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Generic Routing Encapsulation (GRE)

Status of this Memo

This memo provides information for the Internet community. This memo does not specify an Internet standard of any kind. Distribution of this memo is unlimited.

Abstract

This document specifies a protocol for performing encapsulation of an arbitrary network layer protocol over another arbitrary network layer protocol.

Introduction

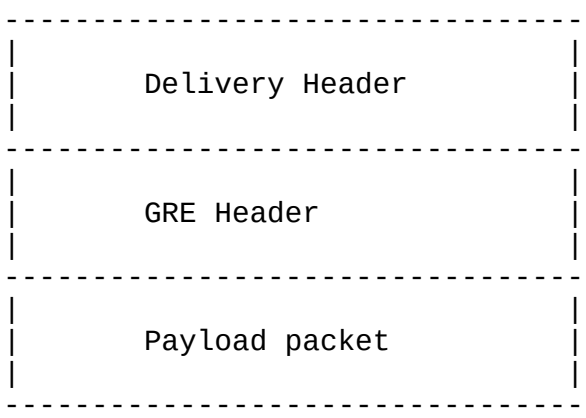
A number of different proposals [RFC 1234, RFC 1226] currently exist for the encapsulation of one protocol over another protocol. Other types of encapsulations [RFC 1241, SDRP, RFC 1479] have been proposed for transporting IP over IP for policy purposes. This memo describes a protocol which is very similar to, but is more general than, the above proposals. In attempting to be more general, many protocol specific nuances have been ignored. The result is that this proposal is may be less suitable for a situation where a specific "X over Y" encapsulation has been described. It is the attempt of this protocol to provide a simple, general purpose mechanism which is reduces the problem of encapsulation from its current O(n^2) problem to a more manageable state. This proposal also attempts to provide a lightweight encapsulation for use in policy based routing. This memo explicitly does not address the issue of when a packet should be encapsulated. This memo acknowledges, but does not address problems with mutual encapsulation [RFC 1326].

In the most general case, a system has a packet that needs to be encapsulated and routed. We will call this the payload packet. The payload is first encapsulated in a GRE packet, which possibly also includes a route. The resulting GRE packet can then be encapsulated in some other protocol and then forwarded. We will call this outer

protocol the delivery protocol. The algorithms for processing this packet are discussed later.

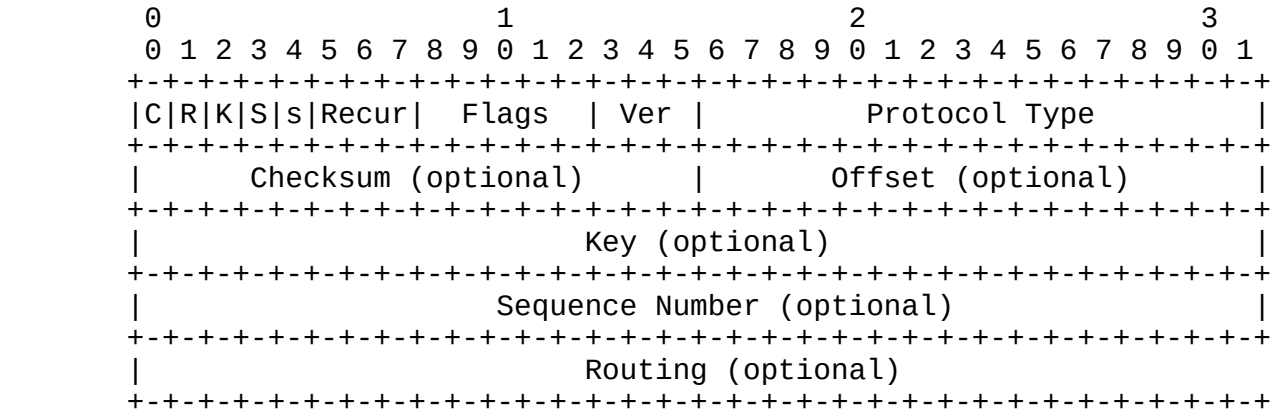
Overall packet

The entire encapsulated packet would then have the form:



Packet header

The GRE packet header has the form:



Flags and version (2 octets)

The GRE flags are encoded in the first two octets. Bit 0 is the most significant bit, bit 15 is the least significant bit. Bits 13 through 15 are reserved for the Version field. Bits 5 through 12 are reserved for future use and MUST be transmitted as zero.

Checksum Present (bit 0)

If the Checksum Present bit is set to 1, then the Checksum field is present and contains valid information.

If either the Checksum Present bit or the Routing Present bit are set, BOTH the Checksum and Offset fields are present in the GRE packet.

Routing Present (bit 1)

If the Routing Present bit is set to 1, then it indicates that the Offset and Routing fields are present and contain valid information.

If either the Checksum Present bit or the Routing Present bit are set, BOTH the Checksum and Offset fields are present in the GRE packet.

Key Present (bit 2)

If the Key Present bit is set to 1, then it indicates that the Key field is present in the GRE header. Otherwise, the Key field is not present in the GRE header.

Sequence Number Present (bit 3)

If the Sequence Number Present bit is set to 1, then it indicates that the Sequence Number field is present. Otherwise, the Sequence Number field is not present in the GRE header.

Strict Source Route (bit 4)

The meaning of the Strict Source route bit is defined in other documents. It is recommended that this bit only be set to 1 if all of the the Routing Information consists of Strict Source Routes.

Recursion Control (bits 5-7)

Recursion control contains a three bit unsigned integer which contains the number of additional encapsulations which are permissible. This SHOULD default to zero.

Version Number (bits 13-15)

The Version Number field MUST contain the value 0. Other values are outside of the scope of this document.

Protocol Type (2 octets)

The Protocol Type field contains the protocol type of the payload packet. In general, the value will be the Ethernet protocol type field for the packet. Currently defined protocol types are listed below. Additional values may be defined in other documents.

Offset (2 octets)

The offset field indicates the octet offset from the start of the Routing field to the first octet of the active Source Route Entry to be examined. This field is present if the Routing Present or the Checksum Present bit is set to 1, and contains valid information only if the Routing Present bit is set to 1.

Checksum (2 octets)

The Checksum field contains the IP (one's complement) checksum of the GRE header and the payload packet. This field is present if the Routing Present or the Checksum Present bit is set to 1, and contains valid information only if the Checksum Present bit is set to 1.

Key (4 octets)

The Key field contains a four octet number which was inserted by the encapsulator. It may be used by the receiver to authenticate the source of the packet. The techniques for determining authenticity are outside of the scope of this document. The Key field is only present if the Key Present field is set to 1.

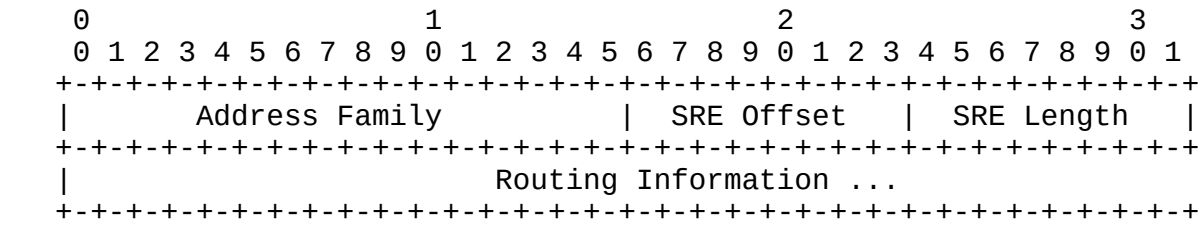
Sequence Number (4 octets)

The Sequence Number field contains an unsigned 32 bit integer which is inserted by the encapsulator. It may be used by the receiver to establish the order in which packets have been transmitted from the encapsulator to the receiver. The exact algorithms for the generation of the Sequence Number and the semantics of their reception is outside of the scope of this document.

Routing (variable)

The Routing field is optional and is present only if the Routing Present bit is set to 1.

The Routing field is a list of Source Route Entries (SREs). Each SRE has the form:



The routing field is terminated with a "NULL" SRE containing an address family of type 0x0000 and a length of 0.

Address Family (2 octets)

The Address Family field contains a two octet value which indicates the syntax and semantics of the Routing Information field. The values for this field and the corresponding syntax and semantics for Routing Information are defined in other documents.

SRE Offset (1 octet)

The SRE Offset field indicates the octet offset from the start of the Routing Information field to the first octet of the active entry in Source Route Entry to be examined.

SRE Length (1 octet)

The SRE Length field contains the number of octets in the SRE. If the SRE Length is 0, this indicates this is the last SRE in the Routing field.

Routing Information (variable)

The Routing Information field contains data which may be used in routing this packet. The exact semantics of this field is defined in other documents.

Forwarding of GRE packets

Normally, a system which is forwarding delivery layer packets will not differentiate GRE packets from other packets in any way. However, a GRE packet may be received by a system. In this case, the system should use some delivery-specific means to determine that this is a GRE packet. Once this is determined, the Key, Sequence Number and Checksum fields if they contain valid information as indicated by the corresponding flags may be checked. If the Routing Present bit

is set to 1, then the Address Family field should be checked to determine the semantics and use of the SRE Length, SRE Offset and Routing Information fields. The exact semantics for processing a SRE for each Address Family is defined in other documents.

Once all SREs have been processed, then the source route is complete, the GRE header should be removed, the payload's TTL MUST be decremented (if one exists) and the payload packet should be forwarded as a normal packet. The exact forwarding method depends on the Protocol Type field.

Current List of Protocol Types

The following are currently assigned protocol types for GRE. Future protocol types must be taken from DIX ethernet encoding. For historical reasons, a number of other values have been used for some protocols. The following table of values MUST be used to identify the following protocols:

Protocol Family	PTYPE
Reserved	0000
SNA	0004
OSI network layer	00FE
PUP	0200
XNS	0600
IP	0800
Chaos	0804
RFC 826 ARP	0806
Frame Relay ARP	0808
VINES	0BAD
VINES Echo	0BAE
VINES Loopback	0BAF
DECnet (Phase IV)	6003
Transparent Ethernet Bridging	6558
Raw Frame Relay	6559
Apollo Domain	8019
Ethertalk (Appletalk)	809B
Novell IPX	8137
RFC 1144 TCP/IP compression	876B
IP Autonomous Systems	876C
Secure Data	876D
Reserved	FFFF

See the IANA list of Ether Types for the complete list of these values.

URL = ftp://ftp.isi.edu/in-notes/iana/assignments/ethernet-numbers.

References

RFC 1479
Steenstrup, M. "Inter-Domain Policy Routing Protocol Specification: Version 1", RFC1479, BBN Systems and Technologies, July 1993.

RFC 1226
Kantor, B. "Internet Protocol Encapsulation of AX.25 Frames", RFC 1226, University of California, San Diego, May 1991.

RFC 1234
Provan, D. "Tunneling IPX Traffic through IP Networks", RFC 1234, Novell, Inc., June 1991.

RFC 1241
Woodburn, R., and D. Mills, "Scheme for an Internet Encapsulation Protocol: Version 1", RFC 1241, SAIC, University of Delaware, July 1991.

RFC 1326
Tsuchiya, P., "Mutual Encapsulation Considered Dangerous", RFC 1326, Bellcore, May 1992.

SDRP
Estrin, D., Li, T., and Y. Rekhter, "Source Demand Routing Protocol Specification (Version 1)", Work in Progress.

RFC 1702
Hanks, S., Li, T., Farinacci, D., and P. Traina, "Generic Routing Encapsulation over IPv4 networks", RFC 1702, NetSmiths, Ltd., cisco Systems, October 1994.

Security Considerations

Security issues are not discussed in this memo.

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