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Use of Status-Server Packets in the Remote Authentication Dial In User Service (RADIUS) Protocol

Abstract

This document describes a deployed extension to the Remote Authentication Dial In User Service (RADIUS) protocol, enabling clients to query the status of a RADIUS server. This extension utilizes the Status-Server (12) Code, which was reserved for experimental use in RFC 2865.

Status of This Memo

This document is not an Internet Standards Track specification; it is published for informational purposes.

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Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc5997.

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1. Introduction

This document specifies a deployed extension to the Remote Authentication Dial In User Service (RADIUS) protocol, enabling clients to query the status of a RADIUS server. While the Status-Server (12) Code was defined as experimental in [RFC2865], Section 3, details of the operation and potential uses of the Code were not provided.

As with the core RADIUS protocol, the Status-Server extension is stateless, and queries do not otherwise affect the normal operation of a server, nor do they result in any side effects, other than perhaps incrementing an internal packet counter. Most of the implementations of this extension have utilized it alongside implementations of RADIUS as defined in [RFC2865], so that this document focuses solely on the use of this extension with UDP transport.

The rest of this document is laid out as follows. Section 2 contains the problem statement, and explanations as to why some possible solutions can have unwanted side effects. Section 3 defines the Status-Server packet format. Section 4 contains client and server requirements, along with some implementation notes. Section 5 contains a RADIUS table of attributes. The remaining text discusses security considerations not covered elsewhere in the document.

1.1. Applicability

This protocol is being recommended for publication as an Informational RFC rather than as a Standards-Track RFC because of problems with deployed implementations. This includes security vulnerabilities. The fixes recommended here are compatible with existing servers that receive Status-Server packets, but impose new security requirements on clients that send Status-Server packets.

Some existing implementations of this protocol do not support the Message-Authenticator attribute ([RFC3579]). This enables an unauthorized client to spoof Status-Server packets, potentially leading to incorrect Access-Accepts. In order to remedy this problem, this specification requires the use of the Message-Authenticator attribute to provide per-packet authentication and integrity protection.

With existing implementations of this protocol, the potential exists for Status-Server requests to be in conflict with Access-Request or Accounting-Request packets using the same Identifier. This specification recommends techniques to avoid this problem.

These limitations are discussed in more detail below.

1.2. Terminology

This document uses the following terms:

"Network Access Server (NAS)"

The device providing access to the network. Also known as the Authenticator (in IEEE 802.1X terminology) or RADIUS client.

"RADIUS Proxy"

In order to provide for the routing of RADIUS authentication and accounting requests, a RADIUS proxy can be employed. To the NAS, the RADIUS proxy appears to act as a RADIUS server, and to the RADIUS server, the proxy appears to act as a RADIUS client.

"silently discard"

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

1.3. Requirements Language

In this document, several words are used to signify the requirements of the specification. The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

2. Overview

Status-Server packets are sent by a RADIUS client to a RADIUS server in order to test the status of that server. The destination of a Status-Server packet is set to the IP address and port of the server that is being tested. A single Status-Server packet MUST be included within a UDP datagram. A Message-Authenticator attribute MUST be included so as to provide per-packet authentication and integrity protection.

RADIUS proxies or servers MUST NOT forward Status-Server packets. A RADIUS server or proxy implementing this specification SHOULD respond to a Status-Server packet with an Access-Accept (authentication port) or Accounting-Response (accounting port). An Access-Challenge

response is NOT RECOMMENDED. An Access-Reject response MAY be used. The list of attributes that are permitted in Status-Server packets, and in Access-Accept or Accounting-Response packets responding to Status-Server packets, is provided in Section 5. Section 6 provides several examples.

Since a Status-Server packet MUST NOT be forwarded by a RADIUS proxy or server, the client is provided with an indication of the status of that server only, since no RADIUS proxies are on the path between the RADIUS client and server. As servers respond to a Status-Server packet without examining the User-Name attribute, the response to a Status-Server packet cannot be used to infer any information about the reachability of specific realms.

The "hop-by-hop" functionality of Status-Server packets is useful to RADIUS clients attempting to determine the status of the first element on the path between the client and a server. Since the Status-Server packet is non-forwardable, the lack of a response may only be due to packet loss or the failure of the server at the destination IP address, and not due to faults in downstream links, proxies, or servers. It therefore provides an unambiguous indication of the status of a server.

This information may be useful in situations in which the RADIUS client does not receive a response to an Access-Request. A client may have multiple proxies configured, with one proxy marked as primary and another marked as secondary. If the client does not receive a response to a request sent to the primary proxy, it can "failover" to the secondary, and send requests to the secondary proxy instead.

However, it is possible that the lack of a response to requests sent to the primary proxy was due not to a failure within the primary, but to alternative causes such as a failed link along the path to the destination server or the failure of the destination server itself.

In such a situation, it may be useful for the client to be able to distinguish between failure causes so that it does not trigger failover inappropriately. For example, if the primary proxy is down, then a quick failover to the secondary proxy would be prudent; whereas, if a downstream failure is the cause, then the value of failover to a secondary proxy will depend on whether packets forwarded by the secondary will utilize independent links, intermediaries, or destination servers.

The Status-Server packet is not a "Keep-Alive" as discussed in [RFC2865], Section 2.6. "Keep-Alives" are Access-Request packets sent to determine whether a downstream server is responsive. These packets are typically sent only when a server is suspected to be down, and they are no longer sent as soon as the server is available again.

2.1. Why Access-Request is Inappropriate

One possible solution to the problem of querying server status is for a NAS to send specially formed Access-Request packets to a RADIUS server's authentication port. The NAS can then look for a response and use this information to determine if the server is active or unresponsive.

However, the server may see the request as a normal login request for a user and conclude that a real user has logged onto that NAS. The server may then perform actions that are undesirable for a simple status query. The server may alternatively respond with an Access-Challenge, indicating that it believes an extended authentication conversation is necessary.

Another possibility is that the server responds with an Access-Reject, indicating that the user is not authorized to gain access to the network. As above, the server may also perform local-site actions, such as warning an administrator of failed login attempts. The server may also delay the Access-Reject response, in the traditional manner of rate-limiting failed authentication attempts. This delay in response means that the querying administrator is unsure as to whether or not the server is down, slow to respond, or intentionally delaying its response to the query.

In addition, using Access-Request queries may mean that the server may have local users configured whose sole reason for existence is to enable these query requests. Unless the server policy is designed carefully, it may be possible for an attacker to use those credentials to gain unauthorized network access.

We note that some NAS implementations currently use Access-Request packets as described above, with a fixed (and non-configurable) user name and password. Implementation issues with that equipment mean that if a RADIUS server does not respond to those queries, it may be marked as unresponsive by the NAS. This marking may happen even if the server is actively responding to other Access-Requests from that same NAS. This behavior is confusing to administrators who then need to determine why an active server has been marked as "unresponsive".

2.1.1. Recommendation against Access-Request

For the reasons outlined above, NAS implementors SHOULD NOT generate Access-Request packets solely to see if a server is alive. Similarly, site administrators SHOULD NOT configure test users whose sole reason for existence is to enable such queries via Access-Request packets.

Note that it still may be useful to configure test users for the purpose of performing end-to-end or in-depth testing of a server policy. While this practice is widespread, we caution administrators to use it with care.

2.2. Why Accounting-Request is Inappropriate

A similar solution for the problem of querying server status may be for a NAS to send specially formed Accounting-Request packets to a RADIUS server's accounting port. The NAS can then look for a response and use this information to determine if the server is active or unresponsive.

As seen above with Access-Request, the server may then conclude that a real user has logged onto a NAS, and perform local-site actions that are undesirable for a simple status query.

Another consideration is that some attributes are mandatory to include in an Accounting-Request. This requirement forces the administrator to query an accounting server with fake values for those attributes in a test packet. These fake values increase the work required to perform a simple query, and they may pollute the server's accounting database with incorrect data.

2.2.1. Recommendation against Accounting-Request

For the reasons outlined above, NAS implementors SHOULD NOT generate Accounting-Request packets solely to see if a server is alive. Similarly, site administrators SHOULD NOT configure accounting policies whose sole reason for existence is to enable such queries via Accounting-Request packets.

Note that it still may be useful to configure test users for the purpose of performing end-to-end or in-depth testing of a server's policy. While this practice is widespread, we caution administrators to use it with care.

3. Packet Format

Status-Server packets reuse the RADIUS packet format, with the fields and values for those fields as defined in [RFC2865], Section 3. We do not include all of the text or diagrams of that section here, but instead explain the differences required to implement Status-Server.

The Authenticator field of Status-Server packets MUST be generated using the same method as that used for the Request Authenticator field of Access-Request packets, as given below.

The role of the Identifier field is the same for Status-Server as for other packets. However, as Status-Server is taking the role of Access-Request or Accounting-Request packets, there is the potential for Status-Server requests to be in conflict with Access-Request or Accounting-Request packets with the same Identifier. In Section 4.2 below, we describe a method for avoiding these problems. This method MUST be used to avoid conflicts between Status-Server and other packet types.

Request Authenticator

In Status-Server packets, the Authenticator value is a 16-octet random number called the Request Authenticator. The value SHOULD be unpredictable and unique over the lifetime of a secret (the password shared between the client and the RADIUS server), since repetition of a request value in conjunction with the same secret would permit an attacker to reply with a previously intercepted response. Since it is expected that the same secret MAY be used to authenticate with servers in disparate geographic regions, the Request Authenticator field SHOULD exhibit global and temporal uniqueness. See [RFC4086] for suggestions as to how random numbers may be generated.

The Request Authenticator value in a Status-Server packet SHOULD also be unpredictable, lest an attacker trick a server into responding to a predicted future request, and then use the response to masquerade as that server to a future Status-Server request from a client.

Similarly, the Response Authenticator field of an Access-Accept packet sent in response to Status-Server queries MUST be generated using the same method as used for calculating the Response Authenticator of the Access-Accept sent in response to an Access-Request, with the Status-Server Request Authenticator taking the place of the Access-Request Request Authenticator.

The Response Authenticator field of an Accounting-Response packet sent in response to Status-Server queries MUST be generated using the same method as used for calculating the Response Authenticator of the Accounting-Response sent in response to an Accounting-Request, with the Status-Server Request Authenticator taking the place of the Accounting-Request Request Authenticator.

Note that when a server responds to a Status-Server request, it MUST NOT send more than one Response packet.

Response Authenticator

The value of the Authenticator field in Access-Accept or Accounting-Response packets is called the Response Authenticator, and contains a one-way MD5 hash calculated over a stream of octets consisting of: the RADIUS packet, beginning with the Code field, including the Identifier, the Length, the Request Authenticator field from the Status-Server packet, and the response Attributes (if any), followed by the shared secret. That is,

```
ResponseAuth =
   MD5(Code+ID+Length+RequestAuth+Attributes+Secret)
```

where + denotes concatenation.

In addition to the above requirements, all Status-Server packets MUST include a Message-Authenticator attribute. Failure to do so would mean that the packets could be trivially spoofed.

Status-Server packets MAY include NAS-Identifier, and one of NAS-IP-Address or NAS-IPv6-Address. These attributes are not necessary for the operation of Status-Server, but may be useful information to a server that receives those packets.

Other attributes SHOULD NOT be included in a Status-Server packet, and MUST be ignored if they are included. User authentication credentials such as User-Name, User-Password, CHAP-Password, EAP-Message MUST NOT appear in a Status-Server packet sent to a RADIUS authentication port. User or NAS accounting attributes such as Acct-Session-Id, Acct-Status-Type, Acct-Input-Octets MUST NOT appear in a Status-Server packet sent to a RADIUS accounting port.

The Access-Accept MAY contain a Reply-Message or Message-Authenticator attribute. It SHOULD NOT contain other attributes. The Accounting-Response packets sent in response to a Status-Server query SHOULD NOT contain any attributes. As the intent is to

implement a simple query instead of user authentication or accounting, there is little reason to include other attributes in either the query or the corresponding response.

Examples of Status-Server packet flows are given below in Section 6.

3.1. Single Definition for Status-Server

When sent to a RADIUS accounting port, the contents of the Status-Server packets are calculated as described above. That is, even though the packets are being sent to an accounting port, they are not created using the same method as is used for Accounting-Requests. This difference has a number of benefits.

Having a single definition for Status-Server packets is simpler than having different definitions for different destination ports. In addition, if we were to define Status-Server as being similar to Accounting-Request but containing no attributes, then those packets could be trivially forged.

We therefore define Status-Server consistently, and vary the response packets depending on the port to which the request is sent. When sent to an authentication port, the response to a Status-Server query is an Access-Accept packet. When sent to an accounting port, the response to a Status-Server query is an Accounting-Response packet.

4. Implementation Notes

There are a number of considerations to take into account when implementing support for Status-Server. This section describes implementation details and requirements for RADIUS clients and servers that support Status-Server.

The following text applies to the authentication and accounting ports. We use the generic terms below to simplify the discussion:

* Request packet

  An Access-Request packet sent to an authentication port or an Accounting-Request packet sent to an accounting port.

* Response packet

  An Access-Accept, Access-Challenge, or Access-Reject packet sent from an authentication port or an Accounting-Response packet sent from an accounting port.

We also refer to "client" as the originator of the Status-Server packet, and "server" as the receiver of that packet and the originator of the Response packet.

Using generic terms to describe the Status-Server conversations is simpler than duplicating the text for authentication and accounting packets.

4.1. Client Requirements

Clients SHOULD permit administrators to globally enable or disable the generation of Status-Server packets. The default SHOULD be that it is disabled. As it is undesirable to send queries to servers that do not support Status-Server, clients SHOULD also have a per-server configuration indicating whether or not to enable Status-Server for a particular destination. The default SHOULD be that it is disabled.

The client SHOULD use a watchdog timer, such as is defined in Section 2.2.1 of [RFC5080], to determine when to send Status-Server packets.

When Status-Server packets are sent from a client, they MUST NOT be retransmitted. Instead, the Identity field MUST be changed every time a packet is transmitted. The old packet should be discarded, and a new Status-Server packet should be generated and sent, with new Identity and Authenticator fields.

Clients MUST include the Message-Authenticator attribute in all Status-Server packets. Failure to do so would mean that the packets could be trivially spoofed, leading to potential denial-of-service (DoS) attacks. Other attributes SHOULD NOT appear in a Status-Server packet, except as outlined below in Section 5. As the intent of the packet is a simple status query, there is little reason for any additional attributes to appear in Status-Server packets.

The client MAY increment packet counters as a result of sending a Status-Server request or of receiving a Response packet. The client MUST NOT perform any other action that is normally performed when it receives a Response packet, such as permitting a user to have login access to a port.

Clients MAY send Status-Server requests to the RADIUS destination ports from the same source port used to send normal Request packets. Other clients MAY choose to send Status-Server requests from a unique source port that is not used to send Request packets.

The above suggestion for a unique source port for Status-Server packets aids in matching responses to requests. Since the response to a Status-Server packet is an Access-Accept or Accounting-Response

packet, those responses are indistinguishable from other packets sent in response to a Request packet. Therefore, the best way to distinguish them from other traffic is to have a unique port.

A client MAY send a Status-Server packet from a source port also used to send Request packets. In that case, the Identifier field MUST be unique across all outstanding Request packets for that source port, independent of the value of the RADIUS Code field for those outstanding requests. Once the client has either received a response to the Status-Server packet or determined that the Status-Server packet has timed out, it may reuse that Identifier in another packet.

Robust implementations SHOULD accept any Response packet as a valid response to a Status-Server packet, subject to the validation requirements defined above for the Response Authenticator. The Code field of the packet matters less than the fact that a valid, signed response has been received.

That is, prior to accepting the response as valid, the client should check that the Response packet Code field is either Access-Accept (2) or Accounting-Response (5). If the Code does not match any of these values, the packet MUST be silently discarded. The client MUST then validate the Response Authenticator via the algorithm given above in Section 3. If the Response Authenticator is not valid, the packet MUST be silently discarded. If the Response Authenticator is valid, then the packet MUST be deemed to be a valid response from the server.

If the client instead discarded the response because the packet Code did not match what it expected, then it could erroneously discard valid responses from a server, and mark that server as unresponsive. This behavior would affect the stability of a RADIUS network, as responsive servers would erroneously be marked as unresponsive. We therefore recommend that clients should be liberal in what they accept as responses to Status-Server queries.

4.2. Server Requirements

Servers SHOULD permit administrators to globally enable or disable the acceptance of Status-Server packets. The default SHOULD be that acceptance is enabled. Servers SHOULD also permit administrators to enable or disable acceptance of Status-Server packets on a per-client basis. The default SHOULD be that acceptance is enabled.

Status-Server packets originating from clients that are not permitted to send the server Request packets MUST be silently discarded. If a server does not support Status-Server packets, or is configured not to respond to them, then it MUST silently discard the packet.

We note that [RFC2865], Section 3, defines a number of RADIUS Codes, but does not make statements about which Codes are valid for port 1812. In contrast, [RFC2866], Section 3, specifies that only RADIUS Accounting packets are to be sent to port 1813. This specification is compatible with [RFC2865], as it uses a known Code for packets to port 1812. This specification is not compatible with [RFC2866], as it adds a new Code (Status-Server) that is valid for port 1812. However, as the category of [RFC2866] is Informational, this conflict is acceptable.

Servers SHOULD silently discard Status-Server packets if they determine that a client is sending too many Status-Server requests in a particular time period. The method used by a server to make this determination is implementation specific and out of scope for this specification.

If a server supports Status-Server packets, and is configured to respond to them, and receives a packet from a known client, it MUST validate the Message-Authenticator attribute as defined in [RFC3579], Section 3.2. Packets failing that validation MUST be silently discarded.

Servers SHOULD NOT otherwise discard Status-Server packets if they have recently sent the client a Response packet. The query may have originated from an administrator who does not have access to the Response packet stream or one who is interested in obtaining additional information about the server.

The server MAY prioritize the handling of Status-Server packets over the handling of other requests, subject to the rate limiting described above.

The server MAY decide not to respond to a Status-Server, depending on local-site policy. For example, a server that is running but is unable to perform its normal activities MAY silently discard Status-Server packets. This situation can happen, for example, when a server requires access to a database for normal operation, but the connection to that database is down. Or, it may happen when the accepted load on the server is lower than the offered load.

Some server implementations require that Access-Request packets be accepted only on "authentication" ports (e.g., 1812/udp), and that Accounting-Request packets be accepted only on "accounting" ports (e.g., 1813/udp). Those implementations SHOULD reply to Status-Server packets sent to an "authentication" port with an Access-Accept packet and SHOULD reply to Status-Server packets sent to an "accounting" port with an Accounting-Response packet.

Some server implementations accept both Access-Request and Accounting-Request packets on the same port, and they do not distinguish between "authentication only" ports and "accounting only" ports. Those implementations SHOULD reply to Status-Server packets with an Access-Accept packet.

The server MAY increment packet counters as a result of receiving a Status-Server packet or sending a Response packet. The server SHOULD NOT perform any other action that is normally performed when it receives a Request packet, other than sending a Response packet.

4.3. Failover with Status-Server

A client may wish to "failover" from one proxy to another in the event that it does not receive a response to an Access-Request or Accounting-Request. In order to determine whether the lack of response is due to a problem with the proxy or a downstream server, the client can send periodic Status-Server packets to a proxy after the lack of a response.

These packets will help the client determine if the failure was due to an issue on the path between the client and proxy or the proxy itself, or whether the issue is occurring downstream.

If no response is received to Status-Server packets, the RADIUS client can initiate failover to another proxy. By continuing to send Status-Server packets to the original proxy, the RADIUS client can determine when it becomes responsive again.

Once the server has been deemed responsive, normal RADIUS requests may be sent to it again. This determination should be made separately for each server with which the client has a relationship. The same algorithm SHOULD be used for both authentication and accounting ports. The client MUST treat each destination (IP, port) combination as a unique server for the purposes of this determination.

Clients SHOULD use a retransmission mechanism similar to that given in Section 2.2.1 of [RFC5080]. If a reliable transport is used for RADIUS, then the watchdog timer algorithm specified in [RFC3539] MUST be used.

4.4. Proxy Server Handling of Status-Server

Many RADIUS servers can act as proxy servers, and can forward requests to another RADIUS server. Such servers MUST NOT proxy Status-Server packets. The purpose of Status-Server as specified here is to permit the client to query the responsiveness of a server

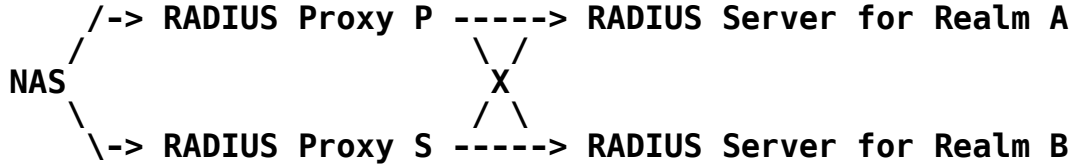
with which it has a direct relationship. Proxying Status-Server queries would negate any usefulness that may be gained by implementing support for them.

Proxy servers MAY be configured to respond to Status-Server queries from clients, and they MAY act as clients sending Status-Server queries to other servers. However, those activities MUST be independent of one another.

4.5. Limitations of Status-Server

RADIUS servers are commonly used in an environment where Network Access Identifiers (NAIs) are used as routing identifiers [RFC4282]. In this practice, the User-Name attribute is decorated with realm-routing information, commonly in the format of "user@realm". Since a particular RADIUS server may act as a proxy for more than one realm, we need to explain how the behavior defined above in Section 4.3 affects realm routing.

The schematic below demonstrates this scenario.



That is, the NAS has relationships with two RADIUS Proxies, P and S. Each RADIUS proxy has relationships with RADIUS servers for both Realm A and Realm B.

In this scenario, the RADIUS proxies can determine if one or both of the RADIUS servers are dead or unreachable. The NAS can determine if one or both of the RADIUS proxies are dead or unreachable. There is an additional case to consider, however.

If RADIUS Proxy P cannot reach the RADIUS server for Realm A, but RADIUS Proxy S can reach that RADIUS server, then the NAS cannot discover this information using the Status-Server queries as outlined above. It would therefore be useful for the NAS to know that Realm A is reachable from RADIUS Proxy S, as it can then route all requests for Realm A to that RADIUS proxy. Without this knowledge, the client may route requests to RADIUS Proxy P, where they may be discarded or rejected.

To complicate matters, the behavior of RADIUS Proxies P and S in this situation is not well defined. Some implementations simply fail to respond to the request, and other implementations respond with an

Access-Reject. If the implementation fails to respond, then the NAS cannot distinguish between the RADIUS proxy being down and the next server along the proxy chain being unreachable.

In the worst case, failures in routing for Realm A may affect users of Realm B. For example, if RADIUS Proxy P can reach Realm B but not Realm A, and RADIUS Proxy S can reach Realm A but not Realm B, then active paths exist to handle all RADIUS requests. However, depending on the NAS and RADIUS proxy implementation choices, the NAS may not be able to determine to which server requests may be sent in order to maintain network stability.

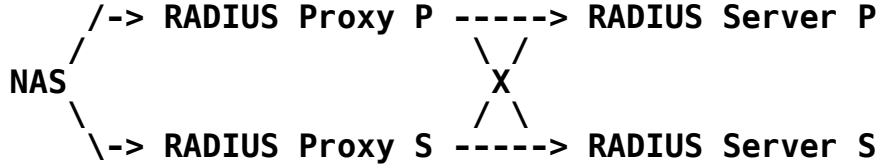
Unfortunately, this problem cannot be solved by using Status-Server requests. A robust solution would involve either a RADIUS routing table for the NAI realms or a RADIUS "destination unreachable" response to authentication requests. Either solution would not fit into the traditional RADIUS model, and both are therefore outside of the scope of this specification.

The problem is discussed here in order to define how best to use Status-Server in this situation, rather than to define a new solution.

When a server has responded recently to a request from a client, that client MUST mark the server as "responsive". In the above case, a RADIUS proxy may be responding to requests destined for Realm A, but not responding to requests destined for Realm B. The client therefore considers the server to be responsive, as it is receiving responses from the server.

The client will then continue to send requests to the RADIUS proxy for destination Realm B, even though the RADIUS proxy cannot route the requests to that destination. This failure is a known limitation of RADIUS, and can be partially addressed through the use of failover in the RADIUS proxies.

A more realistic situation than the one outlined above is one in which each RADIUS proxy also has multiple choices of RADIUS servers for a realm, as outlined below.



In this situation, if all participants implement Status-Server as defined herein, any one link may be broken, and all requests from the NAS will still reach a RADIUS server. If two links are broken at different places (i.e., not both links from the NAS), then all requests from the NAS will still reach a RADIUS server. In many situations where three or more links are broken, requests from the NAS may still reach a RADIUS server.

It is RECOMMENDED, therefore, that implementations desiring the most benefit from Status-Server also implement server failover. The combination of these two practices will maximize network reliability and stability.

4.6. Management Information Base (MIB) Considerations

4.6.1. Interaction with RADIUS Server MIB Modules

Since Status-Server packets are sent to the defined RADIUS ports, they can affect the [RFC4669] and [RFC4671] RADIUS server MIB modules. [RFC4669] defines a counter named radiusAuthServTotalUnknownTypes that counts "The number of RADIUS packets of unknown type that were received". [RFC4671] defines a similar counter named radiusAccServTotalUnknownTypes. Implementations not supporting Status-Server or implementations that are configured not to respond to Status-Server packets MUST use these counters to track received Status-Server packets.

If, however, Status-Server is supported and the server is configured to respond as described above, then the counters defined in [RFC4669] and [RFC4671] MUST NOT be used to track Status-Server requests or responses to those requests. That is, when a server fully implements Status-Server, the counters defined in [RFC4669] and [RFC4671] MUST be unaffected by the transmission or reception of packets relating to Status-Server.

If a server supports Status-Server and the [RFC4669] or [RFC4671] MIB modules, then it SHOULD also support vendor-specific MIB extensions dedicated solely to tracking Status-Server requests and responses. Any definition of the server MIB modules for Status-Server is outside of the scope of this document.

4.6.2. Interaction with RADIUS Client MIB Modules

Clients implementing Status-Server MUST NOT increment [RFC4668] or [RFC4670] counters upon reception of Response packets to Status-Server queries. That is, when a server fully implements Status-

Server, the counters defined in [RFC4668] and [RFC4670] MUST be unaffected by the transmission or reception of packets relating to Status-Server.

If an implementation supports Status-Server and the [RFC4668] or [RFC4670] MIB modules, then it SHOULD also support vendor-specific MIB extensions dedicated solely to tracking Status-Server requests and responses. Any definition of the client MIB modules for Status-Server is outside of the scope of this document.

5. Table of Attributes

The following table provides a guide to which attributes may be found in Status-Server packets, and in what quantity. Attributes other than the ones listed below SHOULD NOT be found in a Status-Server packet.

Status-Server	Access-Accept	Accounting-Response	#	Attribute
0	0	0	1	User-Name
0	0	0	2	User-Password
0	0	0	3	CHAP-Password
0-1	0	0	4	NAS-IP-Address (Note 1)
0	0+	0	18	Reply-Message
0+	0+	0+	26	Vendor-Specific
0-1	0	0	32	NAS-Identifier (Note 1)
0	0	0	79	EAP-Message
1	0-1	0-1	80	Message-Authenticator
0-1	0	0	95	NAS-IPv6-Address (Note 1)
0	0	0	103-121	Digest-*

Note 1: A Status-Server packet SHOULD contain one of (NAS-IP-Address or NAS-IPv6-Address), or NAS-Identifier, or both NAS-Identifier and one of (NAS-IP-Address or NAS-IPv6-Address).

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.

6. Examples

A few examples are presented to illustrate the flow of packets to both the authentication and accounting ports. These examples are not intended to be exhaustive; many others are possible. Hexadecimal dumps of the example packets are given in network byte order, using the shared secret "xyzzy5461".

6.1. Minimal Query to Authentication Port

The NAS sends a Status-Server UDP packet with minimal content to a RADIUS server on port 1812.

The Request Authenticator is a 16-octet random number generated by the NAS. Message-Authenticator is included in order to authenticate that the request came from a known client.

```
0c da 00 26 8a 54 f4 68 6f b3 94 c5 28 66 e3 02
18 5d 06 23 50 12 5a 66 5e 2e 1e 84 11 f3 e2 43
82 20 97 c8 4f a3

 1 Code = Status-Server (12)
 1 ID = 218
 2 Length = 38
16 Request Authenticator

Attributes:
18 Message-Authenticator (80) = 5a665e2e1e8411f3e243822097c84fa3
```

The Response Authenticator is a 16-octet MD5 checksum of the Code (2), ID (218), Length (20), the Request Authenticator from above, and the shared secret.

```
02 da 00 14 ef 0d 55 2a 4b f2 d6 93 ec 2b 6f e8
b5 41 1d 66

1 Code = Access-Accept (2)
1 ID = 218
2 Length = 20
16 Request Authenticator

Attributes:
   None.
```

6.2. Minimal Query to Accounting Port

The NAS sends a Status-Server UDP packet with minimal content to a RADIUS server on port 1813.

The Request Authenticator is a 16-octet random number generated by the NAS. Message-Authenticator is included in order to authenticate that the request came from a known client.

```
0c b3 00 26 92 5f 6b 66 dd 5f ed 57 1f cb 1d b7
ad 38 82 60 50 12 e8 d6 ea bd a9 10 87 5c d9 1f
da de 26 36 78 58

 1 Code = Status-Server (12)
 1 ID = 179
 2 Length = 38
16 Request Authenticator

Attributes:
18 Message-Authenticator (80) = e8d6eabda910875cd91fdade26367858
```

The Response Authenticator is a 16-octet MD5 checksum of the Code (5), ID (179), Length (20), the Request Authenticator from above, and the shared secret.

```
02 b3 00 14 0f 6f 92 14 5f 10 7e 2f 50 4e 86 0a
48 60 66 9c

 1 Code = Accounting-Response (5)
 1 ID = 179
 2 Length = 20
16 Request Authenticator

Attributes:
   None.
```

6.3. Verbose Query and Response

The NAS at 192.0.2.16 sends a Status-Server UDP packet to the RADIUS server on port 1812.

The Request Authenticator is a 16-octet random number generated by the NAS.

```
0c 47 00 2c bf 58 de 56 ae 40 8a d3 b7 0c 85 13
f9 b0 3f be 04 06 c0 00 02 10 50 12 85 2d 6f ec
61 e7 ed 74 b8 e3 2d ac 2f 2a 5f b2

 1 Code = Status-Server (12)
 1 ID = 71
 2 Length = 44
16 Request Authenticator

Attributes:
 6  NAS-IP-Address (4) = 192.0.2.16
18 Message-Authenticator (80) = 852d6fec61e7ed74b8e32dac2f2a5fb2
```

The Response Authenticator is a 16-octet MD5 checksum of the Code (2), ID (71), Length (52), the Request Authenticator from above, the attributes in this reply, and the shared secret.

The Reply-Message is "RADIUS Server up 2 days, 18:40"

```
02 47 00 34 46 f4 3e 62 fd 03 54 42 4c bb eb fd
6d 21 4e 06 12 20 52 41 44 49 55 53 20 53 65 72
76 65 72 20 75 70 20 32 20 64 61 79 73 2c 20 31
38 3a 34 30

 1 Code = Access-Accept (2)
 1 ID = 71
 2 Length = 52
16 Request Authenticator

Attributes:
32 Reply-Message (18)
```

7. Security Considerations

This document defines the Status-Server packet as being similar in treatment to the Access-Request packet, and is therefore subject to the same security considerations as described in [RFC2865], Section 8. Status-Server packets also use the Message-Authenticator attribute, and are therefore subject to the same security considerations as [RFC3579], Section 4.

We reiterate that Status-Server packets MUST contain a Message-Authenticator attribute. Early implementations supporting Status-Server did not enforce this requirement, and were vulnerable to the following attacks:

* Servers not checking the Message-Authenticator attribute could respond to Status-Server packets from an attacker, potentially enabling a reflected DoS attack onto a real client.

* Servers not checking the Message-Authenticator attribute could be subject to a race condition, where an attacker could see an Access-Request packet from a valid client and synthesize a Status-Server packet containing the same Request Authenticator. If the attacker won the race against the valid client, the server could respond with an Access-Accept and potentially authorize unwanted service.

The last attack is similar to a related attack when Access-Request packets contain a CHAP-Password but no Message-Authenticator. We re-iterate the suggestion of [RFC5080], Section 2.2.2, which proposes that all clients send a Message-Authenticator in every Access-Request packet, and that all servers have a configuration setting to require (or not) that a Message-Authenticator attribute be used in every Access-Request packet.

Failure to include a Message-Authenticator attribute in a Status-Server packet means that any RADIUS client or server may be vulnerable to the attacks outlined above. For this reason, implementations of this specification that fail to require use of the Message-Authenticator attribute are NOT RECOMMENDED.

Where this document differs from [RFC2865] is that it defines a new request/response method in RADIUS: the Status-Server request. As this use is based on previously described and implemented standards, we know of no additional security considerations that arise from the use of Status-Server as defined herein.

Attacks on cryptographic hashes are well known [RFC4270] and getting better with time. RADIUS uses the MD5 hash [RFC1321] for packet authentication and attribute obfuscation. There are ongoing efforts in the IETF to analyze and address these issues for the RADIUS protocol.

8. References

8.1. Normative References

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8.2. Informative References

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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.

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[RFC4671] Nelson, D., "RADIUS Accounting Server MIB for IPv6", RFC 4671, August 2006.

Acknowledgments

Parts of the text in Section 3 defining the Request and Response Authenticators were taken, with minor edits, from [RFC2865], Section 3.

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