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Minimal Encapsulation within IP

Status of This Memo

Abstract

This document specifies a method by which an IP datagram may be encapsulated (carried as payload) within an IP datagram, with less overhead than "conventional" IP encapsulation that adds a second IP header to each encapsulated datagram. Encapsulation is suggested as a means to alter the normal IP routing for datagrams, by delivering them to an intermediate destination that would otherwise not be selected by the (network part of the) IP Destination Address field in the original IP header. Encapsulation may be serve a variety of purposes, such as delivery of a datagram to a mobile node using Mobile IP.

1. Introduction

This document specifies a method by which an IP datagram may be encapsulated (carried as payload) within an IP datagram, with less overhead than "conventional" IP encapsulation [4] that adds a second IP header to each encapsulated datagram. Encapsulation is suggested as a means to alter the normal IP routing for datagrams, by delivering them to an intermediate destination that would otherwise not be selected by the (network part of the) IP Destination Address field in the original IP header. The process of encapsulation and decapsulation of a datagram is frequently referred to as "tunneling" the datagram, and the encapsulator and decapsulator are then considered to be the the "endpoints" of the tunnel; the encapsulator node is refered to as the "entry point" of the tunnel, and the decapsulator node is refered to as the "exit point" of the tunnel.

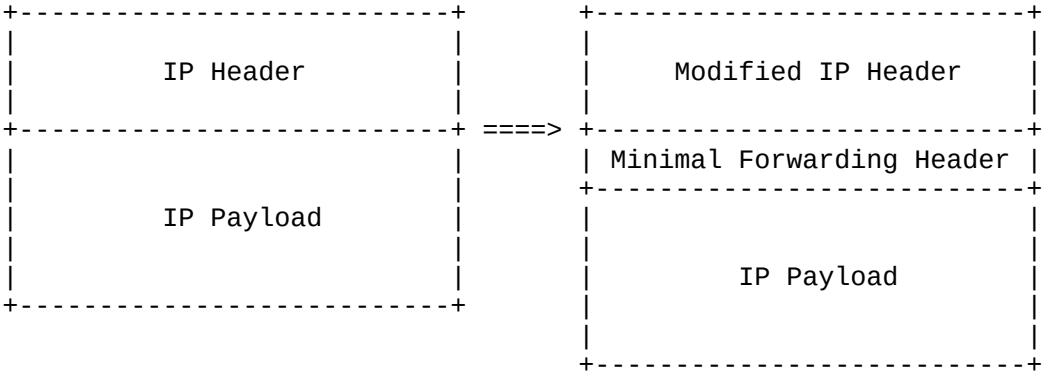
2. Motivation

The Mobile IP working group has specified the use of encapsulation as a way to deliver packets from a mobile node's "home network" to an agent that can deliver datagrams locally by conventional means to the mobile node at its current location away from home [5]. The use of encapsulation may also be indicated whenever the source (or an intermediate router) of an IP datagram must influence the route by which a datagram is to be delivered to its ultimate destination. Other possible applications of encapsulation include multicasting, preferential billing, choice of routes with selected security attributes, and general policy routing.

See [4] for a discussion concerning the advantages of encapsulation versus use of the IP loose source routing option. Using IP headers to encapsulate IP datagrams requires the unnecessary duplication of several fields within the inner IP header; it is possible to save some additional space by specifying a new encapsulation mechanism that eliminates the duplication. The scheme outlined here comes from the Mobile IP Working Group (in earlier Internet Drafts), and is similar to that which had been defined in [2].

3. Minimal Encapsulation

A minimal forwarding header is defined for datagrams which are not fragmented prior to encapsulation. Use of this encapsulating method is optional. Minimal encapsulation MUST NOT be used when an original datagram is already fragmented, since there is no room in the minimal forwarding header to store fragmentation information. To encapsulate an IP datagram using minimal encapsulation, the minimal forwarding header is inserted into the datagram, as follows:



The IP header of the original datagram is modified, and the minimal forwarding header is inserted into the datagram after the IP header, followed by the unmodified IP payload of the original datagram (e.g., transport header and transport data). No additional IP header is added to the datagram.

In encapsulating the datagram, the original IP header [6] is modified as follows:

- The Protocol field in the IP header is replaced by protocol number 55 for the minimal encapsulation protocol.

- The Destination Address field in the IP header is replaced by the IP address of the exit point of the tunnel.

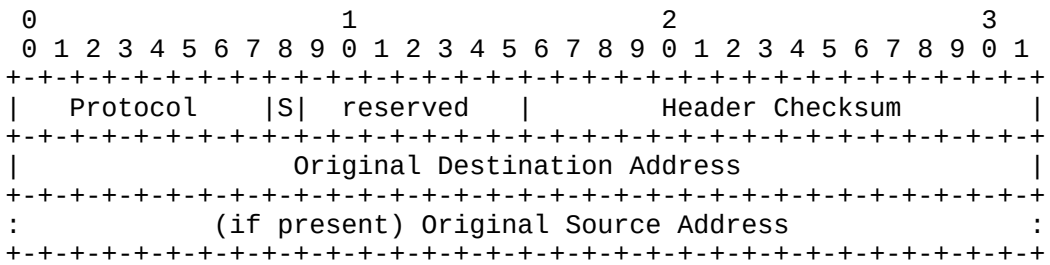
- If the encapsulator is not the original source of the datagram, the Source Address field in the IP header is replaced by the IP address of the encapsulator.

- The Total Length field in the IP header is incremented by the size of the minimal forwarding header added to the datagram. This incremental size is either 12 or 8 octets, depending on whether or not the Original Source Address Present (S) bit is set in the forwarding header.

- The Header Checksum field in the IP header is recomputed [6] or updated to account for the changes in the IP header described here for encapsulation.

Note that unlike IP-in-IP encapsulation [4], the Time to Live (TTL) field in the IP header is not modified during encapsulation; if the encapsulator is forwarding the datagram, it will decrement the TTL as a result of doing normal IP forwarding. Also, since the original TTL remains in the IP header after encapsulation, hops taken by the datagram within the tunnel are visible, for example, to "traceroute".

The format of the minimal forwarding header is as follows:



Protocol

Copied from the Protocol field in the original IP header.

Original Source Address Present (S)

0 The Original Source Address field is not present. The length of the minimal tunneling header in this case is 8 octets.

1 The Original Source Address field is present. The length of the minimal tunneling header in this case is 12 octets.

reserved

Sent as zero; ignored on reception.

Header Checksum

The 16-bit one's complement of the one's complement sum of all 16-bit words in the minimal forwarding header. For purposes of computing the checksum, the value of the checksum field is 0. The IP header and IP payload (after the minimal forwarding header) are not included in this checksum computation.

Original Destination Address

Copied from the Destination Address field in the original IP header.

Original Source Address

Copied from the Source Address field in the original IP header. This field is present only if the Original Source Address Present (S) bit is set.

When decapsulating a datagram, the fields in the minimal forwarding header are restored to the IP header, and the forwarding header is removed from the datagram. In addition, the Total Length field in the IP header is decremented by the size of the minimal forwarding header removed from the datagram, and the Header Checksum field in the IP header is recomputed [6] or updated to account for the changes to the IP header described here for decapsulation.

The encapsulator may use existing IP mechanisms appropriate for delivery of the encapsulated payload to the tunnel exit point. In particular, use of IP options are allowed, and use of fragmentation is allowed unless the "Don't Fragment" bit is set in the IP header. This restriction on fragmentation is required so that nodes employing Path MTU Discovery [3] can obtain the information they seek.

4. Routing Failures

The use of any encapsulation method for routing purposes brings with it increased susceptibility to routing loops. To cut down the danger, a router should follow the same procedures outlined in [4].

5. ICMP Messages from within the Tunnel

ICMP messages are to be handled as specified in [4], including the maintenance of tunnel "soft state".

6. Security Considerations

Security considerations are not addressed in this document, but are generally similar to those outlined in [4].

7. Acknowledgements

The original text for much of Section 3 was taken from the Mobile IP draft [1]. Thanks to David Johnson for improving consistency and making many other improvements to the draft.

References

[1] Perkins, C., Editor, "IPv4 Mobility Support", Work in Progress, May 1995.

[2] David B. Johnson. Scalable and Robust Internetwork Routing for Mobile Hosts. In Proceedings of the 14th International Conference on Distributed Computing Systems, pages 2--11, June 1994.

[3] Mogul, J., and S. Deering, "Path MTU Discovery", RFC 1191, November 1990.

[4] Perkins, C., "IP Encapsulation within IP", RFC 2003, October 1996.

[5] Perkins, C., Editor, "IP Mobility Support", RFC 2002, October 1996.

[6] Postel, J., Editor, "Internet Protocol", STD 5, RFC 791, September 1981.

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