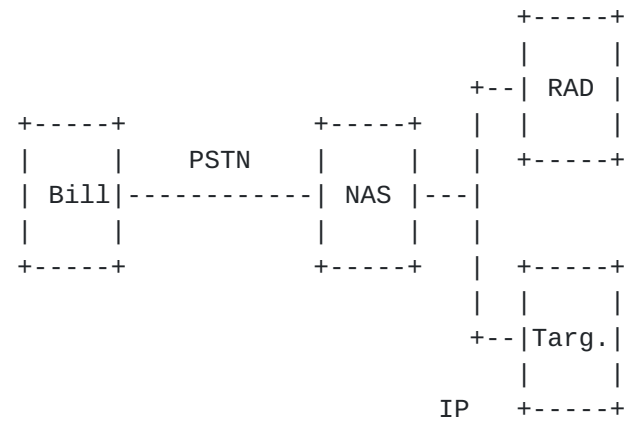
done in order to allow a user to connect to a destination network from the internet as well as to allow multi-protocol over an IP network.

Document [2] defines RADIUS attributes which may be sent from the RADIUS Server to the NAS which contain tunneling information, such as the target tunnel endpoint.

In this example we will examine a user named bill which dials into a NAS which authenticates the user using a local RADIUS Server. The RADIUS Server informs the NAS that tunneling must occur for the user as shown in the user's profile below.

```
bill    Password = password
        Service-Type = Framed,
        Framed-Protocol = PPP,
        Framed-IP-Netmask = 255.255.255.255,
        Framed-MTU = 1500,
        Framed-IP-Address = 2.3.4.5 ,
        Tunnel-Type = L2TP,
        Tunnel-Medium-Type = IP,
        Tunnel-Server-Endpoint = 10.1.1.2,
        Tunnel-Password = password
```

As the user's profile states, once the user is authenticated the NAS will create an L2TP tunnel with the target tunnel endpoint 10.1.1.2. Once the tunnel is established all PPP traffic will be encapsulated and forwarded to the target.



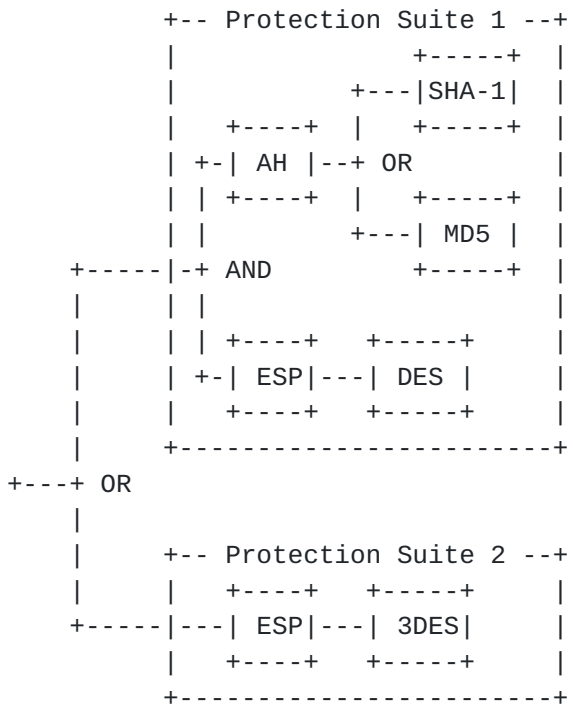
As stated above IPSEC is a mechanism used by the NAS and the target to establish a secure tunnel for the user. Traditionally the NAS must have security policies defined locally which state that all communication with the target host for the user must be secured, and more importantly how secure the communication must be.

3.0 Policy Building

This section will define how Policies are built, and most importantly why this is so complex.

ISAKMP has the ability for an initiator to offer multiple protection suites (a.k.a. proposals), with preferences associated to them. The idea is that the peer has the ability to choose from one of the proposals offerred. In addition it is possible for a proposal to contain more than one transform for a given protocol (analogous to a sub-proposal defined below) which the peer can use.

The following is an example of a complex, yet valid ISAKMP proposal:



In this scenario a requestor proposes two different protection suites, one which consists of both AH and ESP, however note that the AH proposal can use either SHA-1 OR MD5 (note that a preference would be assigned to them). In addition ESP must be used with DES.

The requestor also proposes a second protection suite which only consists of ESP using 3DES.

This type of complexity was not initially designed in the existing RADIUS protocol, since it is not necessary to correlate many attributes to form a single "proposal". However, document [2] does introduce this complexity with the use of the tag field. This document will make use of this mechanism, but also requires additional information within the RADIUS attribute to include preference

information.

The new header format as described in section 5.0 is necessary in order to be able to "build" policies as defined above. Such a policy could be represented as follow:

```
Tag = 1
    Protocol = AH / Preference = 1,
          Transform = SHA-1,
          Auth-Algorithm HMAC-SHA-1,
          SA-Life-Seconds = 28800,
          Encapsulation-Mode = Tunnel
    Protocol = AH / Preference = 2,
          Transform MD5,
          Auth-Algorithm HMAC-MD5,
          SA-Life-Kbs = 1024,
          Encapsulation-Mode = Tunnel
    Protocol = ESP / Preference = 1
          Transform DES,
          SA-Life-Seconds = 57600,
          Encapsulation-Mode = Tunnel

Tag = 2
    Protocol = ESP / Preference = 1
          Transform = 3DES,
          Auth-Algorithm DES-MAC,
          SA-Life-Seconds = 57600,
          SA-Life-Kbs = 2048,
          Encapsulation-Mode = Tunnel

Tag = 3
    Protocol = ESP / Preference = 1
          Transform = 3DES,
          Auth-Algorithm HMAC-SHA-1,
          SA-Life-Seconds = 57600,
          SA-Life-Kbs = 2048,
          Encapsulation-Mode = Transport
```

The above defined policy states that Tag #1 has two AH transforms, the preferred using SHA-1, the alternate using MD5. In addition ESP is to be used with DES as the transform. The second proposal is to only use ESP with 3DES as the transform. The third proposal is added for completeness and depicts a simple policy using only ESP with 3DES in transport mode.

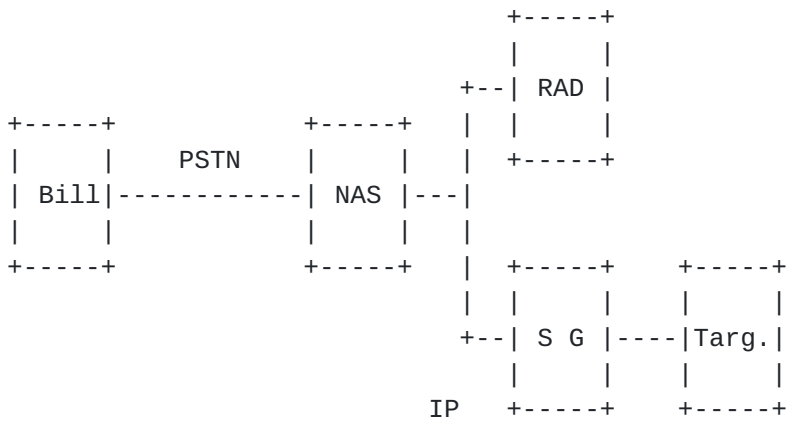
Note that since both the Protocol and the Preference fields are used to "classify" groups of attributes to form a single sub-proposal it is not possible to have more than one protocol type with the same preference number within a given tag.

4.0 Security Gateway Support

The IPSEC Architecture specification[11] defines the concept of a security gateway, which is an intermediate node which provides some security functions. This means that although security from the NAS to the target host may be required, it also means that security from the NAS to the intermediate node is also required.

This functionality further complicates this document since support for such devices must be included.

Consider the following diagram which depicts such a configuration:



In this scenario the NAS is informed that it must first establish an ESP tunnel to the Security Gateway (SG), and then use AH in transport mode to the target host shown above.

Due to this requirement, it must now be possible to associate the peer with a given policy (as shown in section 3.0). Although it is possible to create a new header format to support the above case it would be preferable to simply use the format defined in section 5.0.

Using the header format defined in section 5.0 it is now possible to define a security hierarchy as shown below:

```
Tag = 4
      Flag = First Host,
             SA-Destination = SG,
             Direction = Initiator,
             Remote-ID = foo,
             Policy = 1 / Preference = 1,
             Policy = 2 / Preference = 2,
             Next Hop = Target

Tag = 5
      Flag = NULL
             SA-Destination = Target,
             SA-Direction = Initiator,
```

```
                Remote-ID = bar,
```

Policy = 3 / Preference = 1

The above example describes that a secure link must be established with the Security Gateway using either Policy 1 or 2 (with preference given to #1). Once this is complete, a secure link must be established with the target host using policy 3. Note that the Policy number is essentially the tag number assigned to the policies described in section 3.0

Given the mechanism described above it is now possible to build complex hierarchies of security systems which must be penetrated in order to reach the target host. Note that the last hop will not necessarily be the target host since a Security Gateway may be protecting the network instead.

Since Phase 2 security association are unidirectional, it is neccesary to specify if the given policy is for the initiator or for the responder. In the example given above, the "policies" are what the NAS is to offer to the peer. When the SA-Direction is set to responder, it informs the NAS what policies it may accept from the peer.

5.0 Packet Format

Packet Format is identical to that defined in RFC 2058 and 2059.

6.0 Packet Types

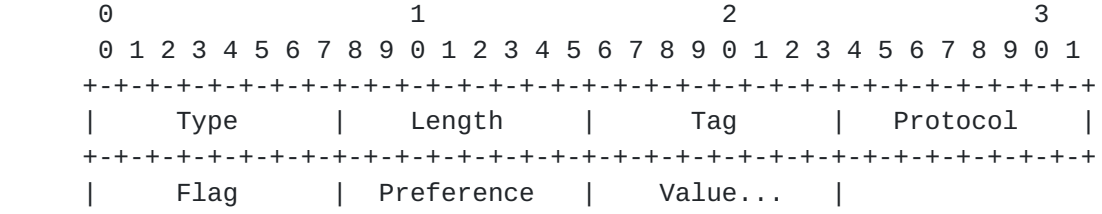
Packet types are identical to those defined in RFC 2058 and 2059.

See "Table of Attributes" below to determine which types of packets can contain which attributes defined here.

7.0 Attributes

This section will define the RADIUS Attributes which are used to send Security Policies or security hierarchies to the NAS for a given user connection.

The new attribute format is shown below:



Type

The Type field is one octet. Up-to-date values of the RADIUS Type field are specified in the most recent "Assigned Numbers" RFC [12]. Values 192-223 are reserved for experimental use, values 224-240 are reserved for implementation-specific use, and values 241-255 are reserved and should not be used. This specification concerns the following values:

1-39	(refer to [1])
40-51	(refer to [8])
52-59	Unused
60-63	(refer to [1])
64-68	(refer to [2])
69-79	(refer to [7])
80	Transform
81	Encryption-Algorithm
82	Hash-Algorithm
83	Authentication-Mechanism
84	SA-Life-Seconds
85	SA-Life-Kbs
86	DH-Group
87	Key-Length
88	Key-Round
89	Encapsulation-Mode
90	Initiator-Id
91	Responder-Id
92	SA-Destination
93	Policy
94	Next-Hop
95	SA-Direction

Length

The Length field is one octet, and indicates the length of this attribute including the Type, Length and Value fields. If an attribute is received in a packet with an invalid Length, the entire request should be silently discarded.

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy or security hierarchy.

Protocol

A Protocol identifier. The following values are supported:

1 - Authentication Header (AH)

3 - Internet Securit Association Key Management Protocol (ISAKMP)
4 - IP Compression (IPCOMP)

If the protocol identifier in the attributes is ISAKMP, the resulting policy is meant for a Phase 1 exchange. A Phase 1 exchange creates ISAKMP SAs which protect further negotiation traffic between the ISAKMP peers.

If the protocol identifier in the attribute is a protocol type other than ISAKMP, the resulting policy is meant for use in a Phase 2 exchange. A Phase 2 exchange happens under the protection of a pre-existing Phase 1 SA, and negotiates a SA for the protocol specified in the attribute.

Flag

The flag field contains information regarding the content of the attribute. Note that each individual attribute description indicate whether the flag bit may be used.

The following bits are defined:
0x1 - (S bit) First Host in a chain

Preference

The specific preference for the stated protocol.

Value

The Value field is zero or more octets and contains information specific to the attribute. The format and length of the Value field is determined by the Type and Length fields.

The format of the value field is one of four data types.

string 0-249 octets

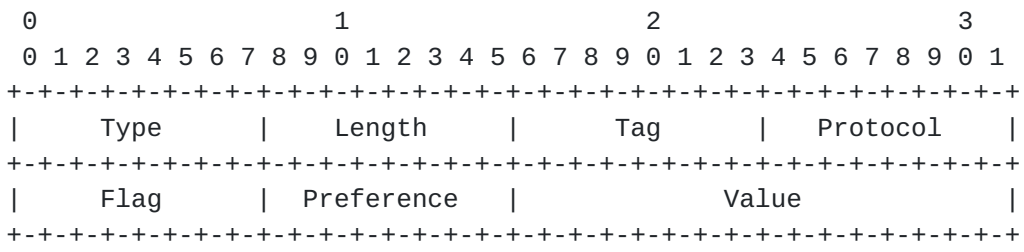
address 32 bit value, most significant octet first.

integer 32 bit value, most significant octet first.

time 32 bit value, most significant octet first -- seconds since 00:00:00 GMT, January 1, 1970. The standard Attributes do not use this data type.

7.1 Transform

This attributes states the desired transform for the protocol.



Type

80 for Transform

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current transform within the proposal. The policy with the lowest preference value is prefered.

Value

The value field contains the transform ID. Note that this field is used in conjunction with the protocol ID in order to identify the specific transform. The following values are supported:

- 0 - NULL (ESP Only)
- 1 - DES (ESP and AH)
- 2 - 3DES (ESP Only)
- 3 - DES_IV64 (ESP Only)
- 4 - RC5 (ESP Only)
- 5 - IDEA (ESP Only)
- 6 - CAST (ESP Only)

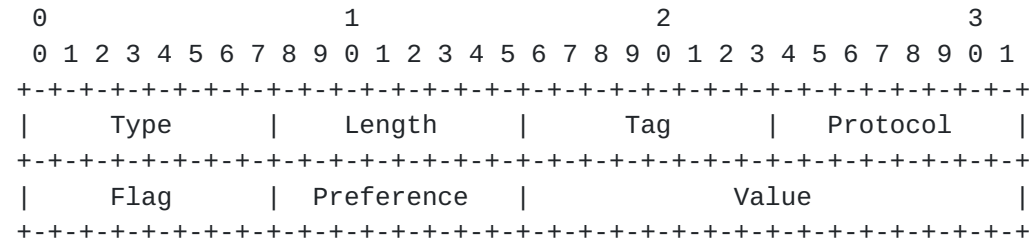
7 - Blowfish (ESP Only)

8 - 3IDEA (ESP Only)
9 - DES_IV32 (ESP Only)
10 - ARCFOUR (ESP Only)
11 - MD5 (AH Only)
12 - SHA-1 (AH Only)
13 - Oakley (ISAKMP Only)
14 - LZS (IPCOMP Only)
15 - V.42bis (IPCOMP Only)
16 - DEFLATE (IPCOMP Only)

It is considered invalid to specify a value which is not relevant to the stated protocol ID in the attribute header.

7.2 Encryption-Algorithm

This attribute states the desired encryption algorithm for ISAKMP phase 1 exchange.



Type

81 for Encryption-Algorithm

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field MUST be set to ISAKMP.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

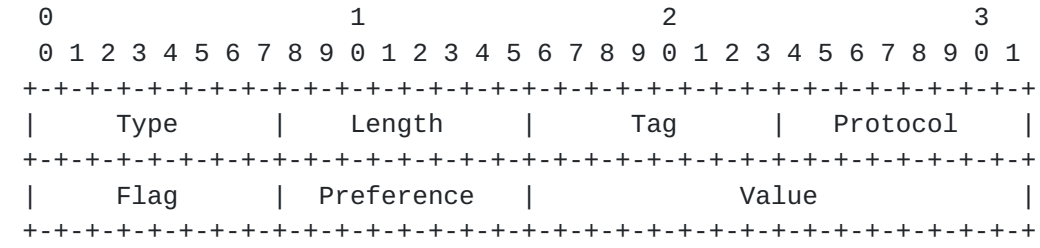
Value

The value field contains the transform ID. Note that this field is used in conjunction with the protocol ID in order to identify the specific transform. The following values are supported:

1 - DES-CBC
2 - IDEA-CBC
3 - Blowfish-CBC
4 - RC5-R16-B64-CBC
5 - 3DES-CBC
6 - CAST-CBC

7.3 Hash-Algorithm

This attribute states the desired hash algorithm for ISAKMP phase 1 exchange.



Type

82 for Hash-Algorithm

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field MUST be set to ISAKMP.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

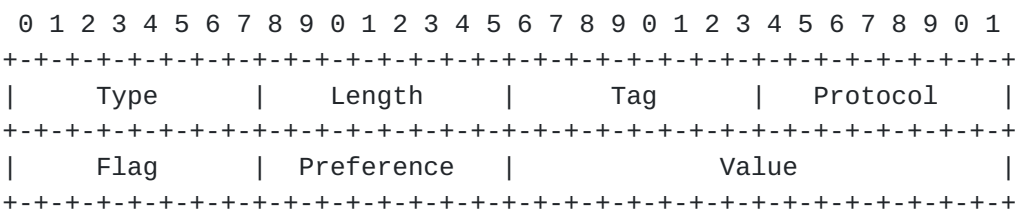
Value

The value field contains the transform ID. Note that this field is used in conjunction with the protocol ID in order to identify the specific transform. The following values are supported:

1 - MD5
2 - SHA
3 - Tiger

7.4 Authentication-Method

This attributes states the desired authentication algorithm for the IPSEC protocols.



Type

83 for Authentication-Method

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

Value

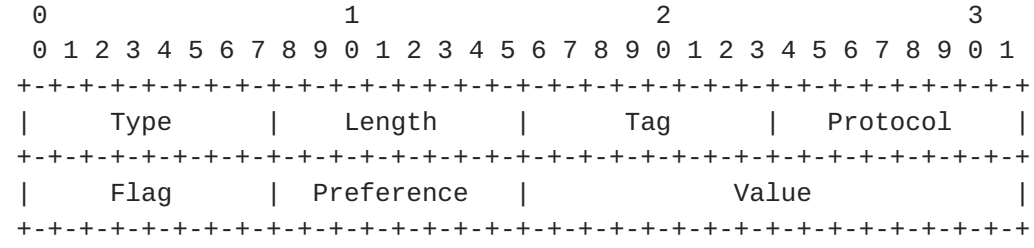
The value field contains the transform ID. Note that this field is used in conjunction with the protocol ID in order to identify the specific transform. The following values are supported:

1 - HMAC-MD5 (ESP and AH)
2 - HMAC-SHA-1 (ESP and AH)
3 - DES-MAC (ESP and AH)
4 - Pre-Shared key (ISAKMP Only)
5 - DSS-Signature (ISAKMP Only)
6 - RSA-Signature (ISAKMP Only)
7 - RSA-Encryption (ISAKMP Only)
8 - Revised-RSA-Encryption (ISAKMP Only)
9 - GSSAPI-Authentication (ISAKMP Only)
10 - KPDK (AH Only - MUST be used with MD5 as transform only)

It is considered invalid to specify a value which is not relevant to the stated protocol ID in the attribute header.

7.5 SA-Life-Seconds

This attributes states the lifetime for the generated Security Association for the IPSEC protocol requested. This attribute defines the lifetime in the number of seconds once the SA is established.



Type

84 for SA-Life-Seconds

Length

8

Tag

The Tag field is one octet in length and is intended to provide a

means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

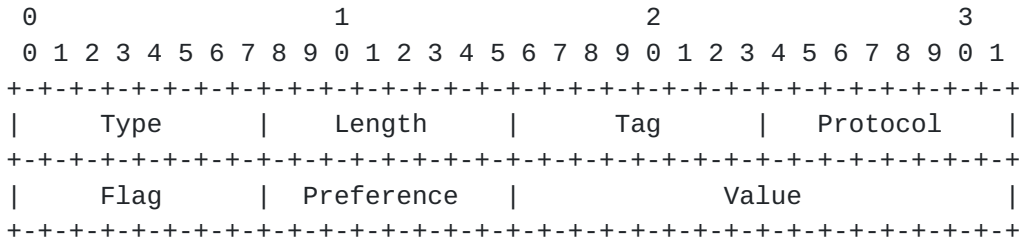
The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

Value

The value field contains the number of seconds before the Security Association must be renegotiated.

7.6 SA-Life-Kbs

This attributes states the lifetime for the generated Security Association for the IPSEC protocol requested. This attribute defines the lifetime in the number of kilobytes transmitted once the SA is established.



Type

85 for SA-Life-Kbs

Length

8

Tag

The Tag field is one octet in length and is intended to provide a

means of grouping attributes in the same packet which refer to the

same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

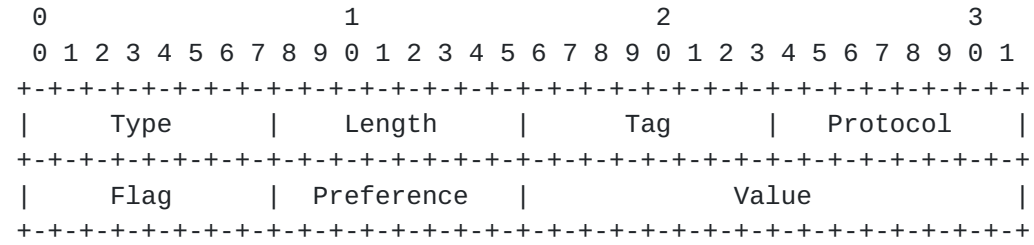
Value

The value field contains the number of kilobytes before the Security Association must be renegotiated.

7.7 DH-Group

This attribute is used to indicate the Diffie-Hellman group for the phase 2 exchange. If perfect forward secrecy is desired, this attribute must be included. It allows for the negotiation of a fresh DH key for phase 2. This new ephemeral DH key can then be used instead of the phase 1 DH key, to derive session keys for the negotiated transforms.

The attribute's format is as follows:



Type

86 for DH-Group

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously. This attribute is not valid for IPCOMP.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

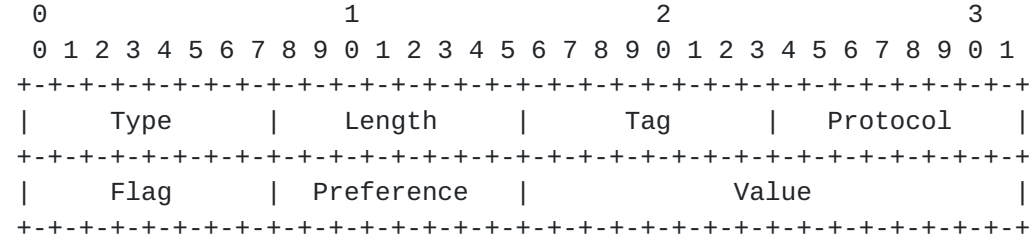
Value

The value field contains the Diffie-Hellman group and may have one of the following values:

1 - First-Oakley-Group (MODP 768 bit)
2 - Second-Oakley-Group (MODP 1024 bit)
3 - Third-Oakley-Group (EC2N on GP[2^155])
4 - Fourth-Oakley-Group (EC2N on GP[2^185])

7.8 Key-Length

For transforms that take variable length keys, this attribute can be used to indicate the key length desired. Its format is as follows:



Type

87 for Key-Length

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously. This attribute is not valid for IPCOMP.

Flag

The Flag field has no meaning with this attribute.

Preference

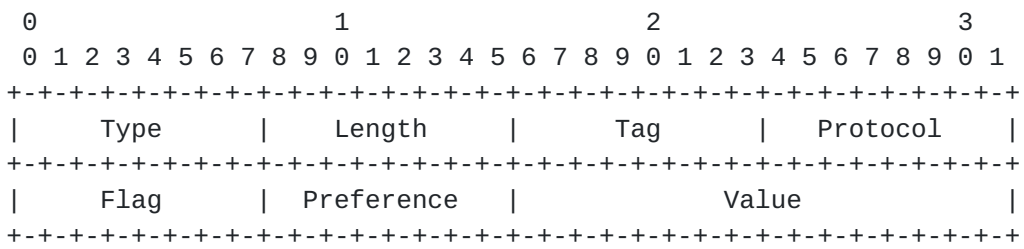
The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

Value

This field contains a non-zero length for the key.

7.9 Key-Round

For transforms that have varying number of rounds, this attribute can be used to indicate the desired number of rounds. Its format is as follows:



Type

88 for Key-Rounds

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously. This attribute is not valid for IPCOMP.

Flag

The Flag field has no meaning with this attribute.

Preference

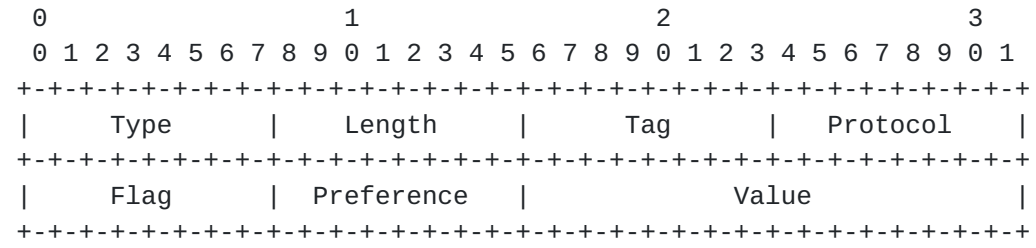
The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

Value

This field contains a non-zero key round value.

7.10 Encapsulation-Mode

This attribute indicates the encapsulation mode for the given protocol. The attribute's format is as follows:



Type

89 for Encapsulation-Mode

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the

same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

Value

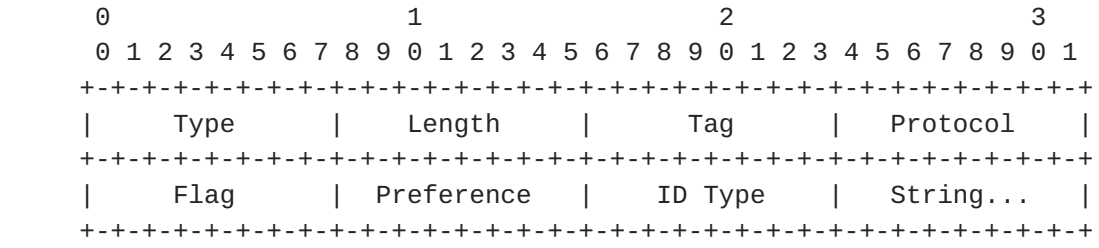
The value field may have one of the following values:
1 - Tunnel-Mode
2 - Transport-Mode

7.11 Initiator-Id

This attribute is used to indicate the identity of the ISAKMP exchange initiator.

If the protocol field is ISAKMP, the identity is meant for a Phase 1 exchange (IDii in [4]). If the NAS happens to be the initiator, it knows its local identity. In this case, the attribute SHOULD not be sent in the Access-Accept. However, if the attribute is sent in the Access-Accept, the NAS has an option of ignoring it. If the attribute is not present in the Access-Accept, the NAS MUST assume that it is to provide its own identity.

If the protocol field is anything but ISAKMP, the attribute provides the user identity on the initiator side for a Phase 2 exchange (IDui in [4]).



Type

90 for Initiator-Id

Length

>8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same policy. This value is also used as a policy identifier.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously. This attribute is not valid for ISAKMP.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

ID Type

The ID Type field is one octet in length and represents the format of the address. The following values are supported:

1 - IPV4-Address (4 octets)
2 - IPV6-Address (20 octets)
3 - FQ-Domain-Name (e.g. 3com.com)
4 - FQ-User-Name (e.g. lobo@3com.com)
5 - IPV4-Subnet (4 octets address followed by 4 octets subnet mask)
6 - IPV4-Range (4 octets start address followed by by a 4 octet end address)
7 - X.500-Distinguished-Name
8 - X.500-General-Name
9 - Vendor-Specific (pre-shared key identity)

String

The string field contains the local identifier.

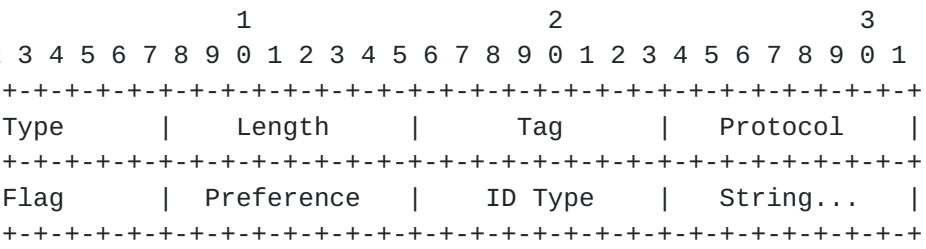
7.12 Responder-Id

This attribute is used to indicate the identity of the ISAKMP exchange

responder.

If the protocol field is ISAKMP, the identity is meant for a Phase 1 exchange (IDir in [4]). If the NAS happens to be the responder, it knows its local identity. In this case, the attribute SHOULD not be sent in the Access-Accept. However, if the attribute is sent in the Access-Accept, the NAS has an option of ignoring it. If the attribute is not present in the Access-Accept, the NAS MUST assume that it is to provide its own identity.

If the protocol field is anything but ISAKMP, the attribute provides the user identity on the responder side for a Phase 2 exchange (IDur in [4]).



Type

91 for Remote-Id

Length

>8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same Security Association Endpoint.

Protocol

The Protocol field identifies for which protocol this attribute is to be used with as defined previously.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field identifies the preference of the current policy. The policy with the lowest preference value is prefered.

ID Type

The ID Type field is one octet in length and represents the format of the address. The following values are supported:

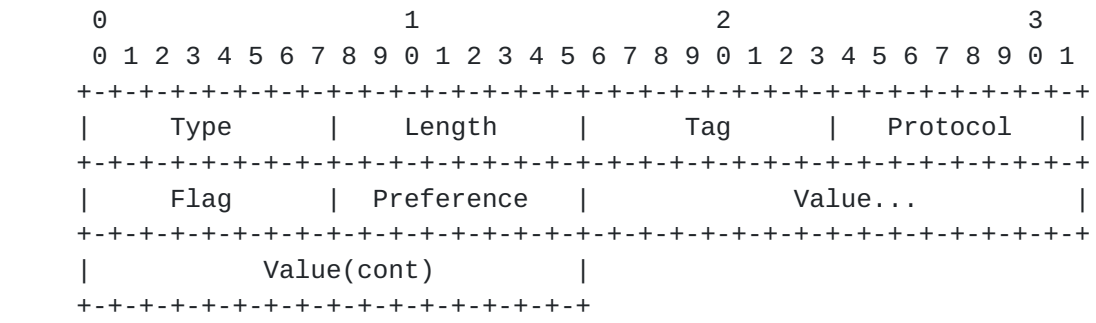
1 - IPV4-Address (4 octets)
2 - IPV6-Address (20 octets)
3 - FQ-Domain-Name (e.g. 3com.com)
4 - FQ-User-Name (e.g. lobo@3com.com)
5 - IPV4-Subnet (4 octets address followed by 4 octets subnet mask)
6 - IPV4-Range (4 octets start address followed by by a 4 octet end address)
7 - X.500-Distinguished-Name
8 - X.500-General-Name
9 - Vendor-Specific (pre-shared key identity)

Value

The value field contains the remote identifier.

7.13 SA-Destination

This attributes defines the destination address with which the Security Association will be established.



Type

92 for SA-Destination

Length

10

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same Security Association Endpoint.

Protocol

The Protocol field has no meaning for this attribute.

Flag

The Flag field field is used in order to identify the first host in a chain of Security Associations. The S bit is enabled if this host is the first security hop to the target. Note that this bit MUST be enabled even if the first hop is also the last hop.

Preference

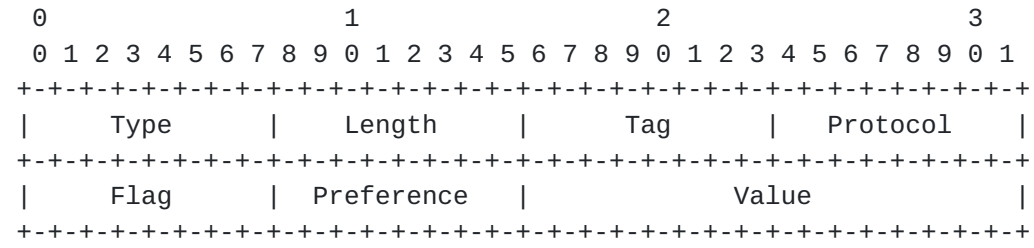
The Preference field has no meaning for this attribute.

Value

The value field contains the address of the IPSEC destination, which may be the target host or an intervening Security Gateway.

7.14 Policy

This attribute is used to reference a specific policy for the user. When more than a single instance of this attribute is present within a given tag, the preference field is used in order to identify the prefered policy.



Type

93 for Policy

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same Security Association Endpoint.

Protocol

The Protocol field has no meaning for this attribute.

Flag

The Flag field has no meaning with this attribute.

Preference

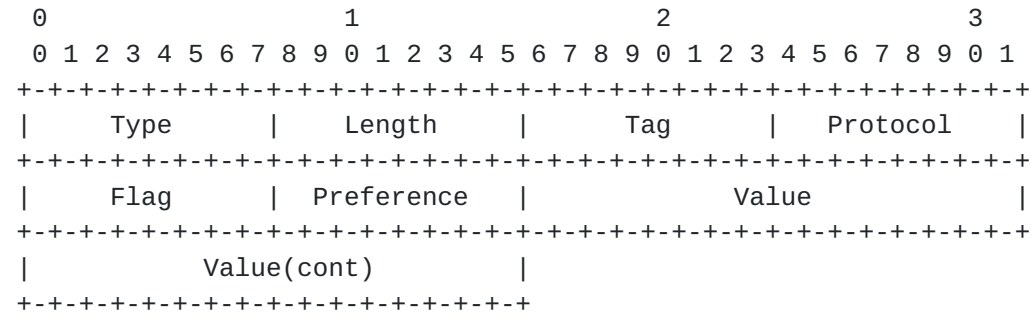
The Preference field identifies the preference of the stated policy. The policy with the lowest preference value is prefered.

Value

The Value field contains the policy identifier as described above. When used with the Preference field it is used in order to associate preferred policies to use for a given SA-Destination.

7.15 Next-Hop

This attribute is used in order to identify the next hop in a chain of security associations. This attribute is used when it is necessary to establish a secure link with a security gateway in order to reach a host using IPSEC or in the case of multiple security gateways.



Type

94 for Next-Hop

Length

10

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the same Security Association Endpoint.

The Protocol field has no meaning for this attribute.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field has no meaning with this attribute.

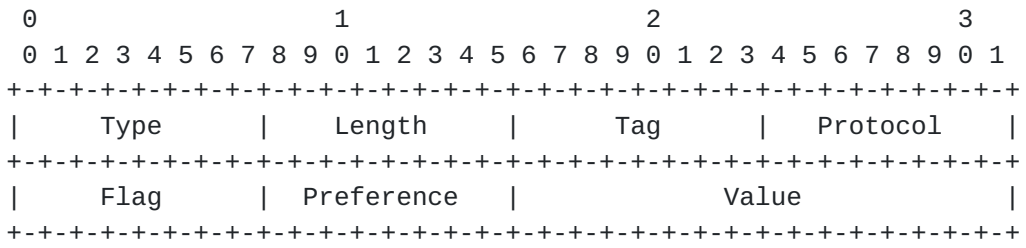
Value

The value field contains the address of the next hop.

7.16 SA-Direction

A Phase 2 SA is unidirectional. This means that a pair of SAs are required to secure a session. If the NAS is initiating the Phase 2 SA exchange, it needs a set of protection suites that it can propose to its peer.

On the other hand, if the NAS is responding to a Phase 2 SA exchange, it receives a set of protection suites from its peer. In this case, it needs a set of local protection suites to compare the proposed suites against. Hence it becomes necessary to provide the NAS with two sets of protection suites; one for use when it is the initiator, and the other when it is the responder.



Type

95 for SA-Direction

Length

8

Tag

The Tag field is one octet in length and is intended to provide a means of grouping attributes in the same packet which refer to the

same Security Association Endpoint.

Protocol

The Protocol field has no meaning for this attribute.

Flag

The Flag field has no meaning with this attribute.

Preference

The Preference field has no meaning with this attribute.

Value

The value field contains the direction of the Security Association. The following values are supported:

1 - Initiator
2 - Reponder

7.17 Table of Attributes

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

Request	Accept	Reject	Challenge	Acct-Request	#	Attribute
0	0+	0	0	0+	80	Transform
0	0+	0	0	0+	81	Encryption-Algorithm
0	0+	0	0	0+	82	Hash-Algorithm
0	0+	0	0	0+	83	Authentication-Mechanism
0	0+	0	0	0+	84	SA-Life-Seconds
0	0+	0	0	0+	85	SA-Life-Kbs
0	0+	0	0	0+	86	DH-Group
0	0+	0	0	0+	87	Key-Length
0	0+	0	0	0+	88	Key-Round
0	0+	0	0	0+	89	Encapsulation-Mode
0	0+	0	0	0+	90	Initiator-Id
0	0+	0	0	0+	91	Responder-Id
0	0+	0	0	0+	92	SA-Destination
0	0+	0	0	0+	93	Policy
0	0+	0	0	0+	94	Next-Hop
0	0+	0	0	0+	95	SA-Direction

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.

8.0 Chair's Address

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