Network Working Group
INTERNET-DRAFT
Obsoletes: 3576
Category: Informational
<draft-chiba-radext-rfc3576bis-01.txt>
3 January 2007

Murtaza S. Chiba
Gopal Dommety
Mark Eklund
Cisco Systems, Inc.
David Mitton
RSA Security, Inc.
Bernard Aboba
Microsoft Corporation

Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)

Copyright Notice

Abstract

This document describes a currently deployed extension to the Remote Authentication Dial In User Service (RADIUS) protocol, allowing dynamic changes to a user session, as implemented by network access server products. This includes support for disconnecting users and changing authorizations applicable to a user session.

Table of Contents

1. Introduction

The RADIUS protocol, defined in [RFC2865], does not support unsolicited messages sent from the RADIUS server to the Network Access Server (NAS).

However, there are many instances in which it is desirable for changes to be made to session characteristics, without requiring the NAS to initiate the exchange. For example, it may be desirable for administrators to be able to terminate a user session in progress. Alternatively, if the user changes authorization level, this may require that authorization attributes be added/deleted from a user session.

To overcome these limitations, several vendors have implemented additional RADIUS commands in order to be able to support unsolicited messages sent from the RADIUS server to the NAS. These extended commands provide support for Disconnect and Change-of-Authorization (CoA) messages. Disconnect messages cause a user session to be terminated immediately, whereas CoA messages modify session authorization attributes such as data filters.

1.1. Applicability

This protocol is being recommended for publication as an Informational RFC rather than as a standards-track RFC because of problems that cannot be fixed without creating incompatibilities with deployed implementations. This includes security vulnerabilities, as well as semantic ambiguities resulting from the design of the Change-of-Authorization (CoA) commands. While fixes are recommended, they cannot be made mandatory since this would be incompatible with existing implementations.

Existing implementations of this protocol do not support authorization checks, so that an ISP sharing a NAS with another ISP could disconnect or change authorizations for another ISP's users. In order to remedy this problem, a "Reverse Path Forwarding" check is recommended. See Section 6.1. for details.

Existing implementations utilize per-packet authentication and integrity protection algorithms with known weaknesses [MD5Attack]. To provide stronger per-packet authentication and integrity protection, the use of IPsec is recommended. See Section 6.3 for details.

Existing implementations lack replay protection. In order to support replay detection, it is recommended that a Nonce or Event-Timestamp Attribute be added to all messages in situations where IPsec replay

protection is not employed. See Section 6.4 for details.

The approach taken with CoA commands in existing implementations results in a semantic ambiguity. Existing implementations of the CoA-Request identify the affected session, as well as supply the authorization changes. Since RADIUS Attributes included within existing implementations of the CoA-Request can be used for session identification or authorization change, it may not be clear which function a given attribute is serving.

The problem does not exist within the Diameter protocol [RFC3588], in which server-initiated authorization change is initiated using a Re-Auth-Request (RAR) command identifying the session via User-Name and Session-Id AVPs and containing a Re-Auth-Request-Type AVP with value "AUTHORIZE_ONLY". This results in initiation of a standard Request/Response sequence where authorization changes are supplied. As a result, in no command can Diameter AVPs have multiple potential meanings.

1.2. Requirements Language

In this document, the key words "MAY", "MUST, "MUST NOT", "OPTIONAL", "REQUIRED", "RECOMMENDED", "SHOULD", and "SHOULD NOT", are to be interpreted as described in [RFC2119].

1.3. Terminology

This document frequently uses the following terms:

Network Access Server (NAS)
: The device providing access to the network.

service
: The NAS provides a service to the user, such as IEEE 802 or PPP.

session
: Each service provided by the NAS to a user constitutes a session, with the beginning of the session defined as the point where service is first provided and the end of the session defined as the point where service is ended. A user may have multiple sessions in parallel or series if the NAS supports that.

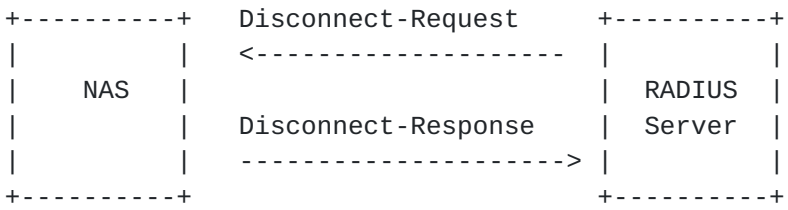
silently discard
: This means the implementation discards the packet without further processing. The implementation SHOULD provide the capability of logging the error, including the contents of the silently discarded packet, and SHOULD record the event in a statistics counter.

2. Overview

This section describes the most commonly implemented features of Disconnect and Change-of-Authorization messages.

2.1. Disconnect Messages (DM)

A Disconnect-Request packet is sent by the RADIUS server in order to terminate a user session on a NAS and discard all associated session context. The Disconnect-Request packet is sent to UDP port 3799, and identifies the NAS as well as the user session to be terminated by inclusion of the identification attributes described in Section 3.



The NAS responds to a Disconnect-Request packet sent by a RADIUS server with a Disconnect-ACK if all associated session context is discarded and the user session is no longer connected, or a Disconnect-NAK, if the NAS was unable to disconnect the session and discard all associated session context. A NAS MUST respond to a Disconnect-Request including a Service-Type Attribute with an unsupported value with a Disconnect-NAK; an Error-Cause Attribute with value "Unsupported Service" MAY be included. A Disconnect-ACK MAY contain the Attribute Acct-Terminate-Cause (49) [RFC2866] with the value set to 6 for Admin-Reset.

A NAS supporting the "Authorize Only" Service-Type within a Disconnect-Request responds with a Disconnect-NAK containing a Service-Type Attribute with value "Authorize Only" and an Error-Cause Attribute with value "Request Initiated". The NAS will then send an Access-Request containing a Service-Type Attribute with a value of "Authorize Only", along with a State Attribute. The RADIUS server MUST reply to this Access-Request with an Access-Reject.

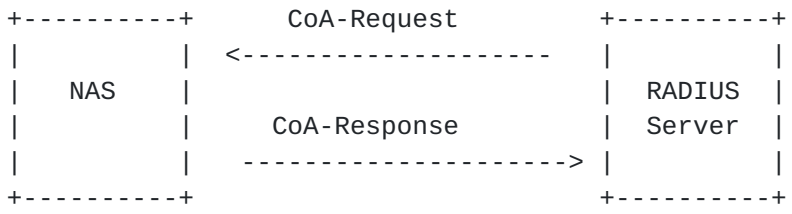
2.2. Change-of-Authorization Messages (CoA)

CoA-Request packets contain information for dynamically changing session authorizations. Typically this is used to change data filters. The data filters can be of either the ingress or egress kind, and are sent in addition to the identification attributes as described in section 3. The port used, and packet format (described in Section 2.3), are the same as that for Disconnect-Request Messages.

The following attributes MAY be sent in a CoA-Request:

Filter-ID (11) - Indicates the name of a data filter list to be applied for the session that the identification attributes map to.

NAS-Filter-Rule (TBD) - Provides a filter list to be applied for the session that the identification attributes map to.



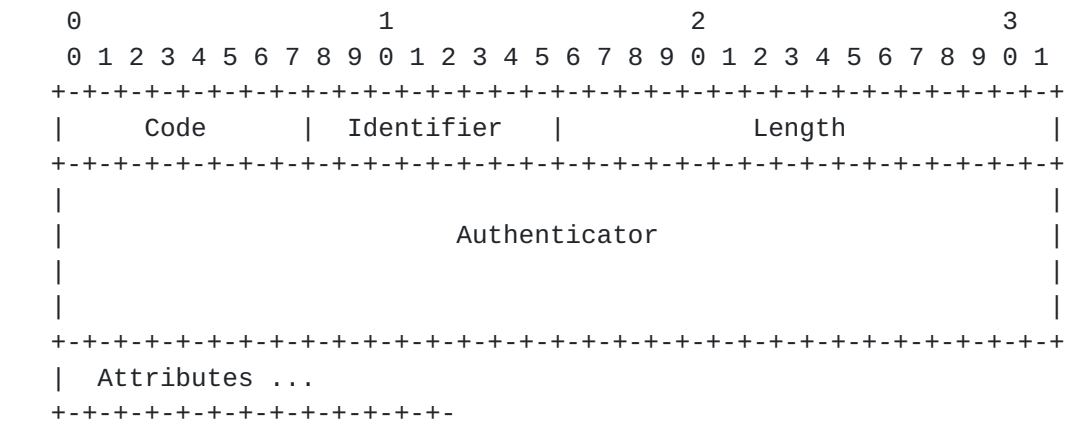
The NAS responds to a CoA-Request sent by a RADIUS server with a CoA-ACK if the NAS is able to successfully change the authorizations for the user session, or a CoA-NAK if the Request is unsuccessful. A NAS MUST respond to a CoA-Request including a Service-Type Attribute with value "Authorize Only" with a CoA-NAK; a CoA-ACK MUST NOT be sent. A NAS MUST respond to a CoA-Request including a Service-Type Attribute with an unsupported value with a CoA-NAK; an Error-Cause Attribute with value "Unsupported Service" MAY be included.

2.3. Packet Format

For either Disconnect-Request or CoA-Request messages UDP port 3799 is used as the destination port. For responses, the source and destination ports are reversed. Exactly one RADIUS packet is encapsulated in the UDP Data field.

A summary of the data format is shown below. The fields are transmitted from left to right.

The packet format consists of the fields: Code, Identifier, Length, Authenticator, and Attributes in Type:Length:Value (TLV) format. All fields hold the same meaning as those described in RADIUS [RFC2865]. The Authenticator field MUST be calculated in the same way as is specified for an Accounting-Request in [RFC2866].



Code

The Code field is one octet, and identifies the type of RADIUS packet. Packets received with an invalid Code field MUST be silently discarded. RADIUS codes (decimal) for this extension are assigned as follows:

40 - Disconnect-Request [RFC2882]
41 - Disconnect-ACK [RFC2882]
42 - Disconnect-NAK [RFC2882]
43 - CoA-Request [RFC2882]
44 - CoA-ACK [RFC2882]
45 - CoA-NAK [RFC2882]

Identifier

The Identifier field is one octet, and aids in matching requests and replies. The RADIUS client can detect a duplicate request if it has the same server source IP address and source UDP port and Identifier within a short span of time.

Unlike RADIUS as defined in [RFC2865], the responsibility for retransmission of Disconnect-Request and CoA-Request messages lies with the RADIUS server. If after sending these messages, the RADIUS server does not receive a response, it will retransmit.

The Identifier field MUST be changed whenever the content of the Attributes field changes, or whenever a valid reply has been received for a previous request. For retransmissions where the contents are identical, the Identifier MUST remain unchanged.

If the RADIUS server is retransmitting a Disconnect-Request or CoA-Request to the same client as before, and the Attributes haven't changed, the same Request Authenticator, Identifier and source port MUST be used. If any Attributes have changed, a new

Authenticator and Identifier MUST be used.

Note that if the Event-Timestamp Attribute is included, it will be updated when the packet is retransmitted, changing the content of the Attributes field and requiring a new Identifier and Request Authenticator.

If the Request to a primary proxy fails, a secondary proxy must be queried, if available. Issues relating to failover algorithms are described in [RFC3539]. Since this represents a new request, a new Request Authenticator and Identifier MUST be used. However, where the RADIUS server is sending directly to the client, failover typically does not make sense, since Disconnect or CoA messages need to be delivered to the NAS where the session resides.

Length

The Length field is two octets. It indicates the length of the packet including the Code, Identifier, Length, Authenticator and Attribute fields. Octets outside the range of the Length field MUST be treated as padding and ignored on reception. If the packet is shorter than the Length field indicates, it MUST be silently discarded. The minimum length is 20 and maximum length is 4096.

Authenticator

The Authenticator field is sixteen (16) octets. The most significant octet is transmitted first. This value is used to authenticate the messages between the RADIUS server and client.

Request Authenticator

In Request packets, the Authenticator value is a 16 octet MD5 [RFC1321] checksum, called the Request Authenticator. The Request Authenticator is calculated the same way as for an Accounting-Request, specified in [RFC2866].

Note that the Request Authenticator of a Disconnect or CoA-Request cannot be done the same way as the Request Authenticator of a RADIUS Access-Request, because there is no User-Password Attribute in a Disconnect-Request or CoA-Request.

Response Authenticator

The Authenticator field in a Response packet (e.g. Disconnect-ACK, Disconnect-NAK, CoA-ACK, or CoA-NAK) is called the

Response Authenticator, and contains a one-way MD5 hash calculated over a stream of octets consisting of the Code, Identifier, Length, the Request Authenticator field from the packet being replied to, and the response Attributes if any, followed by the shared secret. The resulting 16 octet MD5 hash value is stored in the Authenticator field of the Response packet.

Administrative note: As noted in [RFC2865] Section 3, the secret (password shared between the client and the RADIUS server) SHOULD be at least as large and unguessable as a well-chosen password. RADIUS clients MUST use the source IP address of the RADIUS UDP packet to decide which shared secret to use, so that requests can be proxied.

Attributes

In Disconnect and CoA-Request messages, all Attributes are treated as mandatory. A NAS MUST respond to a CoA-Request containing one or more unsupported Attributes or Attribute values with a CoA-NAK; a Disconnect-Request containing one or more unsupported Attributes or Attribute values MUST be answered with a Disconnect-NAK. State changes resulting from a CoA-Request MUST be atomic: if the Request is successful, a CoA-ACK is sent, and all requested authorization changes MUST be made. If the CoA-Request is unsuccessful, a CoA-NAK MUST be sent, and the requested authorization changes MUST NOT be made. Similarly, a state change MUST NOT occur as a result of an unsuccessful Disconnect-Request; here a Disconnect-NAK MUST be sent.

Since within this specification attributes may be used for identification, authorization or other purposes, even if a NAS implements an attribute for use with RADIUS authentication and accounting, it may not support inclusion of that attribute within Disconnect-Request or CoA-Request messages, given the difference in attribute semantics. This is true even for attributes specified within [RFC2865], [RFC2868], [RFC2869], [RFC3162] or [RFC3579] as allowable within Access-Accept messages. As a result, attributes beyond those specified in Section 3.5 SHOULD NOT be included within Disconnect or CoA messages, since this could produce unpredictable results.

If there are any Proxy-State Attributes in a Disconnect-Request or CoA-Request received from the server, the forwarding proxy or NAS MUST include those Proxy-State Attributes in its response to the server.

A forwarding proxy or NAS MUST NOT modify existing Proxy-State,

State, or Class Attributes present in the packet. The forwarding proxy or NAS MUST treat any Proxy-State attributes already in the packet as opaque data. Its operation MUST NOT depend on the content of Proxy-State attributes added by previous proxies. The forwarding proxy MUST NOT modify any other Proxy-State Attributes that were in the packet; it may choose not to forward them, but it MUST NOT change their contents. If the forwarding proxy omits the Proxy-State Attributes in the request, it MUST attach them to the response before sending it.

When the proxy forwards a Disconnect or CoA-Request, it MAY add a Proxy-State Attribute, but it MUST NOT add more than one. If a Proxy-State Attribute is added to a packet when forwarding the packet, the Proxy-State Attribute MUST be added after any existing Proxy-State attributes. The forwarding proxy MUST NOT change the order of any attributes of the same type, including Proxy-State. Other Attributes can be placed before, after or even between the Proxy-State Attributes.

When the proxy receives a response to a CoA-Request or Disconnect-Request, it MUST remove its own Proxy-State (the last Proxy- State in the packet) before forwarding the response. Since Disconnect and CoA responses are authenticated on the entire packet contents, the stripping of the Proxy-State Attribute invalidates the integrity check - so the proxy needs to recompute it.

3. Attributes

In Disconnect-Request and CoA-Request packets, certain attributes are used to uniquely identify the NAS as well as a user session on the NAS. All NAS identification attributes included in a Request message MUST match in order for a Disconnect-Request or CoA-Request to be successful; otherwise a Disconnect-NAK or CoA-NAK SHOULD be sent. For session identification attributes, the User-Name and Acct-Session-Id Attributes, if included, MUST match in order for a Disconnect-Request or CoA-Request to be successful; other session identification attributes SHOULD match. Where a mismatch of session identification attributes is detected, a Disconnect-NAK or CoA-NAK SHOULD be sent. The ability to use NAS or session identification attributes to map to unique/multiple sessions is beyond the scope of this document. Identification attributes include NAS and session identification attributes, as described below.

NAS identification attributes

Attribute	#	Reference	Description
NAS-IP-Address	4	[RFC2865]	The IPv4 address of the NAS.
NAS-Identifier	32	[RFC2865]	String identifying the NAS.
NAS-IPv6-Address	95	[RFC3162]	The IPv6 address of the NAS.

Session identification attributes

Attribute	#	Reference	Description
User-Name	1	[RFC2865]	The name of the user associated with the session.
NAS-Port	5	[RFC2865]	The port on which the session is terminated.
Framed-IP-Address	8	[RFC2865]	The IPv4 address associated with the session.
Called-Station-Id	30	[RFC2865]	The link address to which the session is connected.
Calling-Station-Id	31	[RFC2865]	The link address from which the session is connected.
Acct-Session-Id	44	[RFC2866]	The identifier uniquely identifying the session on the NAS.
Acct-Multi-Session-Id	50	[RFC2866]	The identifier uniquely identifying related sessions.
NAS-Port-Type	61	[RFC2865]	The type of port used.
NAS-Port-Id	87	[RFC2869]	String identifying the port where the session is.
Originating-Line-Info	94	[RFC4005]	Provides information on the characteristics of the line from which a session originated.
Framed-Interface-Id	96	[RFC3162]	The IPv6 Interface Identifier associated with the session; always sent with Framed-IPv6-Prefix.
Framed-IPv6-Prefix	97	[RFC3162]	The IPv6 prefix associated with the session, always sent with Framed-Interface-Id.

To address security concerns described in Section 6.1, and to enable Diameter/RADIUS translation, the User-Name Attribute SHOULD be present in Disconnect-Request or CoA-Request packets; one or more additional session identification attributes MAY also be present. For example, where a Diameter client utilizes the same Session-Id for both authorization and accounting, inclusion of an Acct-Session-Id

Attribute in a Disconnect-Request or CoA-Request can assist with Diameter/RADIUS translation, since Diameter RAR and ASR commands include a Session-Id AVP.

To address security concerns described in Section 6.2, one or more of the NAS-IP-Address or NAS-IPv6-Address Attributes SHOULD be present in Disconnect-Request or CoA-Request packets; the NAS-Identifier Attribute MAY be present in addition.

If one or more authorization changes specified in a CoA-Request cannot be carried out, or if one or more attributes or attribute-values is unsupported, a CoA-NAK MUST be sent. Similarly, if there are one or more unsupported attributes or attribute values in a Disconnect-Request, a Disconnect-NAK MUST be sent.

Where a Service-Type Attribute with value "Authorize Only" is included within a CoA-Request, only NAS or session identification attributes are permitted, as well as Service-Type, Nonce and State attributes. If other attributes are included in such a CoA-Request, implementations MUST send a CoA-NAK; an Error-Cause Attribute with value "Unsupported Attribute" MAY be included.

A Disconnect-Request MUST contain only NAS and session identification attributes (see Section 3), as well as Service-Type, Nonce and State attributes. If other attributes are included in a Disconnect-Request, implementations MUST send a Disconnect-NAK; an Error-Cause Attribute with value "Unsupported Attribute" MAY be included.

3.1. State

[RFC2865] Section 5.44 states:

> An Access-Request MUST contain either a User-Password or a CHAP-Password or State. An Access-Request MUST NOT contain both a User-Password and a CHAP-Password. If future extensions allow other kinds of authentication information to be conveyed, the attribute for that can be used in an Access-Request instead of User-Password or CHAP-Password.

In order to satisfy the requirements of [RFC2865] Section 5.44, an Access-Request with Service-Type="Authorize-Only" MUST contain a State attribute.

In order to provide a State attribute to the NAS, a server sending a CoA-Request or Disconnect-Request with a Service-Type value of "Authorize-Only" MUST include a State Attribute, and the NAS MUST include the State Attribute unchanged in the Access-Request. A NAS receiving a CoA-Request or Disconnect-Request containing a Service-

Type value of "Authorize-Only" but lacking a State attribute MUST send a CoA-NAK or Disconnect-NAK and SHOULD include an Error-Cause attribute with value 402 (Missing Attribute).

3.2. Message-Authenticator

The Message-Authenticator Attribute MAY be used to authenticate and integrity-protect CoA-Request, CoA-ACK, CoA-NAK, Disconnect-Request, Disconnect-ACK and Disconnect-NAK packets order to prevent spoofing.

A RADIUS client receiving a CoA-Request or Disconnect-Request with a Message-Authenticator Attribute present MUST calculate the correct value of the Message-Authenticator and silently discard the packet if it does not match the value sent. A RADIUS server receiving a CoA/Disconnect-ACK or CoA/Disconnect-NAK with a Message-Authenticator Attribute present MUST calculate the correct value of the Message-Authenticator and silently discard the packet if it does not match the value sent.

When a Message-Authenticator Attribute is included within a CoA-Request or Disconnect-Request, it is calculated as follows:

Message-Authenticator = HMAC-MD5 (Type, Identifier, Length, Request Authenticator, Attributes)

When the HMAC-MD5 message integrity check is calculated the Request Authenticator field and Message-Authenticator Attribute should be considered to be sixteen octets of zero. The Message-Authenticator Attribute is calculated and inserted in the packet before the Request Authenticator is calculated.

When a Message-Authenticator Attribute is included within a CoA-ACK, CoA-NAK, Disconnect-ACK or Disconnect-NAK, it is calculated as follows:

Message-Authenticator = HMAC-MD5 (Type, Identifier, Length, Request Authenticator, Attributes)

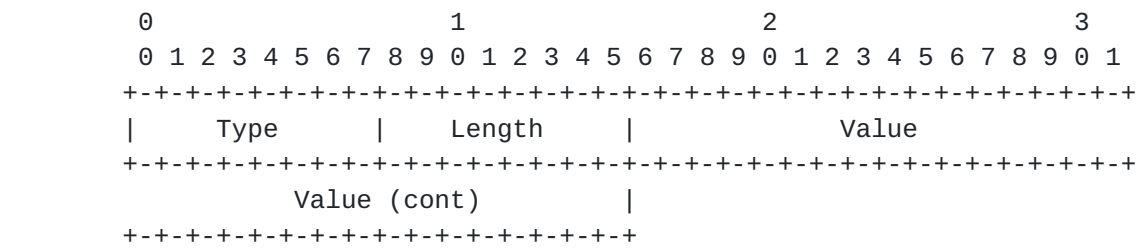
When the HMAC-MD5 message integrity check is calculated the Message-Authenticator Attribute should be considered to be sixteen octets of zero. The Request Authenticator is taken from the corresponding CoA/Disconnect-Request. The Message-Authenticator is calculated and inserted in the packet before the Response Authenticator is calculated.

3.3. Nonce

Description

Since the Request Authenticator field within CoA-Request and Disconnect-Request packets does not contain a nonce within the Request Authenticator field, these packets are vulnerable to replay attack without the countermeasures described in Section 6.4. As noted in Section 6.4, replay attacks can be addressed by using IPsec to protect RADIUS or by adding an Event-Timestamp attribute to CoA-Request and Disconnect-Request packets. Since use of the Event-Timestamp Attribute requires loose time synchronization, where this is not possible an alternative replay protection mechanism is required. For this purpose, a Nonce Attribute MAY be included within CoA-Request, CoA-ACK, CoA-NAK, Disconnect-Request, Disconnect-ACK, Disconnect-NAK and Accounting-Request packets.

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



Type

TBD for Nonce

Length

6

Value

The Value field is four octets, containing a randomly chosen value [RFC4086].

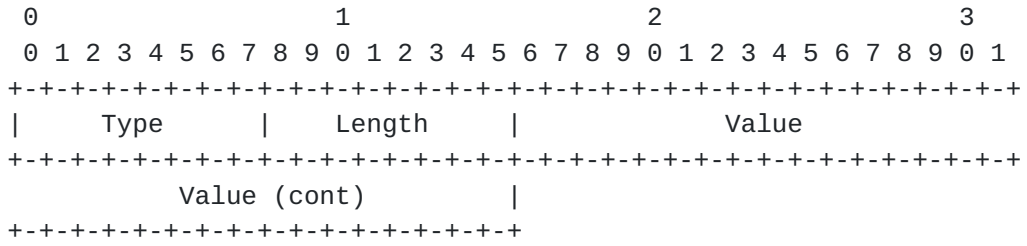
3.4. Error-Cause

Description

It is possible that the NAS cannot honor Disconnect-Request or CoA-Request messages for some reason. The Error-Cause Attribute

provides more detail on the cause of the problem. It MAY be included within Disconnect-ACK, Disconnect-NAK and CoA-NAK messages.

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



Type

101 for Error-Cause

Length

6

Value

The Value field is four octets, containing an integer specifying the cause of the error. Values 0-199 and 300-399 are reserved. Values 200-299 represent successful completion, so that these values may only be sent within Disconnect-ACK or CoA-ACK message and MUST NOT be sent within a Disconnect-NAK or CoA-NAK. Values 400-499 represent fatal errors committed by the RADIUS server, so that they MAY be sent within CoA-NAK or Disconnect-NAK messages, and MUST NOT be sent within CoA-ACK or Disconnect-ACK messages. Values 500-599 represent fatal errors occurring on a NAS or RADIUS proxy, so that they MAY be sent within CoA-NAK and Disconnect-NAK messages, and MUST NOT be sent within CoA-ACK or Disconnect-ACK messages. Error-Cause values SHOULD be logged by the RADIUS server. Error-Code values (expressed in decimal) include:

#	Value
201	Residual Session Context Removed
202	Invalid EAP Packet (Ignored)
401	Unsupported Attribute
402	Missing Attribute
403	NAS Identification Mismatch
404	Invalid Request
405	Unsupported Service

406 Unsupported Extension
501 Administratively Prohibited
502 Request Not Routable (Proxy)
503 Session Context Not Found
504 Session Context Not Removable
505 Other Proxy Processing Error
506 Resources Unavailable
507 Request Initiated

"Residual Session Context Removed" is sent in response to a Disconnect-Request if the user session is no longer active, but residual session context was found and successfully removed. This value is only sent within a Disconnect-ACK and MUST NOT be sent within a CoA-ACK, Disconnect-NAK or CoA-NAK.

"Invalid EAP Packet (Ignored)" is a non-fatal error that MUST NOT be sent by implementations of this specification.

"Unsupported Attribute" is a fatal error sent if a Request contains an attribute (such as a Vendor-Specific or EAP-Message Attribute) that is not supported.

"Missing Attribute" is a fatal error sent if critical attributes (such as NAS or session identification attributes) are missing from a Request.

"NAS Identification Mismatch" is a fatal error sent if one or more NAS identification attributes (see Section 3) do not match the identity of the NAS receiving the Request.

"Invalid Request" is a fatal error sent if some other aspect of the Request is invalid, such as if one or more attributes (such as EAP- Message Attribute(s)) are not formatted properly.

"Unsupported Service" is a fatal error sent if a Service-Type Attribute included with the Request is sent with an invalid or unsupported value.

"Unsupported Extension" is a fatal error sent due to lack of support for an extension such as Disconnect and/or CoA messages. This will typically be sent by a proxy receiving an ICMP port unreachable message after attempting to forward a Request to the NAS.

"Administratively Prohibited" is a fatal error sent if the NAS is configured to prohibit honoring of Request messages for the specified session.

"Request Not Routable" is a fatal error which MAY be sent by a RADIUS proxy and MUST NOT be sent by a NAS. It indicates that the RADIUS proxy was unable to determine how to route the Request to the NAS. For example, this can occur if the required entries are not present in the proxy's realm routing table.

"Session Context Not Found" is a fatal error sent if the session context identified in the Request does not exist on the NAS.

"Session Context Not Removable" is a fatal error sent in response to a Disconnect-Request if the NAS was able to locate the session context, but could not remove it for some reason. It MUST NOT be sent within a CoA-ACK, CoA-NAK or Disconnect-ACK, only within a Disconnect-NAK.

"Other Proxy Processing Error" is a fatal error sent in response to a Request that could not be processed by a proxy, for reasons other than routing.

"Resources Unavailable" is a fatal error sent when a Request could not be honored due to lack of available NAS resources (memory, non- volatile storage, etc.).

"Request Initiated" is a fatal error sent in response to a Request including a Service-Type Attribute with a value of "Authorize Only". It indicates that the Disconnect-Request or CoA-Request has not been honored, but that a RADIUS Access-Request including a Service-Type Attribute with value "Authorize Only" is being sent to the RADIUS server.

3.5. Table of Attributes

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

Change-of-Authorization Messages

Request	ACK	NAK	#	Attribute
0-1	0	0	1	User-Name [Note 1]
0-1	0	0	4	NAS-IP-Address [Note 1]
0-1	0	0	5	NAS-Port [Note 1]
0-1	0	0-1	6	Service-Type [Note 6]
0-1	0	0	7	Framed-Protocol [Note 3]
0-1	0	0	8	Framed-IP-Address [Note 1]
0-1	0	0	9	Framed-IP-Netmask [Note 3]
0-1	0	0	10	Framed-Routing [Note 3]
0+	0	0	11	Filter-ID [Note 3]
Request	ACK	NAK	#	Attribute

Request	ACK	NAK	#	Attribute
0-1	0	0	12	Framed-MTU [Note 3]
0+	0	0	13	Framed-Compression [Note 3]
0+	0	0	14	Login-IP-Host [Note 3]
0-1	0	0	15	Login-Service [Note 3]
0-1	0	0	16	Login-TCP-Port [Note 3]
0+	0	0	18	Reply-Message [Note 2]
0-1	0	0	19	Callback-Number [Note 3]
0-1	0	0	20	Callback-Id [Note 3]
0+	0	0	22	Framed-Route [Note 3]
0-1	0	0	23	Framed-IPX-Network [Note 3]
0-1	0-1	0-1	24	State [Note 7]
0+	0	0	25	Class [Note 3]
0+	0	0	26	Vendor-Specific [Note 3]
0-1	0	0	27	Session-Timeout [Note 3]
0-1	0	0	28	Idle-Timeout [Note 3]
0-1	0	0	29	Termination-Action [Note 3]
0-1	0	0	30	Called-Station-Id [Note 1]
0-1	0	0	31	Calling-Station-Id [Note 1]
0-1	0	0	32	NAS-Identifier [Note 1]
0+	0+	0+	33	Proxy-State
0-1	0	0	34	Login-LAT-Service [Note 3]
0-1	0	0	35	Login-LAT-Node [Note 3]
0-1	0	0	36	Login-LAT-Group [Note 3]
0-1	0	0	37	Framed-AppleTalk-Link [Note 3]
0+	0	0	38	Framed-AppleTalk-Network [Note 3]
0-1	0	0	39	Framed-AppleTalk-Zone [Note 3]
0-1	0	0	44	Acct-Session-Id [Note 1]
0-1	0	0	50	Acct-Multi-Session-Id [Note 1]
0-1	0-1	0-1	55	Event-Timestamp
0-1	0	0	61	NAS-Port-Type [Note 1]
0-1	0	0	62	Port-Limit [Note 3]
0-1	0	0	63	Login-LAT-Port [Note 3]
0+	0	0	64	Tunnel-Type [Note 5]
0+	0	0	65	Tunnel-Medium-Type [Note 5]
0+	0	0	66	Tunnel-Client-Endpoint [Note 5]
0+	0	0	67	Tunnel-Server-Endpoint [Note 5]
0+	0	0	69	Tunnel-Password [Note 5]
0-1	0	0	71	ARAP-Features [Note 3]
0-1	0	0	72	ARAP-Zone-Access [Note 3]
0+	0	0	78	Configuration-Token [Note 3]
0+	0-1	0	79	EAP-Message [Note 2]
0-1	0-1	0-1	80	Message-Authenticator
0+	0	0	81	Tunnel-Private-Group-ID [Note 5]
0+	0	0	82	Tunnel-Assignment-ID [Note 5]
0+	0	0	83	Tunnel-Preference [Note 5]
0-1	0	0	85	Acct-Interim-Interval [Note 3]
Request	ACK	NAK	#	Attribute

Request	ACK	NAK	#	Attribute
0-1	0	0	87	NAS-Port-Id [Note 1]
0-1	0	0	88	Framed-Pool [Note 3]
0+	0	0	90	Tunnel-Client-Auth-ID [Note 5]
0+	0	0	91	Tunnel-Server-Auth-ID [Note 5]
0-1	0	0	94	Originating-Line-Info [Note 1]
0-1	0	0	95	NAS-IPv6-Address [Note 1]
0-1	0	0	96	Framed-Interface-Id [Note 1]
0+	0	0	97	Framed-IPv6-Prefix [Note 1]
0+	0	0	98	Login-IPv6-Host [Note 3]
0+	0	0	99	Framed-IPv6-Route [Note 3]
0-1	0	0	100	Framed-IPv6-Pool [Note 3]
0	0	0+	101	Error-Cause
0-1	0	0	TBD	NAS-Filter-Rule
0-1	0-1	0-1	TBD	Nonce [Note 8]
Request	ACK	NAK	#	Attribute

Disconnect Messages

Request	ACK	NAK	#	Attribute
0-1	0	0	1	User-Name [Note 1]
0-1	0	0	4	NAS-IP-Address [Note 1]
0-1	0	0	5	NAS-Port [Note 1]
0-1	0	0-1	6	Service-Type [Note 6]
0-1	0	0	8	Framed-IP-Address [Note 1]
0+	0	0	18	Reply-Message [Note 2]
0-1	0-1	0-1	24	State [Note 7]
0+	0	0	25	Class [Note 4]
0+	0	0	26	Vendor-Specific
0-1	0	0	30	Called-Station-Id [Note 1]
0-1	0	0	31	Calling-Station-Id [Note 1]
0-1	0	0	32	NAS-Identifier [Note 1]
0+	0+	0+	33	Proxy-State
0-1	0	0	44	Acct-Session-Id [Note 1]
0-1	0-1	0	49	Acct-Terminate-Cause
0-1	0	0	50	Acct-Multi-Session-Id [Note 1]
0-1	0-1	0-1	55	Event-Timestamp
0-1	0	0	61	NAS-Port-Type [Note 1]
0+	0-1	0	79	EAP-Message [Note 2]
0-1	0-1	0-1	80	Message-Authenticator
0-1	0	0	87	NAS-Port-Id [Note 1]
0-1	0	0	94	Orginating-Line-Info [Note 1]
0-1	0	0	95	NAS-IPv6-Address [Note 1]
0-1	0	0	96	Framed-Interface-Id [Note 1]
0+	0	0	97	Framed-IPv6-Prefix [Note 1]
0	0+	0+	101	Error-Cause
0-1	0-1	0-1	TBD	Nonce [Note 8]
Request	ACK	NAK	#	Attribute

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.

[Note 1] Where NAS or session identification attributes are included in Disconnect-Request or CoA-Request messages, they are used for identification purposes only. These attributes MUST NOT be used for purposes other than identification (e.g. within CoA-Request messages to request authorization changes).

[Note 2] The Reply-Message Attribute is used to present a displayable message to the user. The message is only displayed as a result of a successful Disconnect-Request or CoA-Request (where a Disconnect-ACK or CoA-ACK is subsequently sent). Where EAP is used for authentication, an EAP-Message/Notification-Request Attribute is sent instead, and Disconnect-ACK or CoA-ACK messages contain an EAP-Message/Notification-Response Attribute.

[Note 3] When included within a CoA-Request, these attributes represent an authorization change request. When one of these attributes is omitted from a CoA-Request, the NAS assumes that the attribute value is to remain unchanged. Attributes included in a CoA-Request replace all existing value(s) of the same attribute(s).

[Note 4] When included within a successful Disconnect-Request (where a Disconnect-ACK is subsequently sent), the Class Attribute SHOULD be sent unmodified by the client to the accounting server in the Accounting Stop packet. If the Disconnect-Request is unsuccessful, then the Class Attribute is not processed.

[Note 5] When included within a CoA-Request, these attributes represent an authorization change request. Where tunnel attribute(s) are sent within a successful CoA-Request, all existing tunnel attributes are removed and replaced by the new attribute(s).

[Note 6] When included within a Disconnect-Request or CoA-Request, a Service-Type Attribute with value "Authorize Only" indicates that the Request only contains NAS and session identification attributes, and that the NAS should attempt reauthorization by sending an Access-Request with a Service-Type Attribute with value "Authorize Only". This enables a usage model akin to that supported in Diameter, thus easing translation between the two protocols. Support for the Service-Type Attribute is optional within CoA-Request and Disconnect-Request messages; where it is not included, the Request message may contain both identification and authorization attributes. A NAS that

does not support the Service-Type Attribute with the value "Authorize Only" within a Disconnect-Request MUST respond with a Disconnect-NAK including no Service-Type Attribute; an Error-Cause Attribute with value "Unsupported Service" MAY be included. A NAS that does not support the Service-Type Attribute with the value "Authorize Only" within a CoA-Request MUST respond with a CoA-NAK including no Service-Type Attribute; an Error-Cause Attribute with value "Unsupported Service" MAY be included.

A NAS supporting the "Authorize Only" Service-Type value within Disconnect-Request or CoA-Request messages MUST respond with a Disconnect-NAK or CoA-NAK respectively, containing a Service-Type Attribute with value "Authorize Only", and an Error-Cause Attribute with value "Request Initiated". The NAS then sends an Access-Request to the RADIUS server with a Service-Type Attribute with value "Authorize Only". This Access-Request SHOULD contain the NAS attributes from the Disconnect or CoA-Request, as well as the session attributes from the Request legal for inclusion in an Access-Request as specified in [RFC2865], [RFC2868], [RFC2869] and [RFC3162]. As noted in [RFC2869] Section 5.19, a Message-Authenticator attribute SHOULD be included in an Access-Request that does not contain a User-Password, CHAP-Password, ARAP-Password or EAP-Message Attribute. The RADIUS server should send back an Access-Accept to (re-)authorize the session or an Access-Reject to refuse to (re-)authorize it.

[Note 7] The State Attribute is available to be sent by the RADIUS server to the NAS in a Disconnect-Request or CoA-Request message and MUST be sent unmodified from the NAS to the RADIUS server in a subsequent ACK or NAK message. If a Service-Type Attribute with value "Authorize Only" is included in a Disconnect-Request or CoA-Request then a State Attribute MUST be present, and MUST be sent unmodified from the NAS to the RADIUS server in the resulting Access-Request sent to the RADIUS server, if any. The State Attribute is also available to be sent by the RADIUS server to the NAS in a CoA-Request that also includes a Termination-Action Attribute with the value of RADIUS-Request. If the client performs the Termination-Action by sending a new Access-Request upon termination of the current session, it MUST include the State Attribute unchanged in that Access-Request. In either usage, the client MUST NOT interpret the Attribute locally. A Disconnect- Request or CoA-Request packet must have only zero or one State Attribute. Usage of the State Attribute is implementation dependent. If the RADIUS server does not recognize the State Attribute in the Access-Request, then it MUST send an Access-Reject.

[Note 8] A Nonce Attribute SHOULD be included in a CoA-Request or Disconnect-Request packet that is not protected by IPsec or does not contain an Event-Timestamp Attribute, so as to prevent replay

attacks. A Nonce Attribute MAY also be included in CoA-ACK, CoA-NAK, Disconnect-ACK, Disconnect-NAK, or Accounting-Request packets.

4. Diameter Considerations

Due to differences in handling change-of-authorization requests in RADIUS and Diameter, it may be difficult or impossible for a Diameter/RADIUS gateway to successfully translate a Diameter Re-Auth-Request (RAR) to a CoA-Request and vice versa. For example, since a CoA-Request only initiates an authorization change but does not initiate re-authentication, a RAR command containing a Re-Auth-Request-Type AVP with value "AUTHORIZE_AUTHENTICATE" cannot be directly translated to a CoA-Request. A Diameter/RADIUS gateway receiving a CoA-Request containing authorization changes will need to translate this into two Diameter exchange. First, the Diameter/RADIUS gateway will issue a RAR command including a Session-Id AVP and a Re-Auth-Request-Type AVP with value "AUTHORIZE ONLY". Then the Diameter/RADIUS gateway will respond to the ensuing access request with a response including the authorization attributes gleaned from the CoA-Request. For the translation to be possible, the CoA-Request MUST include a Acct-Session-Id Attribute. If the Diameter client uses the same Session-Id for both authorization and accounting, then the Diameter/RADIUS gateway can copy the contents of the Acct-Session-Id Attribute into the Session-Id AVP; otherwise, it will need to map the Acct-Session-Id value to an equivalent Session-Id for use within a RAR command.

To simplify translation between RADIUS and Diameter, a server compliant with this specification MAY include a Service-Type Attribute with value "Authorize Only" within a CoA-Request. Such a CoA-Request MUST contain a State Attribute. A NAS supporting the "Authorize Only" Service-Type within a CoA-Request responds with a CoA-NAK containing a Service-Type Attribute with value "Authorize Only", and an Error-Cause Attribute with value "Request Initiated". The NAS will then send an Access-Request containing a Service-Type Attribute with a value of "Authorize Only", along with a State Attribute. A Diameter/RADIUS gateway receiving a CoA-Request containing a Service-Type with value "Authorize Only" translates this to a RAR with Re-Auth-Request-Type AVP with value "AUTHORIZE ONLY". The received RAA is then translated to a CoA-NAK with a Service-Type value of "Authorize Only". If the Result-Code AVP in the RAA has a value in the success category, then an Error-Cause Attribute with value "Request Initiated" is included in the CoA-NAK. If the Result-Code AVP in the RAA has a value indicating a Protocol Error or a Transient or Permanent Failure, then an alternate Error-Cause Attribute is returned as suggested below.

Within Diameter, a server can request that a session be aborted by

sending an Abort-Session-Request (ASR), identifying the session to be terminated using Session-ID and User-Name AVPs. The ASR command is translated to a Disconnect-Request containing an Acct-Session-Id and User-Name attribute. If the Diameter client utilizes the same Session-Id in both authorization and accounting, then the value of the Session-ID AVP may be placed in the Acct-Session-Id attribute; otherwise the value of the Session-ID AVP will need to be mapped to an appropriate Acct-Session-Id value. For a Disconnect-Request to be translatable to an ASR, an Acct-Session-Id attribute MUST be present. If the Diameter client utilizes the same Session-Id in both authorization and accounting, then the value of the Acct-Session-Id may be placed into the Session-ID AVP within the ASR; otherwise the value of the Acct-Session-Id will need to be mapped to an appropriate Session-ID value.

An Abort-Session-Answer (ASA) command is sent in response to an ASR in order to indicate the disposition of the request. A Diameter/RADIUS gateway receiving a Disconnect-ACK translates this to an ASA command with a Result-Code AVP of "DIAMETER_SUCCESS". A Disconnect-NAK received from the server is translated to an ASA command with a Result-Code AVP which depends on the value of the Error-Cause Attribute. Suggested translations between Error-Cause Attribute values and Result-Code AVP values are included below:

#	Error-Cause Attribute Value	Result-Code AVP
201	Residual Session Context Removed	DIAMETER_SUCCESS
202	Invalid EAP Packet (Ignored)	DIAMETER_LIMITED_SUCCESS
401	Unsupported Attribute	DIAMETER_AVP_UNSUPPORTED
402	Missing Attribute	DIAMETER_MISSING_AVP
403	NAS Identification Mismatch	DIAMETER_REALM_NOT_SERVED
404	Invalid Request	DIAMETER_UNABLE_TO_COMPLY
405	Unsupported Service	DIAMETER_COMMAND_UNSUPPORTED
406	Unsupported Extension	DIAMETER_APPLICATION_UNSUPPORTED
501	Administratively Prohibited	DIAMETER_AUTHORIZATION_REJECTED
502	Request Not Routable (Proxy)	DIAMETER_UNABLE_TO_DELIVER
503	Session Context Not Found	DIAMETER_UNKNOWN_SESSION_ID
504	Session Context Not Removable	DIAMETER_AUTHORIZATION_REJECTED
505	Other Proxy Processing Error	DIAMETER_UNABLE_TO_COMPLY
506	Resources Unavailable	DIAMETER_RESOURCES_EXCEEDED
507	Request Initiated	DIAMETER_SUCCESS

Since both the ASR/ASA and Disconnect-Request/Disconnect-NAK/Disconnect-ACK exchanges involve just a request and response, inclusion of an "Authorize Only" Service-Type within a Disconnect-Request is not needed to assist in Diameter/RADIUS translation, and may make translation more difficult. As a result, inclusion of a Service-Type of "Authorize Only" within a Disconnect-Request is NOT RECOMMENDED.

5. IANA Considerations

This specification does not create any new registries.

This document uses the RADIUS [RFC2865] namespace, see <http://www.iana.org/assignments/radius-types>. Allocation of one update for the section "RADIUS Attribute Types" is requested. The RADIUS attribute for which a value is requested is:

TBD - Nonce

There are six updates for the section: RADIUS Packet Type Codes. These Packet Types are allocated in [RFC3575]:

40 - Disconnect-Request
41 - Disconnect-ACK
42 - Disconnect-NAK
43 - CoA-Request
44 - CoA-ACK
45 - CoA-NAK

A new Service-Type value for "Authorize Only" (17) is allocated in [RFC3576]. This draft also uses the UDP [RFC768] namespace, see <http://www.iana.org/assignments/port-numbers>. UDP port 3799 has been assigned [RFC3576]. This specification also utilizes the Error-Cause Attribute (101) allocated in [RFC3576], with the following decimal values:

#	Value
201	Residual Session Context Removed
202	Invalid EAP Packet (Ignored)
401	Unsupported Attribute
402	Missing Attribute
403	NAS Identification Mismatch
404	Invalid Request
405	Unsupported Service
406	Unsupported Extension
501	Administratively Prohibited
502	Request Not Routable (Proxy)

```
503    Session Context Not Found
504    Session Context Not Removable
505    Other Proxy Processing Error
506    Resources Unavailable
507    Request Initiated
```

6. Security Considerations

6.1. Authorization Issues

Where a NAS is shared by multiple providers, it is undesirable for one provider to be able to send Disconnect-Request or CoA-Requests affecting the sessions of another provider.

A NAS or RADIUS proxy MUST silently discard Disconnect-Request or CoA-Request messages from untrusted sources. By default, a RADIUS proxy SHOULD perform a "reverse path forwarding" (RPF) check to verify that a Disconnect-Request or CoA-Request originates from an authorized RADIUS server. In addition, it SHOULD be possible to explicitly authorize additional sources of Disconnect-Request or CoA-Request packets relating to certain classes of sessions. For example, a particular source can be explicitly authorized to send CoA-Request messages relating to users within a set of realms.

To perform the RPF check, the proxy uses the session identification attributes included in Disconnect-Request or CoA-Request messages, in order to determine the RADIUS server(s) to which an equivalent Access-Request could be routed. If the source address of the Disconnect-Request or CoA-Request is within this set, then the Request is forwarded; otherwise it MUST be silently discarded.

Typically the proxy will extract the realm from the Network Access Identifier [RFC4282] included within the User-Name Attribute, and determine the corresponding RADIUS servers in the proxy routing tables. The RADIUS servers for that realm are then compared against the source address of the packet. Where no RADIUS proxy is present, the RPF check will need to be performed by the NAS itself.

Since authorization to send a Disconnect-Request or CoA-Request is determined based on the source address and the corresponding shared secret, the NASes or proxies SHOULD configure a different shared secret for each RADIUS server.

6.2. Impersonation

[RFC2865] Section 3 states:

> A RADIUS server MUST use the source IP address of the RADIUS

UDP packet to decide which shared secret to use, so that RADIUS requests can be proxied.

When RADIUS requests are forwarded by a proxy, the NAS-IP-Address or NAS-IPv6-Address Attributes will typically not match the source address observed by the RADIUS server. Since the NAS-Identifier Attribute need not contain an FQDN, this attribute may not be resolvable to the source address observed by the RADIUS server, even when no proxy is present.

As a result, the authenticity check performed by a RADIUS server or proxy does not verify the correctness of NAS identification attributes. This makes it possible for a rogue NAS to forge NAS-IP-Address, NAS-IPv6-Address or NAS-Identifier Attributes within a RADIUS Access-Request in order to impersonate another NAS. It is also possible for a rogue NAS to forge session identification attributes such as the Called-Station-Id, Calling-Station-Id, or Originating-Line-Info [RFC4005]. This could fool the RADIUS server into sending Disconnect-Request or CoA-Request messages containing forged session identification attributes to a NAS targeted by an attacker.

To address these vulnerabilities RADIUS proxies SHOULD check whether NAS identification attributes (see Section 3) match the source address of packets originating from the NAS. Where one or more attributes do not match, Disconnect-Request or CoA-Request messages SHOULD be silently discarded.

Such a check may not always be possible. Since the NAS-Identifier Attribute need not correspond to an FQDN, it may not be resolvable to an IP address to be matched against the source address. Also, where a NAT exists between the RADIUS client and proxy, checking the NAS-IP-Address or NAS-IPv6-Address Attributes may not be feasible.

6.3. IPsec Usage Guidelines

In addition to security vulnerabilities unique to Disconnect or CoA messages, the protocol exchanges described in this document are susceptible to the same vulnerabilities as RADIUS [RFC2865]. It is RECOMMENDED that IPsec be employed to afford better security.

Implementations of this specification SHOULD support IPsec [RFC2401] along with IKE [RFC2409] for key management. IPsec ESP [RFC2406] with non-null transform SHOULD be supported, and IPsec ESP with a non-null encryption transform and authentication support SHOULD be used to provide per-packet confidentiality, authentication, integrity and replay protection. IKE SHOULD be used for key management.

Within RADIUS [RFC2865], a shared secret is used for hiding of Attributes such as User-Password, as well as in computation of the Response Authenticator. In RADIUS accounting [RFC2866], the shared secret is used in computation of both the Request Authenticator and the Response Authenticator.

Since in RADIUS a shared secret is used to provide confidentiality as well as integrity protection and authentication, only use of IPsec ESP with a non-null transform can provide security services sufficient to substitute for RADIUS application-layer security. Therefore, where IPsec AH or ESP null is used, it will typically still be necessary to configure a RADIUS shared secret.

Where RADIUS is run over IPsec ESP with a non-null transform, the secret shared between the NAS and the RADIUS server MAY NOT be configured. In this case, a shared secret of zero length MUST be assumed. However, a RADIUS server that cannot know whether incoming traffic is IPsec-protected MUST be configured with a non-null RADIUS shared secret.

When IPsec ESP is used with RADIUS, per-packet authentication, integrity and replay protection MUST be used. 3DES-CBC MUST be supported as an encryption transform and AES-CBC SHOULD be supported. AES-CBC SHOULD be offered as a preferred encryption transform if supported. HMAC-SHA1-96 MUST be supported as an authentication transform. DES-CBC SHOULD NOT be used as the encryption transform.

A typical IPsec policy for an IPsec-capable RADIUS client is "Initiate IPsec, from me to any destination port UDP 1812". This IPsec policy causes an IPsec SA to be set up by the RADIUS client prior to sending RADIUS traffic. If some RADIUS servers contacted by the client do not support IPsec, then a more granular policy will be required: "Initiate IPsec, from me to IPsec-Capable-RADIUS-Server, destination port UDP 1812."

For a client implementing this specification the policy would be "Accept IPsec, from any to me, destination port UDP 3799". This causes the RADIUS client to accept (but not require) use of IPsec. It may not be appropriate to require IPsec for all RADIUS servers connecting to an IPsec-enabled RADIUS client, since some RADIUS servers may not support IPsec.

For an IPsec-capable RADIUS server, a typical IPsec policy is "Accept IPsec, from any to me, destination port 1812". This causes the RADIUS server to accept (but not require) use of IPsec. It may not be appropriate to require IPsec for all RADIUS clients connecting to an IPsec-enabled RADIUS server, since some RADIUS clients may not support IPsec.

For servers implementing this specification, the policy would be "Initiate IPsec, from me to any, destination port UDP 3799". This causes the RADIUS server to initiate IPsec when sending RADIUS extension traffic to any RADIUS client. If some RADIUS clients contacted by the server do not support IPsec, then a more granular policy will be required, such as "Initiate IPsec, from me to IPsec-capable-RADIUS-client, destination port UDP 3799".

Where IPsec is used for security, and no RADIUS shared secret is configured, it is important that the RADIUS client and server perform an authorization check. Before enabling a host to act as a RADIUS client, the RADIUS server SHOULD check whether the host is authorized to provide network access. Similarly, before enabling a host to act as a RADIUS server, the RADIUS client SHOULD check whether the host is authorized for that role.

RADIUS servers can be configured with the IP addresses (for IKE Aggressive Mode with pre-shared keys) or FQDNs (for certificate authentication) of RADIUS clients. Alternatively, if a separate Certification Authority (CA) exists for RADIUS clients, then the RADIUS server can configure this CA as a trust anchor [RFC3280] for use with IPsec.

Similarly, RADIUS clients can be configured with the IP addresses (for IKE Aggressive Mode with pre-shared keys) or FQDNs (for certificate authentication) of RADIUS servers. Alternatively, if a separate CA exists for RADIUS servers, then the RADIUS client can configure this CA as a trust anchor for use with IPsec.

Since unlike SSL/TLS, IKE does not permit certificate policies to be set on a per-port basis, certificate policies need to apply to all uses of IPsec on RADIUS clients and servers. In IPsec deployment supporting only certificate authentication, a management station initiating an IPsec-protected telnet session to the RADIUS server would need to obtain a certificate chaining to the RADIUS client CA. Issuing such a certificate might not be appropriate if the management station was not authorized as a RADIUS client.

Where RADIUS clients may obtain their IP address dynamically (such as an Access Point supporting DHCP), Main Mode with pre-shared keys [RFC2409] SHOULD NOT be used, since this requires use of a group pre-shared key; instead, Aggressive Mode SHOULD be used. Where RADIUS client addresses are statically assigned either Aggressive Mode or Main Mode MAY be used. With certificate authentication, Main Mode SHOULD be used.

Care needs to be taken with IKE Phase 1 Identity Payload selection in order to enable mapping of identities to pre-shared keys even with

Aggressive Mode. Where the ID_IPV4_ADDR or ID_IPV6_ADDR Identity Payloads are used and addresses are dynamically assigned, mapping of identities to keys is not possible, so that group pre-shared keys are still a practical necessity. As a result, the ID_FQDN identity payload SHOULD be employed in situations where Aggressive mode is utilized along with pre-shared keys and IP addresses are dynamically assigned. This approach also has other advantages, since it allows the RADIUS server and client to configure themselves based on the fully qualified domain name of their peers.

Note that with IPsec, security services are negotiated at the granularity of an IPsec SA, so that RADIUS exchanges requiring a set of security services different from those negotiated with existing IPsec SAs will need to negotiate a new IPsec SA. Separate IPsec SAs are also advisable where quality of service considerations dictate different handling RADIUS conversations. Attempting to apply different quality of service to connections handled by the same IPsec SA can result in reordering, and falling outside the replay window. For a discussion of the issues, see [RFC2983].

6.4. Replay Protection

Where IPsec replay protection is not used, a Nonce or Event-Timestamp (55) [RFC2869] Attribute SHOULD be included within CoA-Request and Disconnect-Request packets, and MAY be included within CoA-ACK, CoA-NAK, Disconnect-ACK and Disconnect-NAK packets. When the Event-Timestamp attribute is present, both the NAS and the RADIUS server MUST check that the Event-Timestamp Attribute is current within an acceptable time window. If the Event-Timestamp Attribute is not current, then the message MUST be silently discarded. This implies the need for loose time synchronization within the network, which can be achieved by a variety of means, including SNTP, as described in [RFC4330].

Implementations SHOULD be configurable to discard CoA-Request or Disconnect-Request packets containing neither a Nonce nor an Event-Timestamp attribute. A default time window of 300 seconds is recommended.

7. Example Traces

Disconnect Request with User-Name:

```
  0: xxxx xxxx xxxx xxxx xxxx 2801 001c 1b23    .B.....$.-(....#
 16: 624c 3543 ceba 55f1 be55 a714 ca5e 0108    bL5C..U..U...^..
 32: 6d63 6869 6261
```

Disconnect Request with Acct-Session-ID:

```
     0: xxxx xxxx xxxx xxxx xxxx 2801 001e ad0d    .B..... ~.(.....
    16: 8e53 55b6 bd02 a0cb ace6 4e38 77bd 2c0a    .SU.......N8w.,.
    32: 3930 3233 3435 3637                        90234567
```

Disconnect Request with Framed-IP-Address:

```
     0: xxxx xxxx xxxx xxxx xxxx 2801 001a 0bda    .B.....”2.(.....
    16: 33fe 765b 05f0 fd9c c32a 2f6b 5182 0806    3.v[.....*/kQ...
    32: 0a00 0203
```

8. References

8.1. Normative References

[RFC1305] Mills, D. L., "Network Time Protocol (version 3) Specification, Implementation and Analysis, RFC 1305 March, 1992.

[RFC1321] Rivest, R., "The MD5 Message-Digest Algorithm", RFC 1321, April 1992.

[RFC2104] Krawczyk, H., Bellare, M. and R. Canetti, "HMAC: Keyed-Hashing for Message Authentication", RFC 2104, February 1997.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", RFC 2119, March 1997.

[RFC2401] Atkinson, R. and S. Kent, "Security Architecture for the Internet Protocol", RFC 2401, November 1998.

[RFC2406] Kent, S. and R. Atkinson, "IP Encapsulating Security Payload (ESP)", RFC 2406, November 1998

[RFC2409] Harkins, D. and D. Carrel, "The Internet Key Exchange (IKE)", RFC 2409, November 1998

[RFC2434] Alvestrand, H. and T. Narten, "Guidelines for Writing an IANA Considerations Section in RFCs", BCP 26, RFC 2434, October 1998.

[RFC2865] Rigney, C., Rubens, A., Simpson, W. and S. Willens, "Remote Authentication Dial In User Service (RADIUS)", RFC 2865, June 2000.

[RFC2866] Rigney, C., "RADIUS Accounting", RFC 2866, June 2000.

[RFC2869] Rigney, C., Willats W. and P. Calhoun, "RADIUS Extensions", RFC 2869, June 2000.

[RFC3162] Aboba, B., Zorn, G. and D. Mitton, "RADIUS and IPv6", RFC 3162, August 2001.

[RFC3280] Housley, R., Polk, W., Ford, W. and D. Solo, "Internet X.509 Public Key Infrastructure Certificate and Certificate Revocation List (CRL) Profile", RFC 3280, April 2002.

[RFC3575] Aboba, B., "IANA Considerations for RADIUS", RFC 3575, July 2003.

[RFC3579] Aboba, B. and P. Calhoun, "RADIUS Support for Extensible Authentication Protocol (EAP)", RFC 3579, September 2003.

[RFC4086] Eastlake, D., Schiller, J. and S. Crocker, "Randomness Requirements for Security", RFc 4086, June 2005.

[RFC4282] Aboba, B., Beadles, M., Arkko, J. and P. Eronen, "The Network Access Identifier", RFC 4282, December 2005.

8.2. Informative References

[RFC2882] Mitton, D., "Network Access Server Requirements: Extended RADIUS Practices", RFC 2882, July 2000.

[RFC2983] Black, D. "Differentiated Services and Tunnels", RFC 2983, October 2000.

[RFC3539] Aboba, B. and J. Wood, "Authentication, Authorization and Accounting Transport Profile", RFC 3539, June 2003.

[RFC3588] Calhoun, P., Loughney, J., Guttman, E., Zorn, G. and J. Arkko, "Diameter Base Protocol", RFC 3588, September 2003.

[RFC3576] Chiba, M., Dommety, G., Eklund, M., Mitton, D. and B. Aboba, "Dynamic Authorization Extensions to Remote Authentication Dial In User Service (RADIUS)", RFC 3576, July 2003.

[RFC4005] Calhoun, P., Zorn, G., Spence, D. and D. Mitton, "Diameter Network Access Server Application", RFC 4005, August 2005.

[RFC4330] Mills, D., "Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI", RFC 4330, January 2006.

[MD5Attack]
Dobbertin, H., "The Status of MD5 After a Recent Attack", CryptoBytes Vol.2 No.2, Summer 1996.

Acknowledgments

This protocol was first developed and distributed by Ascend Communications. Example code was distributed in their free server kit.

The authors would like to acknowledge the valuable suggestions and feedback from the following people:

Avi Lior <avi@bridgewatersystems.com>,
Randy Bush <randy@psg.net>,
Steve Bellovin <smb@research.att.com>
Glen Zorn <gwz@cisco.com>,
Mark Jones <mjones@bridgewatersystems.com>,
Claudio Lapidus <clapidus@hotmail.com>,
Anurag Batta <Anurag_Batta@3com.com>,
Kuntal Chowdhury <chowdury@nortelnetworks.com>, and
Tim Moore <timmoore@microsoft.com>.
Russ Housley <housley@vigilsec.com>

Authors' Addresses

Murtaza Chiba
Cisco Systems, Inc.
170 West Tasman Dr.
San Jose CA, 95134

EMail: mchiba@cisco.com
Phone: +1 408 525 7198

Gopal Dommety
Cisco Systems, Inc.
170 West Tasman Dr.
San Jose, CA 95134

EMail: gdommety@cisco.com
Phone: +1 408 525 1404

Mark Eklund
Cisco Systems, Inc.
170 West Tasman Dr.
San Jose, CA 95134

EMail: meklund@cisco.com
Phone: +1 865 671 6255

David Mitton
RSA Security, Inc.
174 Middlesex Turnpike
Bedford, MA 01730

EMail: dmitton@circularnetworks.com

Bernard Aboba
Microsoft Corporation
One Microsoft Way
Redmond, WA 98052

EMail: bernarda@microsoft.com
Phone: +1 425 706 6605
Fax: +1 425 936 7329

Appendix A - Changes from RFC 3576

This Appendix lists the major changes between [RFC3576] and this document. Minor changes, including style, grammar, spelling, and editorial changes are not mentioned here.

o Defined the Nonce Attribute for replay protection when IPsec is not used and the Event-Timestamp Attribute is not present (Sections 1, 3.3, 6.4).

o Added details relating to handling of the Proxy-State Attribute (Section 2.3).

o Added requirements for inclusion of the State Attribute in CoA-Request or Disconnect-Request packets with a Service-Type of "Authorize Only" (Section 3.1).

o Use of a Service-Type value of "Authorize Only" within a Disconnect-Request (Section 3.1) is not recommended.

o Added clarification on the calculation of the Message-Authenticator Attribute (Section 3.2)

o Added Diameter Considerations (Section 5).

Intellectual Property Statement

Disclaimer of Validity

Copyright Statement

Acknowledgment

Funding for the RFC Editor function is currently provided by the Internet Society.

Open issues

Open issues relating to this specification are tracked on the following web site:

http://www.drizzle.com/~aboba/RADEXT/