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Multicast Ping Protocol
draft-ietf-mboned-ssmping-09.txt

Abstract

The Multicast Ping Protocol specified in this document allows for checking whether an endpoint can receive multicast, both Source-Specific Multicast (SSM) and Any-Source Multicast (ASM). It can also be used to obtain additional multicast-related information such as multicast tree setup time. This protocol is based on an implementation of tools called ssmping and asmping.

Requirements Language

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 RFC 2119 *[RFC2119]*.

Status of this Memo

Copyright Notice

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1. Introduction

The Multicast Ping Protocol specified in this document allows for checking multicast connectivity. In addition to checking reception of multicast (SSM or ASM), the protocol can provide related information such as multicast tree setup time, the number of hops the packets have traveled, as well as packet delay and loss. This functionality resembles, in part, the ICMP Echo Request/Reply mechanism [RFC0792], but uses UDP [RFC0768] and requires both a client and a server implementing this protocol. Intermediate routers are not required to

support this protocol. They forward Protocol Messages and data traffic as usual.
This protocol is based on the current implementation of the ssmping and asmping tools [impl] which are widely used by the Internet community to conduct multicast connectivity tests.

2. Architecture

Before describing the protocol in detail, we provide a brief overview of how the protocol may be used and what information it may provide.
The protocol is used between clients and servers to check multicast connectivity. Servers are multicast sources and clients are multicast receivers. A server may be configured with a set of ranges of multicast addresses that can be used for testing, or it may use some implementation defaults. Depending on the server configuration or the implementation it may control which clients (which unicast addresses) are allowed to use different group ranges, and also whether clients can select a group address, or if the group address is selected by the server. It also depends on configuration and/or implementation whether several clients are allowed to simultaneously use the same multicast address.
In addition to the above state, a server normally has runtime soft state. The server must generally perform rate limiting to restrict the number of client requests it handles. This rate limiting is per client IP address. This state need usually only be maintained for a few seconds, depending on the limit used. If the server provides unique multicast addresses to clients, it must also have soft state tracking which multicast addresses are used by which client IP address. This state should expire if the server has not received requests within a few minutes. The exact timeout should ideally be configurable to cope with different environments. If a client is expected to perform multicast ping checks continuously for a long period of time, and to cope with requests not reaching the client for several minutes, then this timeout needs to be extended. In order to verify the client IP address, the server should perform a return routability check by giving the client a non-predictable session ID. This would then also be part of the server soft-state for that client.
A client must before it can perform a multicast ping test, know the unicast address of a server. In addition it may be configured with a multicast address or range to use. In that case the client will tell the server which group or range it wishes to use. If not, the server is left to decide the group. Normally a client sends Default-Client-Request-Rate requests per second. It may however be configured to use another rate. See definition of Default-Client-Request-Rate in Section 3.5.1. Note that the value can be less than 1.
At runtime, a client generates a client ID that is unique for the ping test. This ID is included in all messages sent by the client. Further, if not supplied with a specific group address, the client will receive a group address from the server, that is used for the ping requests. It

may also receive a Session ID from the server. The client ID, group address and Session ID (if received) will then be fixed for all ping requests in this session. When a client receives replies from a server, it will verify the client ID in the reply, and ignore it if not matching what it used in the requests. For each reply it may print or record information like round trip time, number of hops etc. The client may once a ping session is ended, calculate and print or record statistics based on the entire ping session.

The typical protocol usage is as follows:

A server runs continuously to serve requests from clients. A client has somehow learned the unicast address of the server and tests the multicast reception from the server.

The client application will then send a unicast message to the server asking for a group to use. Optionally a user may request a specific group or scope, in which case the client will ask for a group matching the user's request. The server will respond with a group to use, or an error if no group is available.

Next, for ASM, the client joins an ASM group G, while for SSM it joins a channel (S,G), where G is the multicast group address specified by the server, and S is the unicast address used to reach the server.

After joining the group/channel, the client unicasts multicast ping requests to the server. The requests are sent using UDP with the destination port set to the standardised multicast ping port [TBD]. The requests are sent periodically to the server. The rate is by default Default-Client-Request-Rate Section 3.5.1 requests per second, but the client may be configured to use another rate. These requests contain a sequence number, and typically a timestamp. The requests are echoed by the server, which may add a few options.

For each request, the server sends two replies. One reply is unicast to the source IP address and source UDP port of the requesting client. The other reply is multicast to the requested multicast group G and the source UDP port of the requesting client.

Both replies are sent from the same port on which the request was received. The server should specify the TTL (IPv4 time-to-live or IPv6 hop-count) used for both the unicast and multicast messages (TTL of at least 64 is recommended) by including a TTL option. This allows the client to compute the number of hops. The client should leave the group/channel when it has finished its measurements.

By use of this protocol, a client (or a user of the client) can obtain information about several multicast delivery characteristics. First, by receiving unicast replies, the client can verify that the server is

receiving the unicast requests, is operational and responding. Hence, provided that the client receives unicast replies, a failure to receive multicast indicates either a multicast problem or a multicast administrative restriction. If it does receive multicast, it knows not only that it can receive multicast traffic, it may also estimate the amount of time it took to establish the multicast tree (at least if it is in the range of seconds), whether there are packet drops, and the length and variation of Round Trip Times (RTT).
For unicast, the RTT is the time from when the unicast request is sent to the time when the reply is received. The measured multicast RTT also references the client's unicast request. By specifying the TTL of the replies when they are originated, the client can also determine the number of router hops it is from the source. Since similar information is obtained in the unicast replies, the host may compare its multicast and unicast results and is able to check for differences such as the number of hops, and RTT.
The number of multicast hops and changes in the number of hops over time may reveal details about the multicast tree and multicast tree changes. Provided that the server sends the unicast and multicast replies nearly simultaneously, the client may also be able to measure the difference in one way delay for unicast and multicast on the path from server to client, and also differences in delay.
Servers may optionally specify a timestamp. This may be useful since the unicast and multicast replies can not be sent simultaneously (the delay is dependent on the host's operating system and load).

3. Protocol Specification

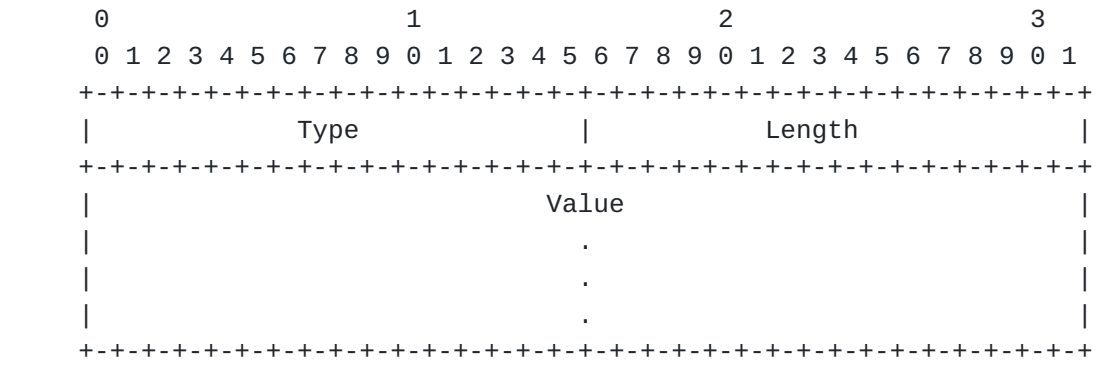
There are four different message types. Echo Request and Echo Reply messages are used for the actual measurements. An Init message SHOULD be used to initialise a ping session and negotiate which group to use. Finally a Server Response message that is mainly used in response to the Init message. The messages MUST always be in network byte order. UDP checksums MUST always be used.
The messages share a common format: one octet specifying the message type, followed by a number of options in TLV (Type, Length and Value) format. This makes the protocol easily extendible.
Message types in the range 0-253 are reserved and available for allocation in an IANA Registry. Message types 254 and 255 are not registered and are freely available for experimental use. See Section 8.
The Init message generally contains some prefix options asking the server for a group from one of the specified prefixes. The server responds with a Server Response message that contains the group address to use, or possibly prefix options describing what multicast groups the server may be able to provide.
For an Echo Request the client includes a number of options, and a server MAY simply echo the contents (only changing the message type) without inspecting the options if it does not support any options. This

might be true for a simple Multicast Ping Protocol server, but it severly limits what information a client can obtain, and hence makes the protocol less useful. However, the server SHOULD add a TTL option (allowing the client to determine the number of router hops a reply has traversed), and there are other options that a server implementation MAY support, e.g., the client may ask for certain information or a specific behaviour from the server. The Echo Replies (one unicast and one multicast) MUST first contain the exact options from the request (in the same order), and then, immediately following, any options appended by the server. A server MUST NOT process unknown options, but they MUST still be included in the Echo Reply. A client MUST ignore any unknown options.

The size of the protocol messages is generally smaller than the Path MTU and fragmentation is not a concern. There may however be cases where the Path MTU is really small, or that a client sends large requests in order to verify that it can receive fragmented multicast datagrams. This document does not specify whether Path MTU Discovery should be performed, etc. A possible extension could be an option where a client requests Path MTU Discovery and receives the current Path MTU from the server.

This document defines a number of different options. Some options do not require processing by servers and are simply returned unmodified in the reply. There are, however, other client options that the server may care about, as well as server options that may be requested by a client. Unless otherwise specified, an option MUST NOT be used multiple times in the same message.

3.1. Option Format



All options are TLVs formatted as below.

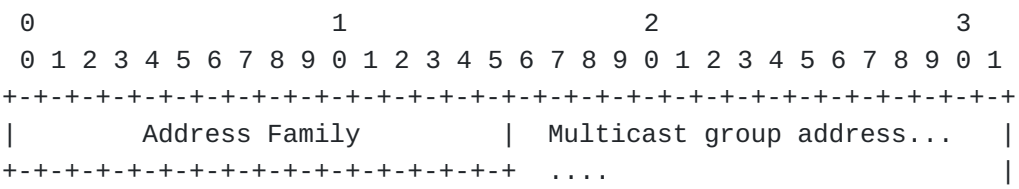
Type (2 octets) specifies the option.

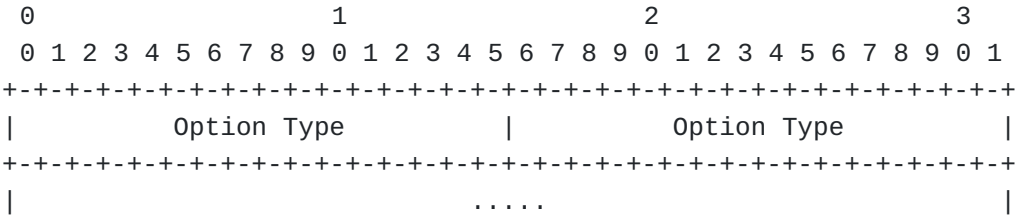
Length (2 octets) specifies the length of the value field. Depending on the option type, it can be from 0 to 65535.

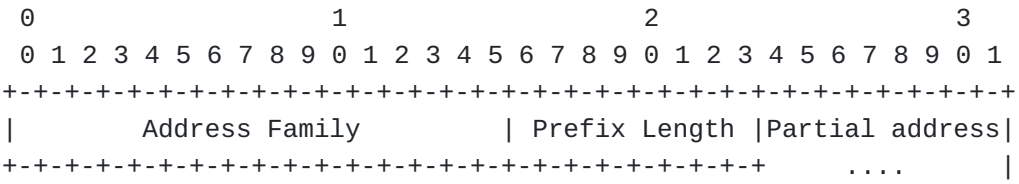
Value must always be of the specified length. See the respective option definitions for possible values. If the length is 0, the value field is not included.

3.2. Defined Options

This document defines the following options: Version (0), Client ID (1), Sequence Number (2), Client Timestamp (3), Multicast Group (4), Option Request Option (5), Server Information (6), TTL (9), Multicast Prefix (10), Session ID (11) and Server Timestamp (12). Values 7 and 8 are deprecated and must not be allocated by any future document. The options are defined below.
Option types in the range 0-65531 are reserved and available for allocation in an IANA Registry. Option types in the range 65532-65535 are not registered and are freely available for experimental use. See Section 8.







*Version, type 0

-Length MUST be 1. This option MUST always be included in all messages, and for the current specified protocol this value MUST be set to 2 (in decimal). Note that there are implementations of older revisions of this protocol that only partly follow this specification. They can be regarded as version 1 and do not use this option. If a server receives a message with a version other than 2 (or missing), the server SHOULD (unless it supports the particular version) send a Server Response message back with version set to 2. This tells the client that the server expects version 2 messages. Client ID and Sequence Number options MUST be echoed if present, so that a client can be certain it is a response to one of its messages, and exactly which message. The server SHOULD NOT

include any other options. A client receiving a response with a version other than 2 MUST stop sending requests to the server (unless it supports the particular version).

*Client ID, type 1

-Length MUST be non-zero. A client SHOULD always include this option in all messages (both Init and Echo Request). The client may use any value it likes to detect whether a reply is a reply to its Init/Echo Request or not. A server should treat this as opaque data, and MUST echo this option back in the reply if present (both Server Response and Echo Reply). The value might be a pseudo random byte string that is likely to be unique, possibly combined with the client IP address. Predictability is not a big concern here. This is used by the client to ensure that server messages are in response to its requests. In some cases a client may receive multicast responses to queries from other clients. It is left to the client implementer how to use this option.

*Sequence Number, type 2

-Length MUST be 4. A client MUST always include this in Echo Request messages and MUST NOT include it in Init messages. A server replying to an Echo Request message MUST copy it into the Echo Reply (or Server Response message on error). The sequence number is a 32-bit integer. Values typically start at 1 and increase by one for each Echo Request in a sequence.

*Client Timestamp, type 3

-Length MUST be 8. A client SHOULD include this in Echo Request messages and MUST NOT include it in Init messages. A server replying to an Echo Request message MUST copy it into the Echo Reply. The timestamp specifies the time when the Echo Request message is sent. The first 4 bytes specify the number of seconds since the Epoch (0000 UTC Jan 1, 1970). The next 4 bytes specify the number of microseconds since the second specified in the first 4 bytes. This option would typically be used by a client to compute round trip times.

-Note that while this protocol uses the above 32 bit format, it would have been better to use another format, such as the one defined in NTPv4 [RFC5905]. This should be considered for future extensions of the protocol.

*Multicast Group, type 4

-Length MUST be greater than 2. It MAY be used in Server Response messages to tell the client what group to use in

subsequent Echo Request messages. It MUST be used in Echo Request messages to tell the server what group address to respond to (this group would typically be previously obtained in a Server Response message). It MUST be used in Echo Reply messages (copied from the Echo Request message). It MUST NOT be used in Init messages. The format of the option value is as below. [addrfamily]. This is followed by the group address. Length of the option value will be 6 for IPv4, and 18 for IPv6.

*Option Request Option, type 5

-Length MUST be greater than 1. This option MAY be used in client messages (Init and Echo Request messages). A server MUST NOT send this option, except that if it is present in an Echo Request message, the server MUST echo it in replies (Echo Reply message) to the Echo Request. This option contains a list of option types for options that the client is requesting from the server. Support for this option is OPTIONAL for both clients and servers. The length of this option will be a non-zero even number, since it contains one or more option types that are two octets each. The format of the option value is as below.

*Server Information, type 6

-Length MUST be non-zero. It MAY be used in Server Response messages and MUST NOT be used in other messages. Support for this option is OPTIONAL. A server supporting this option SHOULD add it in Server Response messages if and only if requested by the client. The value is a UTF-8 [RFC3629] string that might contain vendor and version information for the server implementation. It may also contain information on which options the server supports. An interactive client MAY support this option, and SHOULD then allow a user to request this string and display it. Although support for this is OPTIONAL, we say that a server SHOULD return it if requested, since this may be helpful to a user running the client. It is however purely informational, it is not needed for the protocol to function.

*Deprecated, type 7

-This option code value was used by implementations of version 1 of this protocol, and is not used in this version. Servers MUST treat it as an unknown option (not process it if received, but if received in an Echo Request message, it MUST be echoed in the Echo Reply message).

*Deprecated, type 8

- This option code value was used by implementations of version 1 of this protocol, and is not used in this version. Servers MUST treat it as an unknown option (not process it if received, but if received in an Echo Request message, it MUST be echoed in the Echo Reply message).

*TTL, type 9

- Length MUST be 1. This option contains a single octet specifying the TTL of an Echo Reply message. Every time a server sends a unicast or multicast Echo Reply message, it SHOULD include this option specifying the TTL. This is used by clients to determine the number of hops the messages have traversed. It MUST NOT be used in other messages. A server SHOULD specify this option if it knows what the TTL of the Echo Reply will be. In general the server can specify a specific TTL to the host stack. Note that the TTL is not necessarily the same for unicast and multicast. Also note that this option SHOULD be included even when not requested by the client. The protocol will work even if this option is not included, but it limits what information a client can obtain.

- If the server did not include this TTL option, there is no reliable way for the client to know the initial TTL of the Echo Reply, and therefore the client SHOULD NOT attempt to calculate the number of hops the message has traversed.

*Multicast Prefix, type 10

- Length MUST be greater than 2. It MAY be used in Init messages to request a group within the prefix(es) and it MAY be used in Server Response messages to tell the client what prefix(es) it may try to obtain a group from. It MUST NOT be used in Echo Request/Reply messages. Note that this option MAY be included multiple times to specify multiple prefixes. [addrfamily]. This is followed by a prefix length (4-32 for IPv4, 8-128 for IPv6, or 0 for the special "wildcard" use discussed below), and finally a group address. For any family, prefix length 0 means that any multicast address from that family is acceptable. This is what we call "wildcard." The group address need only contain enough octets to cover the prefix length bits (i.e., the group address would have to be 3 octets long if the prefix length is 17-24, and there need be no group address for the wildcard with prefix length 0). Any bits past the prefix length MUST be ignored. For IPv4, the option value length will be 4-7, while for IPv6, it will be 4-19, and for the wildcard, it will be 3.

*Session ID, type 11

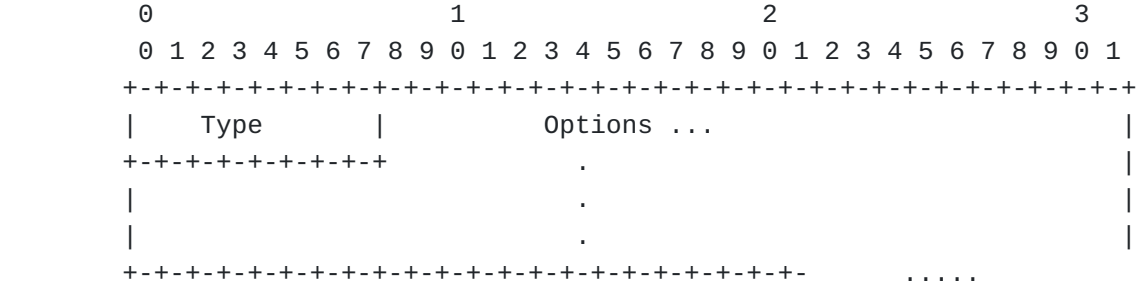
-Length MUST be 4 or larger. A server SHOULD include this in Server Response messages. If a client receives this option in a message, the client MUST echo the Session ID option in subsequent Echo Request messages, with the exact same value. The Session ID may help the server in keeping track of clients and possibly manage per client state. The value of a new Session ID SHOULD be a pseudo random byte string that is hard to predict, see [RFC4086]. The string MUST be at least 4 bytes long. The Session ID can be used to mitigate spoofing of the source address of Echo Request messages. We say that this option SHOULD be used, because it is important for security reasons. There may however be environments where this is not required. See the Security Considerations for details.

*Server Timestamp, type 12

-Length MUST be 8 bytes. A server supporting this option, SHOULD include it in Echo Reply messages, if requested by the client. The timestamp specifies the time when the Echo Reply message is sent. The first 4 bytes specify the number of seconds since the Epoch (0000 UTC Jan 1, 1970). The next 4 bytes specify the number of microseconds since the second specified in the first 4 bytes. If this option is not included, the protocol will still work, but it makes it impossible for a client to compute one way delay.

-Note that while this protocol uses the above 32 bit format, it would have been better to use another format, such as the one defined in NTPv4 [RFC5905]. This should be considered for future extensions of the protocol.

3.3. Packet Format



The format of all messages is a one octet message type, followed by a variable number of options.
There are four message types defined. Type 81 (the character Q in ASCII) specifies an Echo Request (Query). Type 65 (the character A in ASCII) specifies an Echo Reply (Answer). Type 73 (the character I in

ASCII) is an Init message, and type 83 (the character S in ASCII) is a Server Response message.
The options immediately follow the type octet and are not aligned in any way (no spacing or padding), i.e., options might start at any octet boundary. The option format is specified above.

3.4. Message Types and Options

There are four message types defined. We will now describe each of the message types and which options they may contain.

*Init, type 73

- This message is sent by a client to request information from a server. It is mainly used for requesting a group address, but it may also be used to check which group prefixes the server may provide groups from, or other server information. It MUST include a Version option, and SHOULD include a Client ID. It MAY include Option Request and Multicast Prefix Options. This message is a request for a group address if and only if it contains Multicast Prefix options. If multiple Prefix options are included, they should be in prioritised order. I.e., the server will consider the prefixes in the order they are specified, and if it finds a group for a prefix, it will only return that one group, not considering the remaining prefixes.

*Server Response, type 83

- This message is sent by a server, either as a response to an Init, or in response to an Echo Request. When responding to Init, it may provide the client with a multicast group (if requested by the client), or it may provide other server information. In response to an Echo Request, the message tells the client to stop sending Echo Requests. The Version option MUST always be included. Client ID and Sequence Number options are echoed if present in the client message. When providing a group to the client, it includes a Multicast Group option. It SHOULD include Server Information and Prefix options if requested. It SHOULD also include the Session ID option.

*Echo Request, type 81

- This message is sent by a client, asking the server to send unicast and multicast Echo Replies. It MUST include Version, Sequence Number and Multicast Group options. If a Session ID was received in a Server Response message, then the Session ID MUST be included. It SHOULD include Client ID and Client Timestamp options. It MAY include an Option Request option.

*Echo Reply, type 65

-This message is sent by a server in response to an Echo Request message. This message is always sent in pairs, one as unicast and one as multicast. The contents of the messages are mostly the same. The server always echoes all of the options (but never the Session ID) from the Echo Request. Any options in the Echo Request that are unsupported by the server, are also to be echoed. The two Echo Reply messages SHOULD both always contain a TTL option (not necessarily equal). Both Echo Reply messages SHOULD also when requested contain Server Timestamps (not necessarily equal).

Option \ Message Type	Init	Server Response	Echo Request	Echo Reply
Version (0)	MUST	MUST	MUST	ECHO
Client ID (1)	SHOULD	ECHO	SHOULD	ECHO
Sequence Number (2)	NOT	ECHO	MUST	ECHO
Client Timestamp (3)	NOT	NOT	SHOULD	ECHO
Multicast Group (4)	NOT	MAY	MUST	ECHO
Option Request (5)	MAY	NOT	MAY	ECHO
Server Information (6)	NOT	RQ	NOT	NOT
Deprecated (7)	NOT	NOT	NOT	ECHO
Deprecated (8)	NOT	NOT	NOT	ECHO
TTL (9)	NOT	NOT	NOT	SHOULD
Multicast Prefix (10)	MAY	MAY	NOT	NOT
Session ID (11)	NOT	SHOULD	ECHO	NOT
Server Timestamp (12)	NOT	NOT	NOT	RQ

The below matrix summarises what options can go in what messages.

3.5. Rate Limiting

Clients MUST by default send at most Default-Client-Request-Rate Section 3.5.1 Echo Requests per second. Note that the value can be less than 1. Servers MUST by default perform rate limiting, to guard against this protocol being used for DoS attacks. A server MUST by default limit the number of clients that can be served at the same time, and a server MUST also by default for a given client, respond to on average at most Default-Server-Rate-Limit (see Section 3.5.1) Echo Request messages per second. Note that the value can be less than 1. Server implementations should provide configuration options allowing certain clients to perform more rapid Echo Requests. If higher rates are allowed for specific client IP addresses, then Init messages and the Session ID option MUST be used to help mitigate spoofing.

Implementers of applications/tools using this protocol SHOULD consider the UDP guidelines *[RFC5405]*, in particular if clients are to send, or servers are to accept, Echo Requests at rates exceeding the defaults given in this document. See Section 9, "Security Considerations", for additional discussion.

3.5.1. Message Rate Variables

There are two variables that control message rates. They are defined as follows.

*Default-Client-Request-Rate

-This variable defines the default client echo request rate, specifying the number of requests per second. Note that the value may be less than one. E.g., a value of 0.1 means one packet per 10 seconds. The value 1 is RECOMMENDED, but the value might be too small or large depending on the type of network the client is deployed in. The value 1 is chosen because it should be safe in most deployments, and it is similar to what is typically used for the common tool "ping" for ICMP Echo Requests.

*Default-Server-Rate-Limit

-This variable defines the default per client rate limit that a server uses for responding to Echo Request messages. The average rate of replies, MUST NOT exceed Default-Server-Rate-Limit per second. Note that the value may be less than one. E.g., a value of 0.1 means an average of one packet per 10 seconds. The value 1 is RECOMMENDED, but the value might be too small or large depending on the type of network the client is deployed in. The value 1 is chosen because it should be safe in most deployments. This value SHOULD be high enough to accept the value chosen for the Default-Client-Request-Rate.

4. Client Behaviour

We will consider how a typical interactive client using the above protocol would behave.
A client only requires a user to specify the unicast address of the server. It can then send an Init message with a prefix option containing the desired address family and zero prefix length (wildcard entry). The server can then decide which group, from the specified family, it should return. A client may also allow the user to specify group address(es) or prefix(es) (for IPv6, the user may only be required to specify a scope or an RP address, from which the client can construct the desired prefix, possibly embedded-RP). From this the client can specify one or more prefix options in an Init message to tell the server which address it would prefer. If the user specifies a

group address, that can be encoded as a prefix of maximal length (e.g., 32 for IPv4). The prefix options are in prioritised order, i.e., the client should put the most preferred prefix first.
If the client receives a Server Response message containing a group address it can start sending Echo Request messages, see the next paragraph. If there is no group address option, the client would typically exit with an error message. The server may have included some prefix options in the Server Response. The client may use this to provide the user some feedback on what prefixes or scopes are available.
Assuming the client got a group address in a Server Response, it can start the multicast pings, after letting the user know which group is being used. Normally, a client should send at most Default-Client-Request-Rate Section 3.5.1 Echo Requests per second.
When sending the Echo Requests, the client must always include the group option. If the Server Response contained a Session ID, then it must also include that, with the exact same value, in the Echo Requests. If a client receives a Server Response message in response to an Echo Request (that is, a Server Response message containing a sequence number), this means there is an error and it should stop sending Echo Requests. This could happen after server restart.
The client may allow the user to request server information. If the user requests server information, the client can send an Init message with no prefix options, but with an Option Request Option, requesting the server to return a Server Information option. The server will return server information if supported, and it may also return a list of prefixes it supports. It will however not return a group address.
The client may also try to obtain only a list of prefixes by sending an Init message with no prefixes and not requesting any specific options.
Although not recommended, a client may pick a multicast group and send Echo Request messages without first going through the Init - Server Response negotiation. If this is supported by the server and the server is okay with the group used, the server can then send Echo Reply messages as usual. If the server is not okay, it will send a Server Response telling the client to stop.

5. Server Behaviour

We will consider how a typical server using the above protocol would behave, first looking at how to respond to Init messages.
If the Init message contains prefix options, the server should look at them in order and see if it can assign a multicast address from the given prefix. The server would be configured with, possibly have a default, a set of groups it can offer. It may have a large pool and pick a group at random, or possibly choosing a group based on hashing of the client's IP address or identifier, or simply use a fixed group.
A server could possibly decide whether to include site scoped group ranges based on the client's IP address. It is left to the server to

decide whether it should allow the same address to be used simultaneously by multiple clients.
If the server finds a suitable group address, it returns this in a group option in a Server Response message. The server should additionally include a Session ID. This may help the server if it is to keep some state, for instance to make sure the client uses the group it got assigned. A good Session ID would be a pseudo random byte string that is hard to predict, see [RFC4086]. If the server cannot find a suitable group address, or if there were no prefixes in the Init message, it may send a Server Response message containing prefix options listing what prefixes may be available to the client. Finally, if the Init message requests the Server Information option, the server should include that.
When the server receives an Echo Request message, it must first check that the group address and Session ID (if provided) are valid. If the server is satisfied, it will send a unicast Echo Reply message back to the client, and also a multicast Echo Reply message to the group address. The Echo Reply messages contain the exact options (but no Session ID) and in the same order, as in the Echo Request, and after that the server adds a TTL option and additional options if needed. For example, it may add a timestamp if requested by the client. If the server is not happy with the Echo Request (such as bad group address or Session ID, request is too large), it may send a Server Response message asking the client to stop. This Server Response must echo the sequence number from the Echo Request. This Server Response may contain group prefixes from which a client can try to request a group address. The unicast and multicast Echo Reply messages have identical UDP payload apart from possibly TTL and timestamp option values.
Note that the server may receive Echo Request messages with no prior Init message. This may happen when the server restarts or if a client sends an Echo Request with no prior Init message. The server may go ahead and respond if it is okay with the group and Session ID (if included) used. If it is not okay, the server sends back a Server Response.

6. Recommendations for Implementers

The protocol as specified is fairly flexible and leaves a lot of freedom for implementers. In this section we present some recommendations.
Server administrators should be able to configure one or multiple group prefixes in a server implementation. When deploying servers on the Internet and in other environments, the server administrator should be able to restrict the server to respond to only a few multicast groups which should not be currently used by multicast applications. A server implementation should also provide flexibility for an administrator to apply various policies to provide one or multiple group prefixes to specific clients, e.g., site scoped addresses for clients that are inside the site.

As specified in Section 3.5, a server must by default for a given client, respond to at most an average rate of Default-Server-Rate-Limit Echo Request messages per second. A leaky bucket algorithm is suggested, where the rate can be higher for a few seconds, but the average rate should by default be limited to Default-Server-Rate-Limit messages per per client per second. Server implementations should provide administrative control of which client IP addresses to serve, and may also allow certain clients to perform more rapid Echo Requests. If a server uses different policies for different IP addresses, it should require clients to send Init messages and return an unpredictable Session ID to help mitigate spoofing. This is an absolute requirement if exceeding the default rate limit. See specification in Section 3.5.

7. Acknowledgments

The ssmping concept was proposed by Pavan Namburi, Kamil Sarac and Kevin C. Almeroth in the paper SSM-Ping: A Ping Utility for Source Specific Multicast, and also the Internet Draft draft-sarac-mping-00.txt. Mickael Hoerdt has contributed with several ideas. Alexander Gall, Nicholas Humfrey, Nick Lamb and Dave Thaler have contributed in different ways to the implementation of the ssmping tools at [impl]. Many people in communities like TERENA, Internet2 and the M6Bone have used early implementations of ssmping and provided feedback that have influenced the current protocol. Thanks to Kevin Almeroth, Tony Ballardie, Bill Cerveny, Toerless Eckert, Marshall Eubanks, Gorry Fairhurst, Alfred Hoenes, Liu Hui, Bharat Joshi, Olav Kvittem, Hugo Santos, Kamil Sarac, Pekka Savola, Trond Skjesol and Cao Wei for reviewing and providing feedback on this draft. In particular Hugo, Gorry and Bharat have provided lots of input on several revisions of the draft.

8. IANA Considerations

IANA is requested to assign a UDP user-port in the range 1024-49151 for use by this protocol, and also to provide registries for message and option types. The string "[TBD]" in this document should be replaced with the assigned port.
There should be a message types registry. Message types are in the range 0-255. Message types 0-253 are registered following the procedures for Specification Required from RFC 5226 *[RFC5226]*, while types 254 and 255 are for experimental use and are not registered. The registry should include the messages defined in Section 3.4. A message specification MUST describe the behaviour with known option types as well as the default behaviour with unknown ones.
There should also be an option type registry. Option types 0-65531 are registered following the procedures for Specification Required from RFC 5226 *[RFC5226]*, while types 65532-65535 are for experimental use and are not registered. The registry should include the options defined in

Section 3.2. An option specification must describe how the option may be used with the known message types. This includes which message types the option may be used with.

Multicast Ping Protocol Parameters:

Registry Name: Multicast Ping Protocol Message Types
Reference: [this doc]
Registration Procedures: Specification Required

Registry:

Type	Name	Reference
65	Echo Reply	[this doc]
73	Init	[this doc]
81	Echo Request	[this doc]
83	Server Response	[this doc]
254-255	Experimental	

Registry Name: Multicast Ping Protocol Option Types
Reference: [this doc]
Registration Procedures: Specification Required

Registry:

Type	Name	Reference
0	Version	[this doc]
1	Client ID	[this doc]
2	Sequence Number	[this doc]
3	Client Timestamp	[this doc]
4	Multicast Group	[this doc]
5	Option Request Option	[this doc]
6	Server Information	[this doc]
7	Deprecated	[this doc]
8	Deprecated	[this doc]
9	TTL	[this doc]
10	Multicast Prefix	[this doc]
11	Session ID	[this doc]
12	Server Timestamp	[this doc]
65532-65535	Experimental	

The initial registry definitions are as follows:

9. Security Considerations

There are some security issues to consider. One is that a host may send an Echo Request with an IP source address of another host, and make an arbitrary multicast ping server on the Internet send packets to this other host. This behaviour is fairly harmless. The worst case is if the

host receiving the unicast Echo Replies also happens to be joined to the multicast group used. This is less of a problem for SSM where also the source address of the server must match the address joined. In this case, there would be an amplification effect where the host receives twice as many replies as there are requests sent. See below for how spoofing can be mitigated.

For ASM (Any-Source Multicast) a host could also make a multicast ping server send multicast packets to a group that is used for something else, possibly disturbing other uses of that group. However, server implementations should allow administrators to restrict which groups a server responds to. The administrator should then try to configure a set of groups that are not used for other purposes. Another concern is bandwidth. To limit the bandwidth used, a server MUST by default limit the number of clients that can be served at the same time, and a server MUST also by default perform per client rate limiting.

In order to help mitigate spoofing, a server SHOULD require the client to send an Init message, and return an unpredictable Session ID in the response. The ID should be associated with the IP address and have a limited lifetime. The server SHOULD then only respond to Echo Request messages that have a valid Session ID associated with the source IP address of the Echo Request. Note however that a server is replying with a Server Response message if the Session ID is invalid. This is used to tell the client that something is wrong and that is should stop sending requests, and start over if necessary. This means however, that someone may spoof a client request, and have the server send a message back to the client address. One solution here would be for the server to have a very low rate limit for the Server Responses.

Note that the use of a Session ID only to some degree helps mitigate spoofing. An attacker that is on the path between a client and a server, may eavesdrop the traffic, learn a valid Session ID, and generate Echo Requests using this ID. The server will respond as long as the Session ID remains valid.

This protocol may be used to establish a covert channel between a multicast ping client and other hosts listening to a multicast group. A client can for instance send an Echo Request containing an undefined option with arbitrary data. The server would echo this back in an Echo Reply that may reach other hosts listening to that group. One solution to this which should be considered for future protocol versions, is to reply with a hash of the data, rather than simply a copy of the same data.

10. References

10.1. Normative References

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10.2. Informative References

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