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IPv6 Support for Generic Routing Encapsulation (GRE)
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Abstract

Generic Routing Encapsulation (GRE) can be used to carry any network-layer payload protocol over any network-layer delivery protocol. GRE procedures are specified for IPv4, used as either the payload or delivery protocol. However, GRE procedures are not specified for IPv6.

This document specifies GRE procedures for IPv6, used as either the payload or delivery protocol. It updates the GRE specification, RFC 2784.

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 [RFC2119].

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1. Introduction

Generic Routing Encapsulation (GRE) [RFC2784] [RFC2890] can be used to carry any network-layer payload protocol over any network-layer delivery protocol. GRE procedures are specified for IPv4 [RFC0791], used as either the payload or delivery protocol. However, GRE procedures are not specified for IPv6 [RFC2460].

This document specifies GRE procedures for IPv6, used as either the payload or delivery protocol. It updates RFC 2784 [RFC2784]. Like RFC 2784, this specification describes GRE how GRE has been implemented for IPv6 by several vendors.

1.1. Terminology

The following terms are specific to GRE and are taken from [RFC2784]:

- GRE delivery header - an IPv4 or IPv6 header whose source address represents the GRE ingress node and whose destination address represents the GRE egress node. The GRE delivery header encapsulates a GRE header.

- GRE header - the GRE protocol header. The GRE header is encapsulated in the GRE delivery header and encapsulates GRE payload.

- GRE payload - a network layer packet that is encapsulated by the GRE header.

The following terms are specific MTU discovery:

- path MTU (PMTU) - the minimum MTU of all the links in a path between a source node and a destination node. If the source and destination node are connected through equal cost multipath (ECMP), the PMTU is equal to the minimum link MTU of all links contributing to the multipath.

- Path MTU Discovery (PMTUD) - A procedure for dynamically discovering the PMTU between two nodes on the Internet. PMTUD procedures for IPv6 are defined in [RFC1981].

2. GRE Header Fields

This document does not change the GRE header format or any behaviors specified by [RFC2784] or [RFC2890].

2.1. Checksum Present

When the delivery protocol is IPv6, the GRE ingress router SHOULD set the Checksum Present field to zero. GRE egress routers MUST accept either a value of zero or one in this field. If the GRE egress router receives a value of one, it MUST use that information to calculate the GRE header length. However, the GRE ingress router is not required to use the checksum to verify packet integrity.

2.2. Protocol Type

The Protocol Type field contains the protocol type of the payload packet. Protocol Types are defined in [ETYPES]. An implementation receiving a packet containing a Protocol Type which is not listed in [ETYPES] SHOULD discard the packet.

3. IPv6 as a GRE Payload

When the GRE payload is IPv6, the Protocol Type field in the GRE header MUST be set to 0x86DD.

3.1. MTU Considerations

The GRE ingress router maintains an estimate of the GRE MTU (GMTU). The GMTU is equal to the PMTU associated with the path between the GRE ingress and the GRE egress, minus the GRE overhead. The GRE overhead is the combined length of the GRE and IP delivery headers.

The GRE ingress router obtains a PMTU estimate using any of the following:

- o System defaults
- o Configuration
- o PMTUD

When the GRE ingress receives an IPv6 payload packet whose length is less than or equal to the GMTU, it can encapsulate and forward the packet without fragmentation of any kind. In this case, the GRE ingress router MUST NOT fragment the payload or delivery packets.

When the GRE ingress receives an IPv6 payload packet whose length is greater than the GMTU, and the GMTU is greater than or equal to 1280 octets, the GRE ingress router MUST:

- o discard the IPv6 payload packet
- o send an ICMPv6 Packet Too Big (PTB) [RFC4443] message to the IPv6 payload packet source. The MTU field in the ICMPv6 PTB message is set to the GMTU.

The GRE ingress router MUST support a configuration option that determines how the GRE ingress behaves when it receives an IPv6 payload packet whose length is greater than the GMTU, and the GMTU is less than 1280 octets. In its default configuration, the GRE ingress router MUST:

- o discard the IPv6 packet
- o send an ICMPv6 Packet Too Big (PTB) [RFC4443] message to the IPv6 packet source. The MTU field in the ICMPv6 PTB message is set to the GMTU.

However, in an alternative configuration, the GRE ingress MAY:

- o encapsulate the entire IPv6 packet in a single GRE header and IP delivery header
- o fragment the delivery header, so that it can be reassembled by the GRE egress

4. IPv6 as a GRE Delivery Protocol

When the GRE delivery protocol is IPv6, the GRE header can immediately follow the GRE delivery header. Alternatively, IPv6 extension headers MAY be inserted between the GRE delivery header and the GRE header.

If the GRE header immediately follows the GRE delivery header, the Next Header field in the IPv6 header of the GRE delivery packet MUST be set to 47. If extension headers are inserted between the GRE delivery header and the GRE header, the Next Header field in the last IPv6 extension header MUST be set to 47.

4.1. MTU Considerations

"IPv6 requires that every link in the Internet have an MTU of 1280 octets or greater. On any link that cannot convey a 1280-octet packet in one piece, link-specific fragmentation and reassembly must be provided at a layer below IPv6" [RFC2460].

IP adjacencies formed by GRE over IPv6 share this requirement. The IP adjacency MUST have an MTU of 1280 octets or greater. This requirement is fulfilled if all permissible paths between the GRE ingress and GRE egress have PMTU greater than the 1280 plus the GRE overhead.

In case all permissible routes between the GRE ingress and GRE egress do not have PMTU greater than 1280 plus the GRE overhead, implementations MUST be capable of fragmenting and reassembling the GRE delivery header, as described in Section 3.1.

5. IANA Considerations

This document makes no request of IANA.

6. Security Considerations

This document adds no additional security risks to GRE, beyond what is specified in [RFC2784]. It also does not provide any additional security for GRE.

7. Acknowledgements

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8. Normative References

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