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Internet Control Message Protocol

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.

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 check these fields. 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.

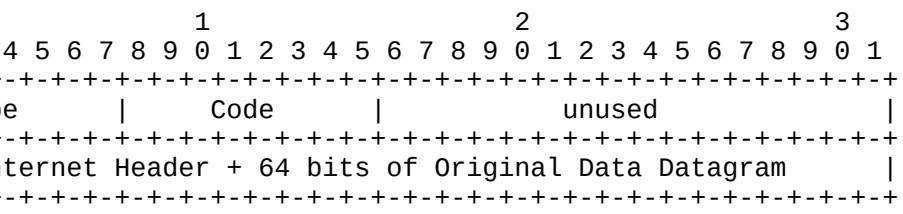
Source Address

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



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.

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

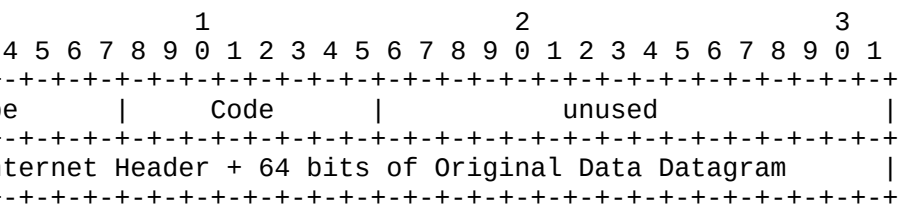
If, according to the information in the gateway's routing tables, the network specified in the internet destination field of a datagram is unreachable, e.g., the distance to the network is infinity, the gateway sends a destination unreachable message to

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 return a destination unreachable message.

Time Exceeded Message



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.

Internet Header + 64 bits of Data Datagram

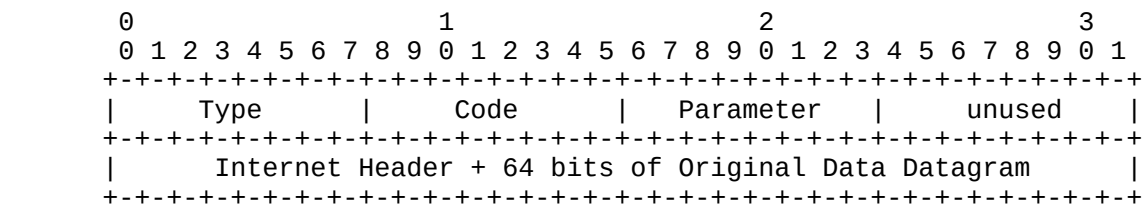
The internet header plus the first 64 bits of the original datagram's data. This data is used by the host to match the message to the appropriate process. If a higher level protocol uses port numbers, they are assumed to be in the first 64 data bits of the original datagram's data.

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.

Parameter Problem Message



IP Fields:

Destination Address

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

ICMP Fields:

Type

12

Code

0 = problem with option.

Parameter

If code = 0, IP option type.

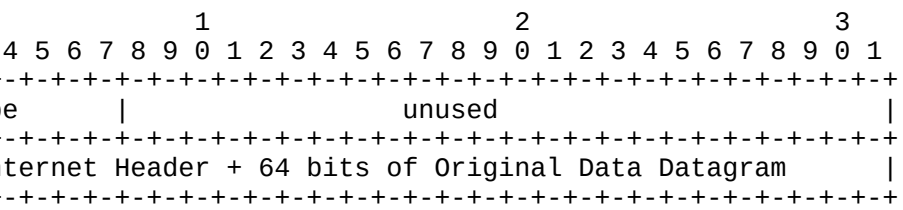
Internet Header + 64 bits of Data Datagram

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 an option that is not implemented, or incorrect arguments in an option. The gateway or host may also notify the source host via the parameter problem message.

Source Quench Message



IP Fields:

Destination Address

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

ICMP Fields:

Type

4

Internet Header + 64 bits of Data Datagram

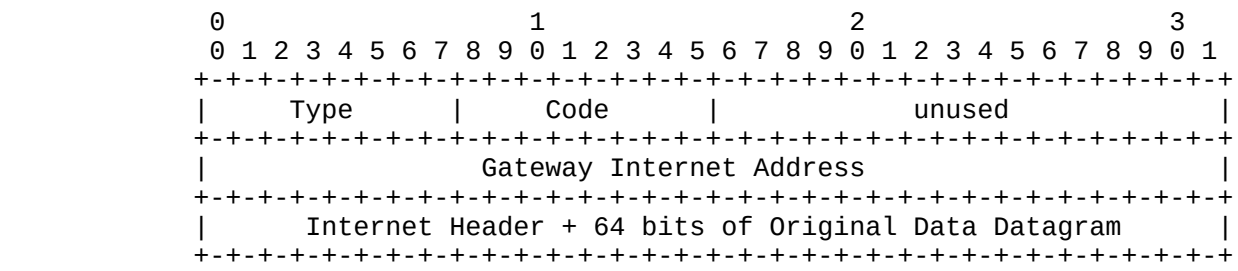
The internet header plus the first 64 bits of the original datagram's data. This data is used by the host to match the message to the appropriate process. If a higher level protocol uses port numbers, they are assumed to be in the first 64 data bits of the original datagram's data.

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.

Redirect Message



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.

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.

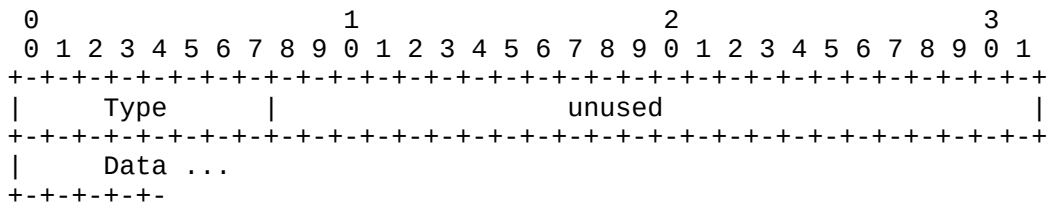
Internet Header + 64 bits of Data Datagram

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.

Echo or Echo Reply Message



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.

IP Fields:

Type

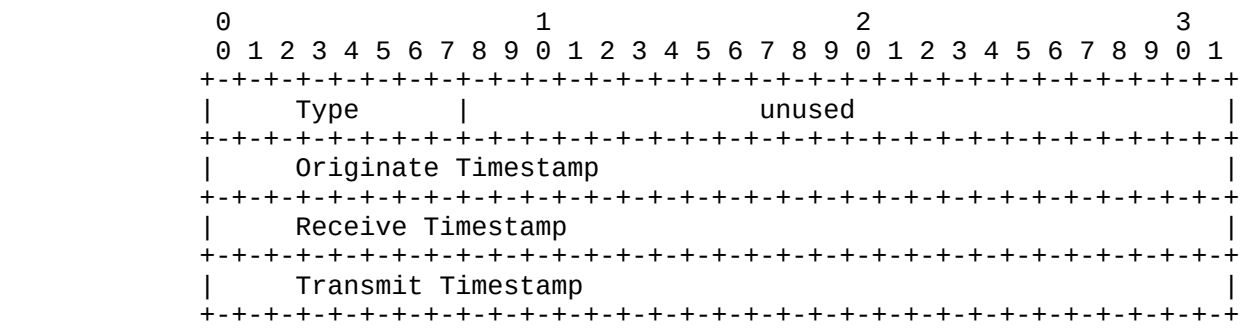
8 for echo message;

0 for echo reply message.

Description

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

Timestamp or Timestamp Reply Message



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.

IP Fields:

Type

13 for timestamp message;

14 for timestamp reply message.

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].

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

References

[1] Postel, J., ed., "DOD Standard Internet Protocol", IEN 128, RFC 760, USC/Information Sciences Institute, NTIS ADA079730, January 1980. Appears in: Computer Communication Review, Special Interest Group on Data Communications, ACM, V.10, N.4, October 1980.

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