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The Generalized TTL Security Mechanism (GTSM) for the Label Distribution Protocol (LDP)

Abstract

The Generalized TTL Security Mechanism (GTSM) describes a generalized use of a packet's Time to Live (TTL) (IPv4) or Hop Limit (IPv6) to verify that the packet was sourced by a node on a connected link, thereby protecting the router's IP control plane from CPU utilization-based attacks. This technique improves security and is used by many protocols. This document defines the GTSM use for the Label Distribution Protocol (LDP).

This specification uses a bit reserved in RFC 5036 and therefore updates RFC 5036.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc6720.

Table of Contents

1. Introduction

LDP [RFC5036] specifies two peer discovery mechanisms, a Basic one and an Extended one, both using UDP transport. The Basic Discovery mechanism is used to discover LDP peers that are directly connected at the link level, whereas the Extended Discovery mechanism is used to locate Label Switching Router (LSR) neighbors that are not directly connected at the link level. Once discovered, the LSR neighbors can establish the LDP peering session, using the TCP transport connection.

The Generalized TTL Security Mechanism (GTSM) [RFC5082] is a mechanism based on IPv4 Time To Live (TTL) or IPv6 Hop Limit value verification so as to provide a simple and reasonably robust defense from infrastructure attacks using forged protocol packets from outside the network. GTSM can be applied to any protocol peering

session that is established between routers that are adjacent. Therefore, GTSM can protect an LDP protocol peering session established using Basic Discovery.

This document specifies LDP enhancements to accommodate GTSM. In particular, this document specifies the enhancements in the following areas:

1. The Common Hello Parameter TLV of LDP Link Hello message

2. Sending and Receiving procedures for LDP Link Hello message

3. Sending and Receiving procedures for LDP Initialization message

GTSM specifies that "it SHOULD NOT be enabled by default in order to remain backward compatible with the unmodified protocol" (see Section 3 of [RFC5082]). This document specifies a "built-in dynamic GTSM capability negotiation" for LDP to suggest the use of GTSM. GTSM will be used as specified in this document provided both peers on an LDP session can detect each others' support for GTSM procedures and agree to use it. That is, the desire to use GTSM (i.e., its negotiation mechanics) is enabled by default without any configuration.

This specification uses a bit reserved in Section 3.5.2 of [RFC5036] and therefore updates [RFC5036].

1.1. Specification of Requirements

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].

1.2. Scope

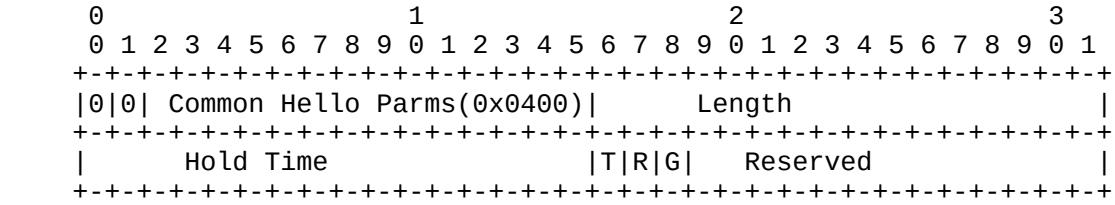
This document defines procedures for LDP using IPv4 routing but not for LDP using IPv6 routing, since the latter has GTSM built into the protocol definition [LDP-IPV6].

Additionally, the GTSM for LDP specified in this document applies only to single-hop LDP peering sessions and not to multi-hop LDP peering sessions, in line with Section 5.5 of [RFC5082]. Consequently, any LDP method or feature (such as LDP IGP Synchronization [RFC5443] or LDP Session Protection [LDP-SPROT]) that relies on multi-hop LDP peering sessions would not work with GTSM and will require (statically or dynamically) disabling the GTSM capability. See Section 3.

2. GTSM Procedures for LDP

2.1. GTSM Flag in the Common Hello Parameter TLV

A new flag in the Common Hello Parameter TLV, named G flag (for GTSM), is defined by this document in a previously reserved bit. An LSR indicates that it is capable of applying GTSM procedures, as defined in this document, to the subsequent LDP peering session, by setting the GTSM flag to 1. The Common Hello Parameters TLV, defined in Section 3.5.2 of [RFC5036], is updated as shown in Figure 1.



T, Targeted Hello
As specified in [RFC5036].

R, Request Send Targeted Hellos
As specified in [RFC5036].

G, GTSM
A value of 1 specifies that this LSR supports GTSM procedures, where a value of 0 specifies that this LSR does not support GTSM.

Reserved
This field is reserved. It MUST be set to zero on transmission and ignored on receipt.

Figure 1: GTSM Flag in the Common Hello Parameter TLV

The G flag is meaningful only if the T flag is set to 0 (which must be the case for Basic Discovery); otherwise, the value of the G flag is ignored on receipt.

Any LSR not supporting GTSM for LDP as defined in this document (i.e., an LSR that does not recognize the G flag) would continue to ignore the G flag, independent of the values of the T and R flags, as per Section 3.5.2 of [RFC5036]. Similarly, an LSR that does recognize the G flag but that does not support GTSM (either because it is not implemented or because it is so configured) would not set the G flag (i.e., G=0) when sending LDP Link Hellos and would effectively ignore the G flag when receiving LDP Link Hello messages.

2.2. GTSM Sending and Receiving Procedures for LDP Link Hello

First, LSRs using LDP Basic Discovery [RFC5036] send LDP Hello messages to link-level multicast address (224.0.0.2 or "all routers"). Such messages are never forwarded beyond one hop and are RECOMMENDED to have their IP TTL or Hop Count = 1.

Unless configured otherwise, an LSR that supports GTSM procedures MUST set the G flag (for GTSM) to 1 in the Common Hello Parameter TLV in the LDP Link Hello message [RFC5036].

If an LSR that supports GTSM and is configured to use it recognizes the presence of the G flag (in the Common Hello Parameter TLV) with the value = 1 in the received LDP Link Hello message, then it MUST enforce GTSM for LDP in the subsequent TCP/LDP peering session with the neighbor that sent the Hello message, as specified in Section 2.3 of this document.

If an LSR does not recognize the presence of the G flag (in the Common Hello Parameter TLV of Link Hello message), or recognizes the presence of G flag with the value = 0, then the LSR MUST NOT enforce GTSM for LDP in the subsequent TCP/LDP peering session with the neighbor that sent the Hello message. This ensures backward compatibility as well as automatic GTSM deactivation.

2.3. GTSM Sending and Receiving Procedures for LDP Initialization

If an LSR that has sent and received LDP Link Hello with G flag = 1 from the directly connected neighbor, then the LSR MUST enforce GTSM procedures, as defined in Section 3 of [RFC5082], in the forthcoming TCP Transport Connection with that neighbor. This means that the LSR MUST check for the incoming unicast packets' TTL or Hop Count to be 255 for the particular LDP/TCP peering session and decide the further processing as per [RFC5082].

If an LSR that has sent LDP Link Hello with G flag = 1, but received LDP Link Hello with G flag = 0 from the directly connected neighbor, then the LSR MUST NOT enforce GTSM procedures, as defined in Section 3 of [RFC5082], in the forthcoming TCP Transport Connection with that neighbor.

3. LDP Peering Scenarios and GTSM Considerations

This section discusses GTSM considerations arising from the LDP peering scenarios used, including single-hop versus multi-hop LDP neighbors, as well as the use of LDP Basic Discovery versus Extended Discovery.

The reason that the GTSM capability negotiation is enabled for Basic Discovery by default (i.e., G=1) but not for Extended Discovery is that the usage of Basic Discovery typically relates to a single-hop LDP peering session, whereas the usage of Extended Discovery typically relates to a multi-hop LDP peering session. GTSM protection for multi-hop LDP sessions is outside the scope of this specification (see Section 1.2). However, it is worth clarifying the following exceptions that may occur with Basic or Extended Discovery usage:

a. Two adjacent LSRs (i.e., back-to-back PE routers) forming a single-hop LDP peering session after doing an Extended Discovery (e.g., for Pseudowire signaling)

b. Two adjacent LSRs forming a multi-hop LDP peering session after doing a Basic Discovery, due to the way IP routing is set up between them (either temporarily or permanently)

c. Two adjacent LSRs (i.e., back-to-back PE routers) forming a single-hop LDP peering session after doing both Basic and Extended Discovery

In the first case (a), GTSM is not enabled for the LDP peering session by default. In the second case (b), GTSM is actually enabled by default and enforced for the LDP peering session; hence, it would prohibit the LDP peering session from getting established (note that this may impact features such as LDP IGP Synchronization [RFC5443] or LDP Session Protection [LDP-SPROT]). In the third case (c), GTSM is enabled by default for Basic Discovery and enforced on the subsequent LDP peering, and is not for Extended Discovery. However, if each LSR uses the same IPv4 transport address object value in both Basic and Extended Discoveries, then it would result in a single LDP peering session that would be enabled with GTSM. Otherwise, GTSM would not be enforced on the second LDP peering session corresponding to the Extended Discovery.

This document allows for the implementation to provide an option to statically (e.g., via configuration) and/or dynamically override the default behavior and enable/disable GTSM on a per-peer basis. This would address all the exceptions listed above.

4. Security Considerations

This document increases the security for LDP, making it more resilient to off-link attacks. Security considerations for GTSM are detailed in Section 5 of [RFC5082].

As discussed in Section 3, it is possible that

- GTSM for LDP may not always be enforced on a single-hop LDP peering session, and LDP may still be susceptible to forged/spoofed protocol packets, if a single-hop LDP peering session is set up using Extended Discovery.

- GTSM for LDP may cause the LDP peering session to not get established (or may be torn down), if IP routing ever declares that the directly connected peer is more than one IP hop away. Suffice to say, use of cryptographic integrity (e.g., [RFC5925]) is recommended as an alternate solution for detecting forged protocol packets (especially for the multi-hop case).

The GTSM specification [RFC5082] says that protocol messages used for dynamic negotiation of GTSM support MUST be authenticated. However, LDP discovery [RFC5036] uses UDP transport and does not have an authentication mechanism. The GTSM specification further elaborates by saying that GTSM is not a substitute for authentication and does not secure against insider on-the-wire attacks. LDP Basic Discovery uses link-level multicast address (224.0.0.2 or "all routers") that are never forwarded beyond the link, and this acts as a basic protection against off-the-wire attacks.

5. Acknowledgments

The authors of this document do not make any claims on the originality of the ideas described. The concept of GTSM for LDP has been proposed a number of times and is documented in both the Experimental and Standards Track specifications of GTSM. Among other people, we would like to acknowledge Enke Chen and Albert Tian for their document "TTL-Based Security Option for the LDP Hello Message".

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6. References

6.1. Normative References

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.

[RFC5036] Andersson, L., Minei, I., and B. Thomas, "LDP Specification", RFC 5036, October 2007.

[RFC5082] Gill, V., Heasley, J., Meyer, D., Savola, P., and C. Pignataro, "The Generalized TTL Security Mechanism (GTSM)", RFC 5082, October 2007.

6.2. Informative References

[LDP-IPV6] Asati, R., Manral, V., Papneja, R., and C. Pignataro, "Updates to LDP for IPv6", Work in Progress, June 2012.

[LDP-SPROT] Cisco Systems, Inc., "MPLS LDP Session Protection", <http://www.cisco.com/en/US/docs/ios-xml/ios/mp_ldp/configuration/12-4m/mp-ldp-sessn-prot.html>.

[RFC5443] Jork, M., Atlas, A., and L. Fang, "LDP IGP Synchronization", RFC 5443, March 2009.

[RFC5925] Touch, J., Mankin, A., and R. Bonica, "The TCP Authentication Option", RFC 5925, June 2010.

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