

RADIUS Attributes for IEEE 802.16  
Privacy Key Management Version 1 (PKMv1) Protocol Support

## Abstract

This document defines a set of Remote Authentication Dial-In User Service (RADIUS) Attributes that are designed to provide RADIUS support for IEEE 802.16 Privacy Key Management Version 1.

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## 1. Introduction

Privacy Key Management Version 1 (PKMv1) [[IEEE.802.16-2004](#)] is a public-key-based authentication and key establishment protocol typically used in fixed wireless broadband network deployments. The protocol utilizes X.509 v3 certificates [[RFC2459](#)], RSA encryption [[RFC2437](#)], and a variety of secret key cryptographic methods to allow an 802.16 Base Station (BS) to authenticate a Subscriber Station (SS) and perform key establishment and maintenance between an SS and BS.

This document defines a set of RADIUS Attributes that are designed to provide support for PKMv1. The target audience for this document consists of those developers implementing RADIUS support for PKMv1; therefore, familiarity with both RADIUS [[RFC2865](#)] and the IEEE 802.16-2004 standard is assumed.

Please note that this document relies on IEEE.802.16-2004, which references [RFC 2437](#) and [RFC 2459](#), rather than any more recent RFCs on RSA and X.509 certificates (e.g., [RFC 3447](#) and [RFC 5280](#)).

## 2. Acronyms

CA

Certification Authority; a trusted party issuing and signing X.509 certificates.

For further information on the following terms, please see Section 7 of [[IEEE.802.16-2004](#)].

SA

Security Association

SAID

Security Association Identifier

TEK

Traffic Encryption Key

## 3. Attributes

The following subsections describe the Attributes defined by this document. This specification concerns the following values:

137 PKM-SS-Cert

138 PKM-CA-Cert

139 PKM-Config-Settings

140 PKM-Cryptosuite-List

141 PKM-SAID

142 PKM-SA-Descriptor

143 PKM-Auth-Key

### 3.1. PKM-SS-Cert

#### Description

The PKM-SS-Cert Attribute is variable length and MAY be transmitted in the Access-Request message. The Value field is of type string and contains the X.509 certificate [RFC2459] binding a public key to the identifier of the Subscriber Station.

The minimum size of an SS certificate exceeds the maximum size of a RADIUS attribute. Therefore, the client MUST encapsulate the certificate in the Value fields of two or more instances of the PKM-SS-Cert Attribute, each (except possibly the last) having a length of 255 octets. These multiple PKM-SS-Cert Attributes MUST appear consecutively and in order within the packet. Upon receipt, the RADIUS server MUST recover the original certificate by concatenating the Value fields of the received PKM-SS-Cert Attributes in order.

A summary of the PKM-SS-Cert Attribute format is shown below. The fields are transmitted from left to right.

```

                                1                2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|   Type   |         Len         |   Value...   |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

#### Type

137 for PKM-SS-Cert

#### Len

> 2

#### Value

The Value field is variable length and contains a (possibly complete) portion of an X.509 certificate.

### 3.2. PKM-CA-Cert

## Description

The PKM-CA-Cert Attribute is variable length and MAY be transmitted in the Access-Request message. The Value field is of type string and contains the X.509 certificate [RFC2459] used by the CA to sign the SS certificate carried in the PKM-SS-Cert attribute (Section 3.1) in the same message.

The minimum size of a CA certificate exceeds the maximum size of a RADIUS attribute. Therefore, the client MUST encapsulate the certificate in the Value fields of two or more instances of the PKM-CA-Cert Attribute, each (except possibly the last) having a length of 255 octets. These multiple PKM-CA-Cert Attributes MUST appear consecutively and in order within the packet. Upon receipt, the RADIUS server MUST recover the original certificate by concatenating the Value fields of the received PKM-CA-Cert Attributes in order.

A summary of the PKM-CA-Cert Attribute format is shown below. The fields are transmitted from left to right.

```

                                1                                2
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+
|      Type      |      Len      |      Value...
+-+--+--+--+--+--+--+--+--+--+--+--+--+--+--+--+

```

## Type

138 for PKM-CA-Cert

Len

$$> 2$$

## Value

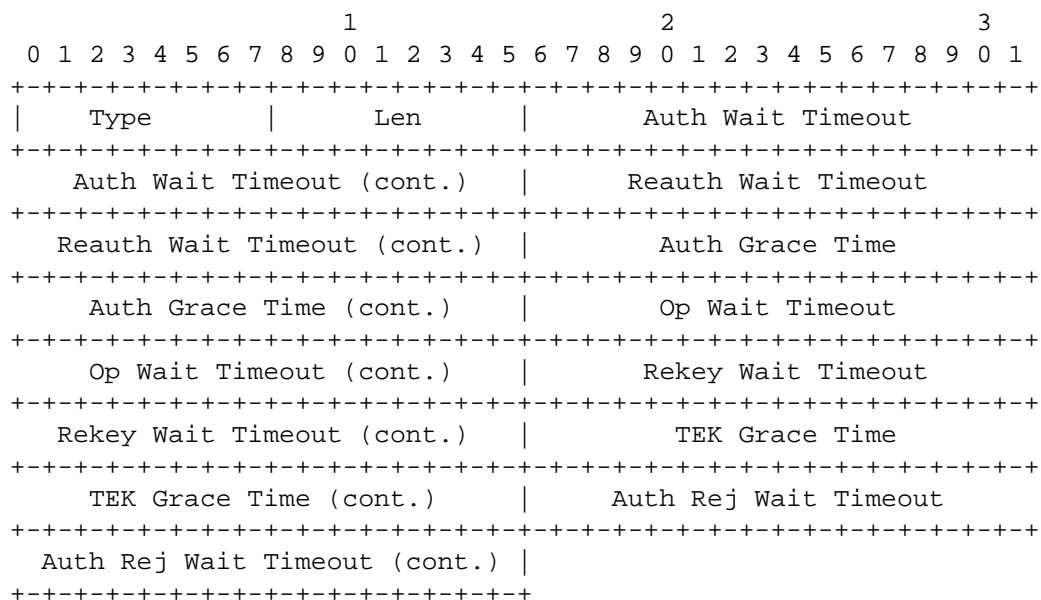
The Value field is variable length and contains a (possibly complete) portion of an X.509 certificate.

### 3.3. PKM-Config-Settings

#### Description

The PKM-Config-Settings Attribute is of type string [RFC2865]. It is 30 octets in length and consists of seven independent fields, each of which is conceptually an unsigned integer. Each of the fields contains a timeout value and corresponds to a Type-Length-Value (TLV) tuple encapsulated in the IEEE 802.16 "PKM configuration settings" attribute; for details on the contents of each field, see Section 11.9.19 of [IEEE.802.16-2004]. One instance of the PKM-Config-Settings Attribute MAY be included in the Access-Accept message.

A summary of the PKM-Config-Settings Attribute format is shown below. The fields are transmitted from left to right.



#### Type

139 for PKM-Config-Settings

#### Len

30

#### Auth Wait Timeout

The Auth Wait Timeout field is 4 octets in length and corresponds to the "Authorize wait timeout" field of the 802.16 "PKM configuration settings" attribute.

#### Reauth Wait Timeout

The Reauth Wait Timeout field is 4 octets in length and corresponds to the "Reauthorize wait timeout" field of the 802.16 "PKM configuration settings" attribute.

#### Auth Grace Time

The Auth Grace Time field is 4 octets in length and corresponds to the "Authorize grace time" field of the 802.16 "PKM configuration settings" attribute.

#### Op Wait Timeout

The Op Wait Timeout field is 4 octets in length and corresponds to the "Operational wait timeout" field of the 802.16 "PKM configuration settings" attribute.

#### Rekey Wait Timeout

The Rekey Wait Timeout field is 4 octets in length and corresponds to the "Rekey wait timeout" field of the 802.16 "PKM configuration settings" attribute.

#### TEK Grace Time

The TEK Grace Time field is 4 octets in length and corresponds to the "TEK grace time" field of the 802.16 "PKM configuration settings" attribute.

#### Auth Rej Wait Timeout

The Auth Rej Wait Timeout field is 4 octets in length and corresponds to the "Authorize reject wait timeout" field of the 802.16 "PKM configuration settings" attribute.

### 3.4. PKM-Cryptosuite-List

#### Description

The PKM-Cryptosuite-List Attribute is of type string [RFC2865] and is variable length; it corresponds roughly to the "Cryptographic-Suite-List" 802.16 attribute (see Section 11.19.15 of [IEEE.802.16-2004]), the difference being that the RADIUS Attribute contains only the list of 3-octet cryptographic suite identifiers, omitting the IEEE Type and Length fields.

The PKM-Cryptosuite-List Attribute MAY be present in an Access-Request message. Any message in which the PKM-Cryptosuite-List Attribute is present MUST also contain an instance of the Message-Authenticator Attribute [RFC3579].

#### Implementation Note

The PKM-Cryptosuite-List Attribute is used as a building block to create the 802.16 "Security-Capabilities" attribute ([IEEE.802.16-2004], Section 11.9.13); since this document only pertains to PKM version 1, the "Version" sub-attribute in that structure MUST be set to 0x01 when the RADIUS client constructs it.

A summary of the PKM-Cryptosuite-List Attribute format is shown below. The fields are transmitted from left to right.

```

      1               2               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|      Type      |      Len      |      Value...      |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

#### Type

140 for PKM-Cryptosuite-List

#### Len

$2 + 3n < 39$ , where 'n' is the number of cryptosuite identifiers in the list.



## Value

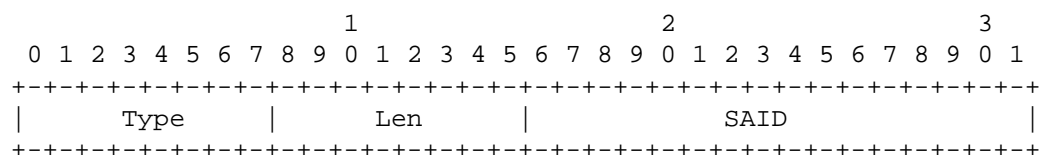
The Value field is variable length and contains a sequence of one or more cryptosuite identifiers, each of which is 3 octets in length and corresponds to the Value field of an IEEE 802.16 Cryptographic-Suite attribute.

## 3.5. PKM-SAID

## Description

The PKM-SAID Attribute is of type string [RFC2865]. It is 4 octets in length and contains a PKM Security Association Identifier ([IEEE.802.16-2004], Section 11.9.7). It MAY be included in an Access-Request message.

A summary of the PKM-SAID Attribute format is shown below. The fields are transmitted from left to right.



## Type

141 for PKM-SAID

## Len

4

## SAID

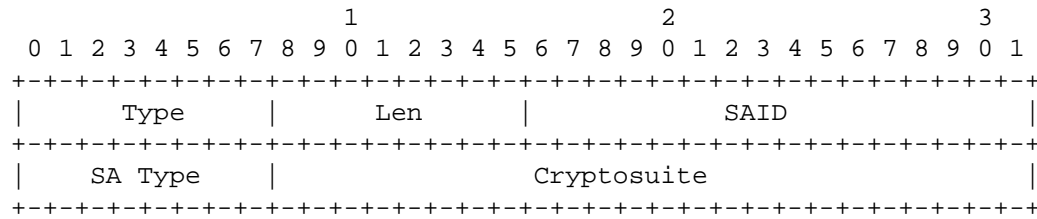
The SAID field is two octets in length and corresponds to the Value field of the 802.16 PKM SAID attribute

## 3.6. PKM-SA-Descriptor

## Description

The PKM-SA-Descriptor Attribute is of type string and is 8 octets in length. It contains three fields, described below, which together specify the characteristics of a PKM security association. One or more instances of the PKM-SA-Descriptor Attribute MAY occur in an Access-Accept message.

A summary of the PKM-SA-Descriptor Attribute format is shown below. The fields are transmitted from left to right.



Type

142 for PKM-SA-Descriptor

Len

8

SAID

The SAID field is two octets in length and contains a PKM SAID ([Section 3.5](#)).

SA Type

The SA Type field is one octet in length. The contents correspond to those of the Value field of an IEEE 802.16 SA-Type attribute.

Cryptosuite

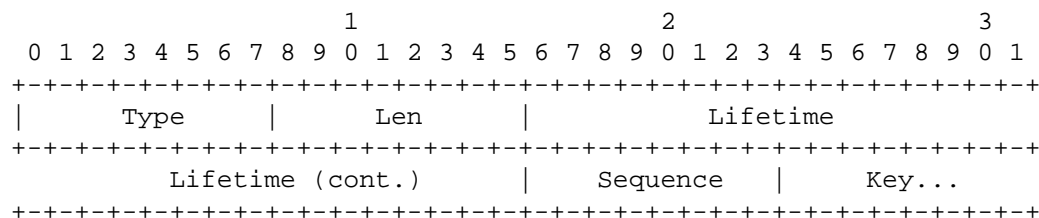
The Cryptosuite field is 3 octets in length. The contents correspond to those of the Value field of an IEEE 802.16 Cryptographic-Suite attribute.

### 3.7. PKM-AUTH-Key

Description

The PKM-AUTH-Key Attribute is of type string, 135 octets in length. It consists of 3 fields, described below, which together specify the characteristics of a PKM authorization key. The PKM-AUTH-Key Attribute MAY occur in an Access-Accept message. Any packet that contains an instance of the PKM-AUTH-Key Attribute MUST also contain an instance of the Message-Authenticator Attribute [[RFC3579](#)].

A summary of the PKM-AUTH-Key Attribute format is shown below. The fields are transmitted from left to right.



#### Type

143 for PKM-AUTH-Key

#### Len

135

#### Lifetime

The Lifetime field is 4 octets in length and represents the lifetime, in seconds, of the authorization key. For more information, see Section 11.9.4 of [IEEE.802.16-2004].

#### Sequence

The Sequence field is one octet in length. The contents correspond to those of the Value field of an IEEE 802.16 Key-Sequence-Number attribute (see [IEEE.802.16-2004], Section 11.9.5).

#### Key

The Key field is 128 octets in length. The contents correspond to those of the Value field of an IEEE 802.16 AUTH-Key attribute. The Key field MUST be encrypted under the public key from the Subscriber Station certificate (Section 3.1) using RSA encryption [RFC2437]; see Section 7.5 of [IEEE.802.16-2004] for further details.

#### Implementation Note

It is necessary that a plaintext copy of this field be returned in the Access-Accept message; appropriate precautions MUST be taken to ensure the confidentiality of the key.

### 3.7.1. AUTH-Key Protection

The PKM-AUTH-Key Attribute ([Section 3.7](#)) contains the AUTH-Key encrypted with the SS's public key. The BS also needs the AK, so a second copy of the AK needs to be returned in the Access-Accept message.

It is RECOMMENDED that the AK is encapsulated in an instance of the MS-MPPE-Send-Key Attribute [[RFC2548](#)]. However, see [Section 4.3.4 of RFC 3579](#) [[RFC3579](#)] for details regarding weaknesses in the encryption scheme used.

If better means for protecting the Auth-Key are available (such as RADIUS key attributes with better security properties, or means of protecting the whole Access-Accept message), they SHOULD be used instead of (or in addition to) the MS-MPPE-Send-Key Attribute.

## 4. 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	Acct-Req	#	Attribute
0+	0	0	0	0	137	PKM-SS-Cert [ <a href="#">Note 1</a> ]
0+	0	0	0	0	138	PKM-CA-Cert [ <a href="#">Note 2</a> ]
0	0-1	0	0	0	139	PKM-Config-Settings
0-1	0	0	0	0	140	PKM-Cryptosuite-List
0-1	0	0	0	0	141	PKM-SAID
0	0+	0	0	0	142	PKM-SA-Descriptor
0	0-1	0	0	0	143	PKM-Auth-Key
0	0-1	0	0	0		MS-MPPE-Send-Key [ <a href="#">Note 3</a> ]

[[Note 1](#)]

No more than one Subscriber Station Certificate may be transferred in an Access-Request packet.

[[Note 2](#)]

No more than one CA Certificate may be transferred in an Access-Request packet.

[[Note 3](#)]

MS-MPPE-Send-Key is one possible attribute that can be used to convey the AK to the BS; other attributes can be used instead (see [Section 3.7.1](#)).

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

Since the Attributes defined in this document are allocated from the standard RADIUS type space (see [Section 7](#)), no special handling is required by Diameter nodes.

## 6. Security Considerations

[Section 4 of RFC 3579](#) [[RFC3579](#)] discusses vulnerabilities of the RADIUS protocol.

[Section 3](#) of the paper "Security Enhancements for Privacy and Key Management Protocol in IEEE 802.16e-2005" [[SecEn](#)] discusses the operation and vulnerabilities of the PKMv1 protocol.

If the Access-Request message is not subject to strong integrity protection, an attacker may be able to modify the contents of the PKM-Cryptosuite-List Attribute, weakening 802.16 security or disabling data encryption altogether.

If the Access-Accept message is not subject to strong integrity protection, an attacker may be able to modify the contents of the PKM-Auth-Key Attribute. For example, the Key field could be replaced with a key known to the attacker.

See [Section 3.7.1](#) for security considerations of sending the authorization key to the BS.

## 7. IANA Considerations

IANA has assigned numbers for the following Attributes:

- 137 PKM-SS-Cert
- 138 PKM-CA-Cert
- 139 PKM-Config-Settings
- 140 PKM-Cryptosuite-List
- 141 PKM-SAID

142 PKM-SA-Descriptor

143 PKM-Auth-Key

The Attribute numbers are to be allocated from the standard RADIUS Attribute type space according to the "IETF Review" policy [[RFC5226](#)].

## 8. Contributors

Pasi Eronen provided most of the text in [Section 3.7.1](#).

## 9. Acknowledgements

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## 10. References

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[IEEE.802.16-2004]

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[RFC3579] Aboba, B. and P. Calhoun, "RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP)", [RFC 3579](#), September 2003.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", [BCP 26](#), [RFC 5226](#), May 2008.

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