Materiales adicionales

de

Redes de Ordenadores

RFC 792-ICMP

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INTERNET CONTROL MESSAGE PROTOCOL

DARPA INTERNET PROGRAM

PROTOCOL SPECIFICATION

Introduction

   The Internet Protocol (IP) [1] is used for host-to-host datagram
   service in a system of interconnected networks called the
   Catenet [2]. The network connecting devices are called Gateways.
   These gateways communicate between themselves for control purposes
   via a Gateway to Gateway Protocol (GGP) [3,4]. Occasionally a
   gateway or destination host will communicate with a source host, for
   example, to report an error in datagram processing. For such
   purposes this protocol, the Internet Control Message Protocol (ICMP),
   is used. ICMP, uses the basic support of IP as if it were a higher
   level protocol, however, ICMP is actually an integral part of IP, and
   must be implemented by every IP module.

   ICMP messages are sent in several situations: for example, when a
   datagram cannot reach its destination, when the gateway does not have
   the buffering capacity to forward a datagram, and when the gateway
   can direct the host to send traffic on a shorter route.

   The Internet Protocol is not designed to be absolutely reliable. The
   purpose of these control messages is to provide feedback about
   problems in the communication environment, not to make IP reliable.
   There are still no guarantees that a datagram will be delivered or a
   control message will be returned. Some datagrams may still be
   undelivered without any report of their loss. The higher level

protocols that use IP must implement their own reliability procedures
if reliable communication is required.

The ICMP messages typically report errors in the processing of
datagrams. To avoid the infinite regress of messages about messages
etc., no ICMP messages are sent about ICMP messages. Also ICMP
messages are only sent about errors in handling fragment zero of
fragemented datagrams. (Fragment zero has the fragment offeset equal
zero).

Message Formats

   ICMP messages are sent using the basic IP header. The first octet of
   the data portion of the datagram is a ICMP type field; the value of
   this field determines the format of the remaining data. Any field
   labeled "unused" is reserved for later extensions and must be zero
   when sent, but receivers should not use these fields (except to
   include them in the checksum). Unless otherwise noted under the
   individual format descriptions, the values of the internet header
   fields are as follows:

   Version

      4

   IHL

      Internet header length in 32-bit words.

   Type of Service

      0

   Total Length

      Length of internet header and data in octets.

   Identification, Flags, Fragment Offset

      Used in fragmentation, see [1].

   Time to Live

Time to live in seconds; as this field is decremented at each
   machine in which the datagram is processed, the value in this
   field should be at least as great as the number of gateways which
   this datagram will traverse.

Protocol

   ICMP = 1

Header Checksum

   The 16 bit one's complement of the one's complement sum of all 16
   bit words in the header. For computing the checksum, the checksum
   field should be zero. This checksum may be replaced in the
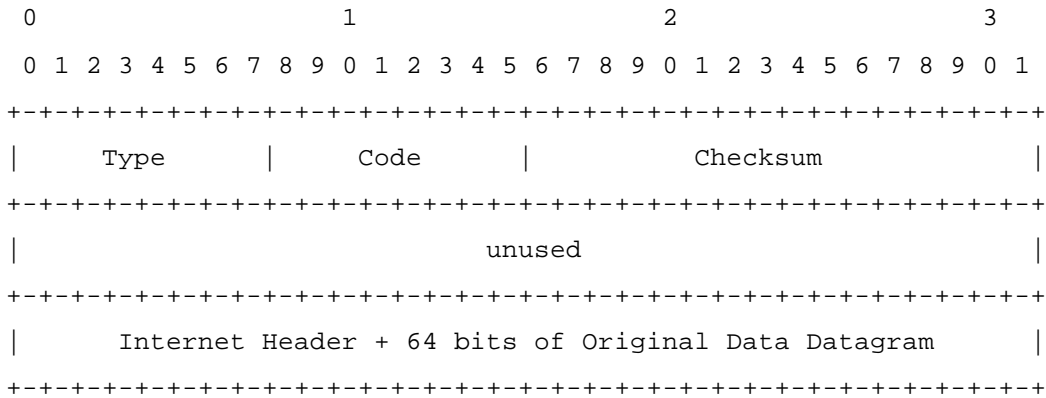   future.

Source Address

The address of the gateway or host that composes the ICMP message.
Unless otherwise noted, this can be any of a gateway's addresses.

Destination Address

The address of the gateway or host to which the message should be
sent.

Destination Unreachable Message

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Code      |          Checksum             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             unused                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Internet Header + 64 bits of Original Data Datagram      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Destination Address

   The source network and address from the original datagram's data.

ICMP Fields:

Type

   3

Code

   0 = net unreachable;

   1 = host unreachable;

   2 = protocol unreachable;

   3 = port unreachable;

4 = fragmentation needed and DF set;

            5 = source route failed.

      Checksum

            The checksum is the 16-bit ones's complement of the one's
            complement sum of the ICMP message starting with the ICMP Type.
            For computing the checksum , the checksum field should be zero.
            This checksum may be replaced in the future.

      Internet Header + 64 bits of Data Datagram

            The internet header plus the first 64 bits of the original

datagram's data. This data is used by the host to match the
message to the appropriate process. If a higher level protocol
uses port numbers, they are assumed to be in the first 64 data
bits of the original datagram's data.

Description

If, according to the information in the gateway's routing tables,
the network specified in the internet destination field of a
datagram is unreachable, e.g., the distance to the network is
infinity, the gateway may send a destination unreachable message
to the internet source host of the datagram. In addition, in some
networks, the gateway may be able to determine if the internet
destination host is unreachable. Gateways in these networks may
send destination unreachable messages to the source host when the
destination host is unreachable.

If, in the destination host, the IP module cannot deliver the
datagram because the indicated protocol module or process port is
not active, the destination host may send a destination
unreachable message to the source host.

Another case is when a datagram must be fragmented to be forwarded
by a gateway yet the Don't Fragment flag is on. In this case the
gateway must discard the datagram and may return a destination
unreachable message.

Codes 0, 1, 4, and 5 may be received from a gateway. Codes 2 and
3 may be received from a host.

Time Exceeded Message

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Code      |          Checksum             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |                             unused                            |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Internet Header + 64 bits of Original Data Datagram      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Destination Address

   The source network and address from the original datagram's data.

ICMP Fields:

Type

   11

Code

   0 = time to live exceeded in transit;

   1 = fragment reassembly time exceeded.

Checksum

   The checksum is the 16-bit ones's complement of the one's

complement sum of the ICMP message starting with the ICMP Type.
For computing the checksum , the checksum field should be zero.
This checksum may be replaced in the future.

Internet Header + 64 bits of Data Datagram

The internet header plus the first 64 bits of the original
datagram's data. This data is used by the host to match the
message to the appropriate process. If a higher level protocol
uses port numbers, they are assumed to be in the first 64 data
bits of the original datagram's data.

Description

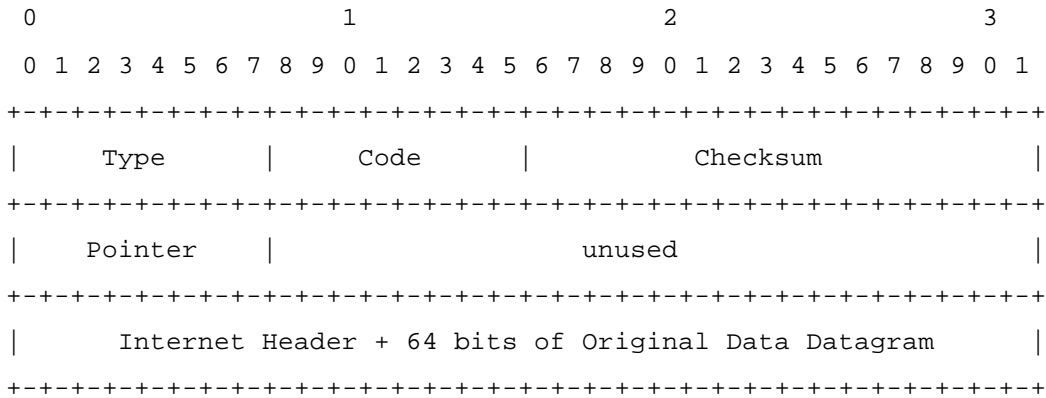If the gateway processing a datagram finds the time to live field

is zero it must discard the datagram. The gateway may also notify
the source host via the time exceeded message.

If a host reassembling a fragmented datagram cannot complete the
reassembly due to missing fragments within its time limit it
discards the datagram, and it may send a time exceeded message.

If fragment zero is not available then no time exceeded need be
sent at all.

Code 0 may be received from a gateway. Code 1 may be received
from a host.

Parameter Problem Message

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Code      |          Checksum             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |    Pointer    |                   unused                      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |      Internet Header + 64 bits of Original Data Datagram      |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Destination Address

    The source network and address from the original datagram's data.

ICMP Fields:

Type

    12

Code

    0 = pointer indicates the error.

Checksum

    The checksum is the 16-bit ones's complement of the one's
    complement sum of the ICMP message starting with the ICMP Type.
    For computing the checksum , the checksum field should be zero.

This checksum may be replaced in the future.

   Pointer

      If code = 0, identifies the octet where an error was detected.

   Internet Header + 64 bits of Data Datagram

      The internet header plus the first 64 bits of the original
      datagram's data. This data is used by the host to match the
      message to the appropriate process. If a higher level protocol
      uses port numbers, they are assumed to be in the first 64 data
      bits of the original datagram's data.
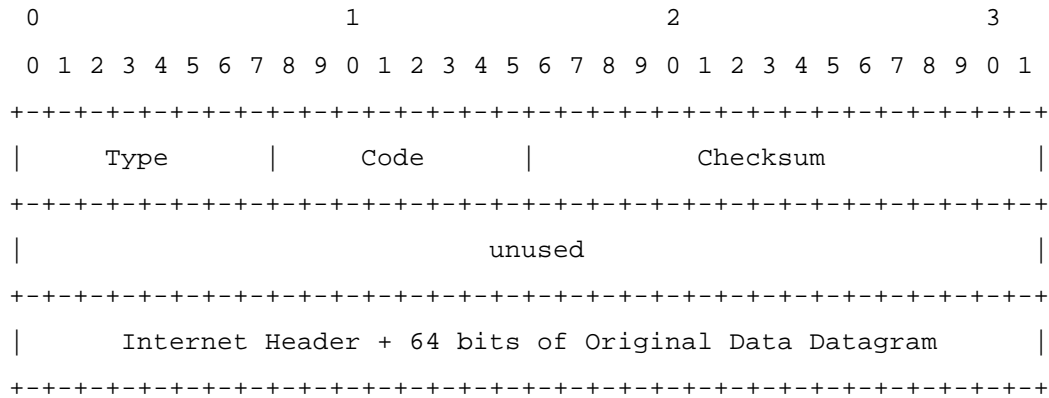
Description

   If the gateway or host processing a datagram finds a problem with
   the header parameters such that it cannot complete processing the
   datagram it must discard the datagram. One potential source of
   such a problem is with incorrect arguments in an option. The
   gateway or host may also notify the source host via the parameter
   problem message. This message is only sent if the error caused
   the datagram to be discarded.

   The pointer identifies the octet of the original datagram's header
   where the error was detected (it may be in the middle of an
   option). For example, 1 indicates something is wrong with the
   Type of Service, and (if there are options present) 20 indicates
   something is wrong with the type code of the first option.

   Code 0 may be received from a gateway or a host.

Source Quench Message

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |          Checksum             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            unused                             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Internet Header + 64 bits of Original Data Datagram      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Destination Address

   The source network and address of the original datagram's data.

ICMP Fields:

Type

   4

Code

   0

Checksum

   The checksum is the 16-bit ones's complement of the one's
   complement sum of the ICMP message starting with the ICMP Type.
   For computing the checksum , the checksum field should be zero.

This checksum may be replaced in the future.

Internet Header + 64 bits of Data Datagram

The internet header plus the first 64 bits of the original
datagram's data. This data is used by the host to match the
message to the appropriate process. If a higher level protocol
uses port numbers, they are assumed to be in the first 64 data
bits of the original datagram's data.

Description

A gateway may discard internet datagrams if it does not have the
buffer space needed to queue the datagrams for output to the next
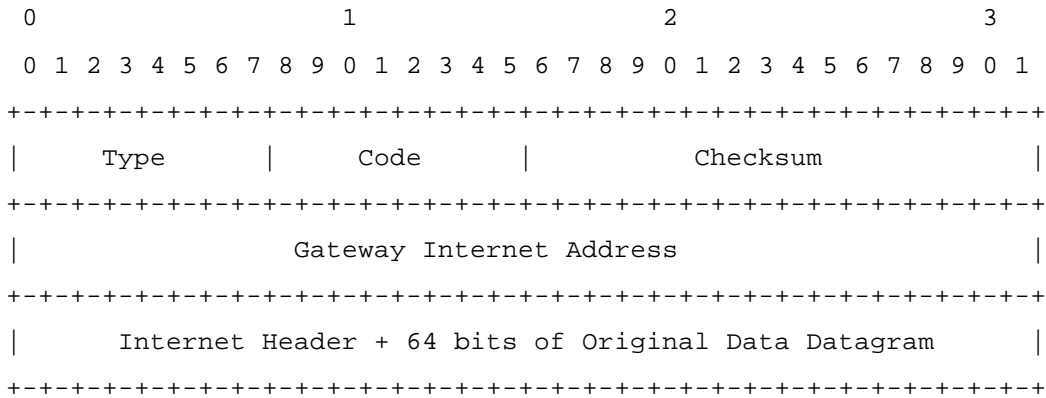network on the route to the destination network. If a gateway

discards a datagram, it may send a source quench message to the internet source host of the datagram. A destination host may also send a source quench message if datagrams arrive too fast to be processed. The source quench message is a request to the host to cut back the rate at which it is sending traffic to the internet destination. The gateway may send a source quench message for every message that it discards. On receipt of a source quench message, the source host should cut back the rate at which it is sending traffic to the specified destination until it no longer receives source quench messages from the gateway. The source host can then gradually increase the rate at which it sends traffic to the destination until it again receives source quench messages.

The gateway or host may send the source quench message when it approaches its capacity limit rather than waiting until the capacity is exceeded. This means that the data datagram which triggered the source quench message may be delivered.

Code 0 may be received from a gateway or a host.

Redirect Message

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |          Checksum             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                 Gateway Internet Address                      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|      Internet Header + 64 bits of Original Data Datagram      |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Destination Address

   The source network and address of the original datagram's data.

ICMP Fields:

Type

   5

Code

   0 = Redirect datagrams for the Network.

   1 = Redirect datagrams for the Host.

   2 = Redirect datagrams for the Type of Service and Network.

   3 = Redirect datagrams for the Type of Service and Host.

Checksum

   The checksum is the 16-bit ones's complement of the one's
   complement sum of the ICMP message starting with the ICMP Type.
   For computing the checksum , the checksum field should be zero.
   This checksum may be replaced in the future.

Gateway Internet Address

   Address of the gateway to which traffic for the network specified
   in the internet destination network field of the original
   datagram's data should be sent.

Internet Header + 64 bits of Data Datagram

The internet header plus the first 64 bits of the original
datagram's data. This data is used by the host to match the
message to the appropriate process. If a higher level protocol
uses port numbers, they are assumed to be in the first 64 data
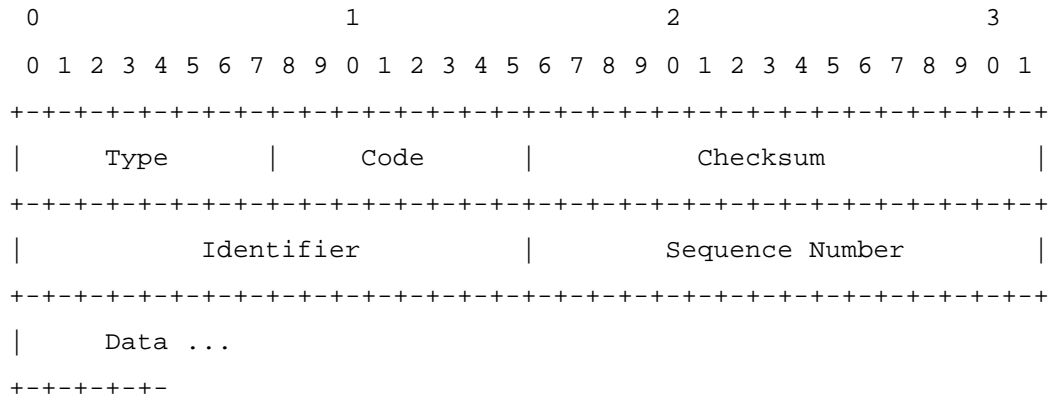bits of the original datagram's data.

Description

The gateway sends a redirect message to a host in the following
situation. A gateway, G1, receives an internet datagram from a
host on a network to which the gateway is attached. The gateway,
G1, checks its routing table and obtains the address of the next
gateway, G2, on the route to the datagram's internet destination
network, X. If G2 and the host identified by the internet source
address of the datagram are on the same network, a redirect
message is sent to the host. The redirect message advises the
host to send its traffic for network X directly to gateway G2 as
this is a shorter path to the destination. The gateway forwards
the original datagram's data to its internet destination.

For datagrams with the IP source route options and the gateway
address in the destination address field, a redirect message is
not sent even if there is a better route to the ultimate
destination than the next address in the source route.

Codes 0, 1, 2, and 3 may be received from a gateway.

Echo or Echo Reply Message

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Type      |     Code      |          Checksum             |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           Identifier          |        Sequence Number        |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     Data ...
+-+-+-+-+-
```

IP Fields:

Addresses

   The address of the source in an echo message will be the
   destination of the echo reply message. To form an echo reply
   message, the source and destination addresses are simply reversed,
   the type code changed to 0, and the checksum recomputed.

IP Fields:

Type

   8 for echo message;

   0 for echo reply message.

Code

   0

Checksum

   The checksum is the 16-bit ones's complement of the one's
   complement sum of the ICMP message starting with the ICMP Type.
   For computing the checksum , the checksum field should be zero.
   If the total length is odd, the received data is padded with one
   octet of zeros for computing the checksum. This checksum may be
   replaced in the future.

Identifier

   If code = 0, an identifier to aid in matching echos and replies,
   may be zero.

Sequence Number

If code = 0, a sequence number to aid in matching echos and
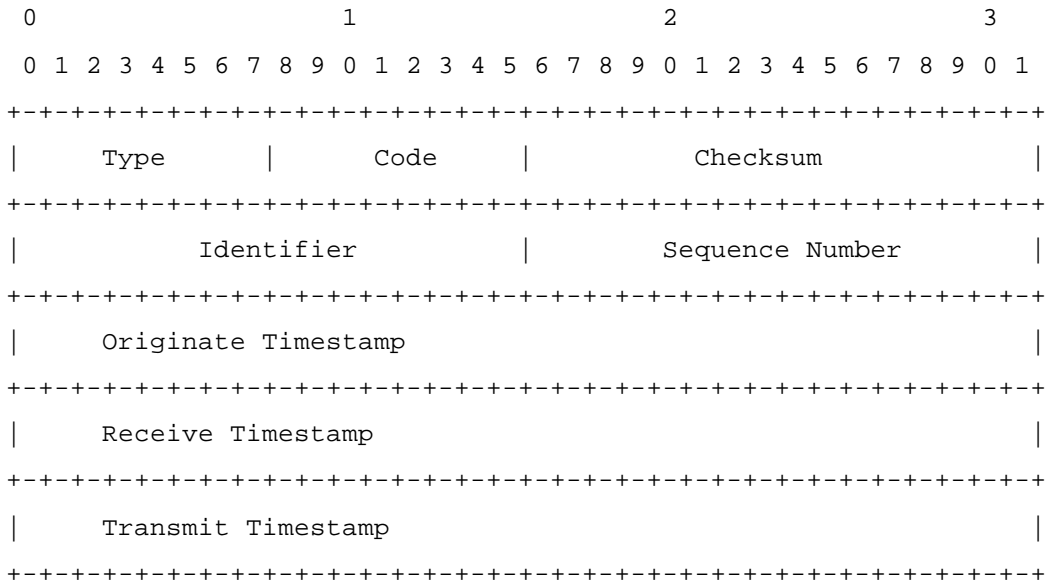replies, may be zero.

Description

The data received in the echo message must be returned in the echo
reply message.

The identifier and sequence number may be used by the echo sender
to aid in matching the replies with the echo requests. For
example, the identifier might be used like a port in TCP or UDP to
identify a session, and the sequence number might be incremented
on each echo request sent. The echoer returns these same values
in the echo reply.

Code 0 may be received from a gateway or a host.

Timestamp or Timestamp Reply Message

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |      Code     |          Checksum             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Identifier          |        Sequence Number        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Originate Timestamp                                       |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Receive Timestamp                                         |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Transmit Timestamp                                        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Addresses

   The address of the source in a timestamp message will be the
   destination of the timestamp reply message. To form a timestamp
   reply message, the source and destination addresses are simply
   reversed, the type code changed to 14, and the checksum
   recomputed.

IP Fields:

Type

   13 for timestamp message;

   14 for timestamp reply message.

Code

   0

Checksum

   The checksum is the 16-bit ones's complement of the one's
   complement sum of the ICMP message starting with the ICMP Type.
   For computing the checksum , the checksum field should be zero.
   This checksum may be replaced in the future.

Identifier

If code = 0, an identifier to aid in matching timestamp and replies, may be zero.

Sequence Number

If code = 0, a sequence number to aid in matching timestamp and replies, may be zero.

Description

The data received (a timestamp) in the message is returned in the reply together with an additional timestamp. The timestamp is 32 bits of milliseconds since midnight UT. One use of these timestamps is described by Mills [5].
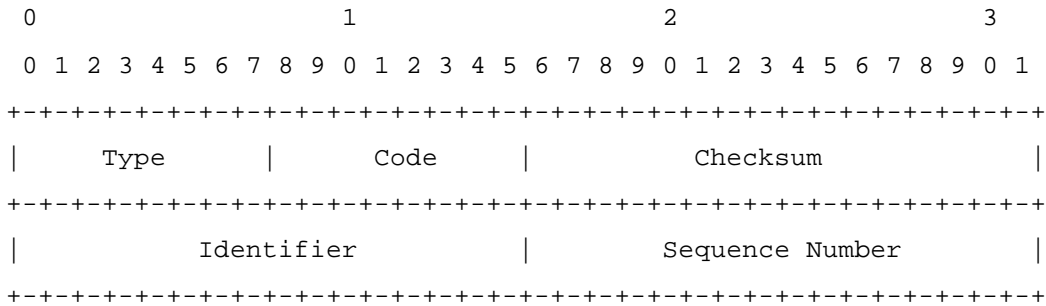
The Originate Timestamp is the time the sender last touched the message before sending it, the Receive Timestamp is the time the echoer first touched it on receipt, and the Transmit Timestamp is the time the echoer last touched the message on sending it.

If the time is not available in miliseconds or cannot be provided with respect to midnight UT then any time can be inserted in a timestamp provided the high order bit of the timestamp is also set to indicate this non-standard value.

The identifier and sequence number may be used by the echo sender to aid in matching the replies with the requests. For example, the identifier might be used like a port in TCP or UDP to identify a session, and the sequence number might be incremented on each request sent. The destination returns these same values in the reply.

Code 0 may be received from a gateway or a host.

Information Request or Information Reply Message

```
    0                   1                   2                   3
    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |     Type      |     Code      |          Checksum             |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
   |           Identifier          |        Sequence Number        |
   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

IP Fields:

Addresses

   The address of the source in a information request message will be
   the destination of the information reply message. To form a
   information reply message, the source and destination addresses
   are simply reversed, the type code changed to 16, and the checksum
   recomputed.

IP Fields:

Type

   15 for information request message;

   16 for information reply message.

Code

   0

Checksum

The checksum is the 16-bit ones's complement of the one's
complement sum of the ICMP message starting with the ICMP Type.
For computing the checksum , the checksum field should be zero.
This checksum may be replaced in the future.

Identifier

If code = 0, an identifier to aid in matching request and replies,
may be zero.

Sequence Number

If code = 0, a sequence number to aid in matching request and
replies, may be zero.

Description

   This message may be sent with the source network in the IP header
   source and destination address fields zero (which means "this"
   network). The replying IP module should send the reply with the
   addresses fully specified. This message is a way for a host to
   find out the number of the network it is on.

   The identifier and sequence number may be used by the echo sender
   to aid in matching the replies with the requests. For example,
   the identifier might be used like a port in TCP or UDP to identify
   a session, and the sequence number might be incremented on each
   request sent. The destination returns these same values in the
   reply.

   Code 0 may be received from a gateway or a host.

Summary of Message Types

     0 Echo Reply

     3 Destination Unreachable

     4 Source Quench

     5 Redirect

     8 Echo

    11 Time Exceeded

    12 Parameter Problem

    13 Timestamp

    14 Timestamp Reply

    15 Information Request

    16 Information Reply

References

[1]   Postel, J. (ed.), "Internet Protocol - DARPA Internet Program
      Protocol Specification," RFC 791, USC/Information Sciences
      Institute, September 1981.

[2]   Cerf, V., "The Catenet Model for Internetworking," IEN 48,
      Information Processing Techniques Office, Defense Advanced
      Research Projects Agency, July 1978.

[3]   Strazisar, V., "Gateway Routing: An Implementation
      Specification", IEN 30, Bolt Beranek and Newman, April 1979.

[4]   Strazisar, V., "How to Build a Gateway", IEN 109, Bolt Beranek
      and Newman, August 1979.

[5]   Mills, D., "DCNET Internet Clock Service," RFC 778, COMSAT
      Laboratories, April 1981.