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LDP Hello Cryptographic Authentication

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Abstract

This document introduces a new Cryptographic Authentication TLV which is used in LDP Hello message as an optional parameter. It enhances the authentication mechanism for LDP by securing the Hello message against spoofing attack.

Conventions used in this document

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 RFC-2119 [RFC2119].

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1. Introduction

The Label Distribution Protocol (LDP) [RFC 5036] utilizes LDP sessions that run between LDP peers. The peers may be directly connected at the link level or may be remote. A label switching router (LSR) that speaks LDP may be configured with the identity of its peers or may discover them using the LDP Hello message sent encapsulated in UDP that may be addressed to "all routers on this subnet" or to a specific IP address. Periodic Hello messages are

also used to maintain the relationship between LDP peers necessary to keep the LDP session active.

Unlike all other LDP messages, the Hello messages are sent using UDP not TCP. This means that they cannot benefit from the security mechanisms available with TCP. [RFC5036] does not provide any security mechanisms for use with Hello messages except to note that some configuration may help protect against bogus discovery events.

Spoofing a Hello packet for an existing adjacency can cause the valid adjacency to time out and in turn can result in termination of the associated session. This can occur when the spoofed Hello specifies a smaller Hold Time, causing the receiver to expect Hellos within this smaller interval, while the true neighbor continues sending Hellos at the previously agreed lower frequency. Spoofing a Hello packet can also cause the LDP session to be terminated directly, which can occur when the spoofed Hello specifies a different Transport Address, other than the previously agreed one between neighbors. Spoofed Hello messages is observed and reported as real problem in production networks.

As described in [RFC5036], the threat of spoofed Basic Hellos can be reduced by accepting Basic Hellos only on interfaces to which LSRs that can be trusted, and ignoring Basic Hellos not addressed to the "all routers on this subnet" multicast group. Spoofing attacks via Extended Hellos are potentially more serious threat. An LSR can reduce the threat of spoofed Extended Hellos by filtering them and accepting only those originating at sources permitted by an access list. However, performing the filtering using access lists requires LSR resource, and the LSR is still vulnerable to the IP source address spoofing.

This document introduces a new Cryptographic Authentication TLV which is used in LDP Hello message as an optional parameter. It enhances the authentication mechanism for LDP by securing the Hello message against spoofing attack, and an LSR can be configured to only accept Hello messages from specific peers when authentication is in use.

Using this Cryptographic Authentication TLV, one or more secret keys (with corresponding key IDs) are configured in each system. For each LDP Hello packet, the key is used to generate and verify a HMAC Hash that is stored in the LDP Hello packet. For cryptographic hash function, this document proposes to use SHA-1, SHA-256, SHA-384, and SHA-512 defined in US NIST Secure Hash Standard (SHS) [FIPS-180-3]. The HMAC authentication mode defined in NIST FIPS 198 is used [FIPS-

198]. Of the above, implementations MUST include support for at least HMAC-SHA-256 and SHOULD include support for HMAC-SHA-1 and MAY include support for either of HMAC-SHA-384 or HMAC-SHA-512.

2. Cryptographic Authentication TLV

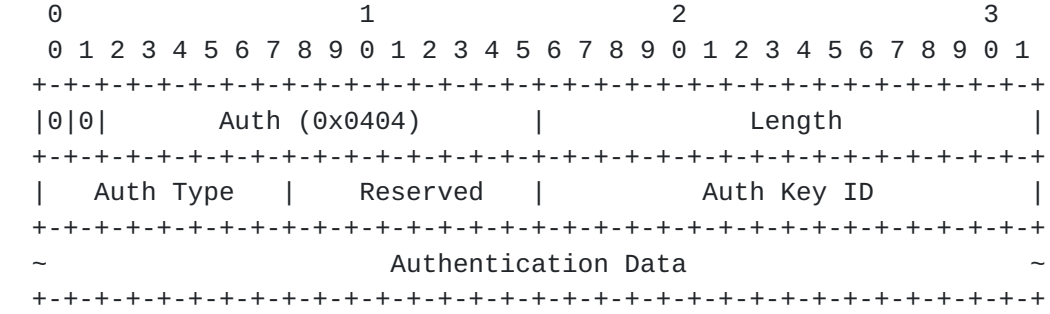
2.1. Optional Parameter for Hello Message

[RFC5036] defines the encoding for the Hello message. Each Hello message contains zero or more Optional Parameters, each encoded as a TLV. Three Optional Parameters are defined by [RFC5036]. This document defines a new Optional Parameter: the Cryptographic Authentication parameter.

Optional Parameter	Type
IPv4 Transport Address	0x0401 (RFC5036)
Configuration Sequence Number	0x0402 (RFC5036)
IPv6 Transport Address	0x0403 (RFC5036)
Cryptographic Authentication	0x0404 (this document, TBD by IANA)

The Cryptographic Authentication TLV Encoding is described in section 2.2.

2.2. Cryptographic Authentication TLV Encoding



- Type: 0x0404 (TBD by IANA), Cryptographic Authentication

- Length: Specifying the length in octets of the value field.

- Auth Type: The authentication type in use

0 - HMAC-SHA-1
1 - HMAC-SHA-256
2 - HMAC-SHA-384
3 - HMAC-SHA-512
4-255 - Reserved for future use
(TBD by IANA)

- Reserved: MUST be set to zero on transmit, and ignored on receipt

- Auth Key ID: The authentication key ID in use for this packet. This allows one or more keys to be active simultaneously.

- Authentication Data:

This field carries the digest computed by the Cryptographic Authentication algorithm in use. The length of the Authentication Data varies based on the cryptographic algorithm in used, which is shown as below:

Auth type	Length
HMAC-SHA1	20 bytes
HMAC-SHA-256	32 bytes
HMAC-SHA-384	48 bytes
HMAC-SHA-512	64 bytes

3. Cryptographic Aspects

In the algorithm description below, the following nomenclature, which is consistent with [FIPS-198], is used:

- H is the specific hashing algorithm specified by Auth Type (e.g. SHA-256).

- K is the Authentication Key for the Hello packet.

- Ko is the cryptographic key used with the hash algorithm.

- B is the block size of H, in octets.

For SHA-1 and SHA-256: B == 64

For SHA-384 and SHA-512: B == 128

- L is the length of the hash outputs, in octets.

- XOR is the exclusive-or operation.

- Ipad is the byte 0x36 repeated B times.

- Opad is the byte 0x5c repeated B times.

- Apad is the byte 0x878FE1F3 repeated (L/4) times.

3.1. Cryptographic Key

As described in RFC 2104, the authentication key K can be of any length up to B. Applications that use keys longer than B bytes will first hash the key using H and then use the resultant L byte string as the actual key to HMAC.

In this application, Ko is always L octets long. If the Authentication Key (K) is L octets long, then Ko is equal to K. If the Authentication Key (K) is more than L octets long, then Ko is set to H(K). If the Authentication Key (K) is less than L octets long, then Ko is set to the Authentication Key (K) with trailing zeros such that Ko is L octets long.

3.2. Hash

First, the Authentication Data field in the Cryptographic Authentication TLV is filled with the value Apad and the Auth Type field is set accordingly per Cryptographic Authentication algorithm in use.

Then, to compute HMAC over the Hello packet it performs:

```
H(Ko XOR Opad || H(Ko XOR Ipad || (Hello Packet)))
```

Hello Packet here is the entire LDP Hello packet including the IP header.

3.3. Result

The resultant Hash becomes the Authentication Data that is sent in the Authentication Data field of the Cryptographic Authentication TLV. The length of the Authentication Data field is always identical to the message digest size of the specific hash function H that is being used.

4. Processing Hello Message Using Cryptographic Authentication

4.1. Transmission Using Cryptographic Authentication

Prior to transmitting Hello message, the Auth Type field is set to indicate the authentication type in use. The Length in the Cryptographic Authentication TLV header is set as per the authentication algorithm that is being used. It is set to 24 for HMAC-SHA-1, 36 for HMAC-SHA-256, 52 for HMAC-SHA-384 and 68 for HMAC-SHA-512.

The Auth Key ID field is set to the ID of the current authentication key. The HMAC Hash is computed as explained in Section 3. The resulting Hash is stored in the Authentication Data field prior to transmission. The authentication key MUST NOT be carried in the packet.

4.2. Receipt Using Cryptographic Authentication

The receiving LSR applies acceptability criteria for received Hellos using cryptographic authentication. If the Cryptographic Authentication TLV is unknown to the receiving LSR, the received packet MUST be discarded according to Section 3.5.1.2.2 of [RFC5036].

If the Cryptographic Authentication TLV in a received Hello packet does not contain a known and acceptable Auth Type value, then the received packet MUST be discarded. If the Auth Key ID field does not match the ID of a configured authentication key, the received packet MUST be discarded.

Before the receiving LSR performs any processing, it needs to save the values of the Authentication Data field. The receiving LSR then replaces the contents of the Authentication Data field with Apad, computes the Hash, using the authentication key specified by the

received Auth Key ID field, as explained in Section 3. If the locally computed Hash is equal to the received value of the Authentication Data field, the received packet is accepted for other normal checks and processing as described in [RFC5036]. Otherwise, the received packet MUST be discarded.

5. Security Considerations

Section 1 of this document describes the security issues arising from the use of unsecured LDP Hello messages. In order to combat those issues, it is RECOMMENDED that all deployments use the Cryptographic Authentication TLV to secure the Hello message.

The quality of the security provided by the Cryptographic Authentication TLV depends completely on the strength of the cryptographic algorithm in use, the strength of the key being used, and the correct implementation of the security mechanism in communicating LDP implementations. Also, the level of security provided by the Cryptographic Authentication TLV varies based on the authentication type used.

6. IANA Considerations

IANA maintains a registry of LDP message parameters with a sub-registry to track LDP TLV Types. This document request IANA to assign a new TLV Types as follows:

TLV	Type
Cryptographic Authentication	0x0404 (TBD)

This document also request IANA to assign a new registry titled "LDP Hello Authentication Type", its recommended values as follows:

Value	LDP Hello Authentication Type Name
0	HMAC-SHA1
1	HMAC-SHA-256
2	HMAC-SHA-384
3	HMAC-SHA-512
4-255 (TBD)	Unassigned

7. Acknowledgments

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8. References

8.1. Normative References

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