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LISP Trans in MPLS Networks
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Abstract

This document proposes an LISP trans solution in MPLS network, provides a new LISP data encapsulation with two layer MPLS label and simplifies the IP-in-IP encapsulation by cutting of the outer IP header when LISP technology deploys in the MPLS network, the outer label is used for data forwarding, and the inner label is used to indicate the LISP data packet and carry the RLOC address information. In additional, three deployment scenarios are provided in this document..

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1. Introduction

It is common recognized that today's Internet routing and addressing system is facing serious scaling problems, which is much discussed in the Internet Architecture Board (IAB) workshop on Routing and Addressing in Amsterdam. Several proposals have emerged after the workshop. These proposals include LISP [LISP], are based on the idea of "ID/Locator split".

LISP is a network-based ID/locator split solution, and needs a mapping mechanism that allows mapping identifiers onto locators. There are several mapping mechanisms, such as ALT [ALT], LISP-MS [MS], and CONS [CONS], NERD [NERD], APT [APT], etc. The [ALT] and [MS] solution is the recommendation mapping mechanism of LISP workgroup. But the deployment of LISP needs further discussion. This document specifics the deployment of LISP in MPLS network.

MPLS network is widely deployment in current network because of the application of VPN service, traffic engineer, QoS etc., so it is considered that the label-based switched technology can be used to deployment the LISP technology.

This document specific an LISP trans solution when LISP deploys in MPLS network, and provides a new data packet encapsulation format that the out IP header of IP-in-IP encapsulation in LISP is cut off. There are two layer MPLS label, the outer MPLS label is used to forward LISP data packet in MPLS network, and the inner MPLS label indicates the LISP data packet and carries the source RLOC address information. The end-to-end MPLS technology can be implemented between ITR and ETR. So the plenty of MPLS services, such as VPN service, traffic engineer, QoS etc can be applied when deployed LISP. There are three deployment scenarios provided in this document according to the role of PE.

2. Terminology

Endpoint ID (EID): a 32-bit (for IPv4) or 128-bit (for IPv6) value used in the source and destination address fields of the first (most inner) LISP header of a packet. The host obtains a destination EID the same way it obtains a destination address today, for example through a DNS lookup or SIP exchange. Usually, the EID is an IP address. If the host is required to support mobility, the EID should be unique.

Routing Locator (RLOC): the IPv4 or IPv6 address of an egress tunnel router (ETR). It is the output of an EID-to-RLOC mapping lookup.

Label Switch Router (LSR): an MPLS node which is capable of forwarding MPLS data packet based on the label forwarding table.

Label Edge Router (LER): an MPLS node that connects an MPLS domain with a node which is outside of the domain, either because it does not run MPLS, and/or because it is in a different domain. If an LSR has a neighboring host which is not running MPLS, that that LSR is an MPLS edge node.

Ingress Tunnel Router (ITR): a router which accepts an IP packet with a single IP header (more precisely, an IP packet that does not contain a LISP header). The router treats this "inner" IP destination address as an EID and performs an EID-to-RLOC mapping lookup through a mapping service. An ITR maintains a local mapping table that stores some recently used EID-to-RLOC mapping. An ITR also acts as the LER in MPLS network, it maintains a label forwarding table. When ITR receives a data packet from its custom site, it does an EID-to-RLOC mapping lookup, then does a label lookup through the label forwarding table by the locator which is the result of EID-to-RLOC mapping lookup.

Egress Tunnel Router (ETR): a router that accepts an IP packet where the destination address in the "outer" IP header is one of its own RLOCs. ETR also acts as the LER equipment and setups the point-to-point LSP tunnel with the ITR. ETR distributes a inner label to its peer ITR .

EID-to-RLOC mapping: a binding between an EID and the RLOC-set that can be used to reach the EID. An RLOC-set may contain multiple RLOC, and perhaps the preference to an RLOC.

3. LSP Signaling and Setup

ITR and ETR act as LER in MPLS network, and there is a point to point LSP tunnel between ITR and ETR. The LSP tunnel is established by the signal protocol, such as LDP, RSVP. If ITR and ETR belong to different AS, the LSP tunnel is an inter-As tunnel. The LISP data packets are forwarded along the LSP tunnel. The LSP should be setup between ITR and ETR before requesting EID-to-RLOC mapping and performing customer packet forwarding.

4. LISP label signaling and setup

It is required for ETR to identify the MPLS packet which encapsulates LISP type packet, and identify the source RLOC of the LISP packet. For this purpose, there is an inner MPLS label between outer MPLS

label and LISP header to identify the LISP data packet. When the LISP data packet with label encapsulation reaches the ETR, ETR strips the MPLS label and gets the LISP data with LISP header, and ETR couldn't deal with the data packet if there is no inner label to identify the LISP header.

The inner MPLS label could be distributed by MP-BGP protocol. The AF (address family) of MP-BGP protocol should be extended to support inner label distribution function in LER (ITR and ETR). The LISP label will be distributed among ITR and ETR when the LISP function is enabled in the peer of ITR and ETR.

5. MPLS label encapsulation format

The left figure shows the IP-in-IP encapsulation. The source and destination IP address of outer IP header are RLOC address, and the source and destination IP address of inner IP header are EID address.

This document proposes a MPLS label encapsulation to encapsulate the LISP data packet, as shows in the right figure. There are two layer labels, the outer label is used for data forwarding, and the inner label identifies the LISP packet. The outer label is distributed by the signal protocol, and the inner label is distributed by extension MP-BGP protocol. The UDP header is cut off in the optimal encapsulation format, and the LISP data checksum can be done by CRC field of layer 2 header.

MPLS label encapsulation format

```
   +-----------+                  +----------+
   +   outer   +                  +  label   +
   + IP Header +                  +          +
   +-----------+                  +----------+
   +    UDP    +                  +  label   +
   +-----------+                  +----------+
   +   LISP    +                  +  LISP    +
   +-----------+                  +----------+
   +   Inner   +                  +  Inner   +
   + IP Header +                  + IP Header+
   +-----------+                  +----------+

IP-in-IP encapsulation      MPLS Label encapsulation
```

Figure 1

6. EID-RLOC-Label mapping

EID-to-RLOC mapping is established by the mapping mechanism, such as ALT, LISP-MS. And there is a cache in ITR to record and store the recently EID-to-RLOC record. ITR and ETR belong to the MPLS domain, and there is label binding to the RLOC address, so the binding of RLOC and label is stored in the ITR.

When there is data packet (whether IPv4 data packet or IPv6 data packet), ITR search the RLOC address in the EID-to-RLOC cache according to the EID address, then search the label forwarding table to get the outer label of RLOC address. The inner MPLS label is distributed according to the LISP-RD, which carries the information of RLOC address. The ETR distributes different inner label to different ITR. When data packet reaches ETR, ETR can get the RLOC address information according to the inner label.

The original data packet will be encapsulated with an LISP header, inner MPLS label and outer MPLS label according to the figure 1.

7. Deployment scenario

7.1. Merging PE and xTR function

7.1.1. Deployment description

There are three deployment scenarios provided in this document according to the role of MPLS PE. The first scenario is that MPLS PE acts as xTR, that is, the ingress PE acts as ITR and egress PE acts as ETR. ITR not only stores and maintains the EID-RLOC mapping in the cache, but also sets up the RLOC and outer label binding, and maintains the label forwarding table. Point-to-point LSP tunnel is established for LISP data forwarding between ITR and ETR by using the current signaling protocol, such as LDP, RSVP etc. The data encapsulation can be optimal as MPLS label encapsulation format in figure 1.

7.1.2. Label-based forwarding

The LISP data packet in MPLS network will be encapsulated by MPLS label, and there is only one layer IP header, and the IP address of the IP header is EID address. The LISP data packet forwards according to the outer MPLS label.

The following is the example of data forwarding process. The figure 2 is the network architecture, and it is supposed that host A belongs to site A and host B belongs to site B, and host A will communicate

with host B.

(1) Host A sends an IP packet (a IPv4 packet or IPv6 packet, whatever) to its default ITR. The destination IP address and source IP address of the IP packet are the EID address of host B and host A respectively;

(2) When ITR receives the IP packet, it looks up the RLOC of the EID address of host B in the local cache. If it finds the RLOC, it means that the packet is not the first packet, then continue to look up the out label of RLOC address, if it does, then skips into step 6 indirectly; if there is no match RLOC address of EID, it means that the data packet is the first packet, then go on with step 3;

(3) ITR encapsulates the LISP-Request message and sends to the mapping system for requesting the RLOC of EID2;

(4) When the mapping system receives LISP-Request, it looks up the RLOC in the mapping database and response the LISP-reply message with the right RLOC address;

(5) When ITR receives the LISP-Reply message, it stores the EID-to-RLC mapping into its local cache, and then look up the point-to-point LSP tunnel between ITR and ETR. Note, the point-to-point LSP tunnel between ITR and ETR should be already setup before requesting RLOC of EID2;

(6) ITR prepends LISP data packet with label encapsulation as figure 1. The destination and source IP address of inner IP header are EID address of host A and host B respectively, then ITR sends the data encapsulated to the MPLS network. The data packet forwards with label switched;

(7) When the LISP data packet reaches the ETR, it strips the label and gets the original IP packet. Usually, the outer label is poped in the penultimate MPLS node, and ETR only lookup the inner label and gets the RLOC address information of ITR;

(8) The IP packet forwards to the destination host B through site B according to the EID address of host B.

label-based forwarding

```
+-------+    +--------+   +-----+   +--------+  +--------+
|site A CE---+ITR/LER +---+ LSR +---+ETR/LER +--CE site B|
+-------+    +--------+   +-----+   +--------+  +--------+

                       MPLS Domain
             -------------------------------
```

Figure 2

7.2. xTRs act as CE

The second scenario is the common traditional deployment solution. xTRs is the exit router which is located in the edge of customer network. Form the view of MPLS network. xTR acts as CE. ITR does the LISP format with IP-in-IP encapsulation and doesn!_t run MPLS technology, and PE does the traditional MPLS encapsulation, which is similar with the MPLS BGP VPN.

The data encapsulation in PE is as following figure. There are MPLS label and IP-in-IP encapsulation. The outer source and destination IP address are the RLOC address of ITR and ETR respectively. The MPLS label is distributed according to the RLOC address of PE, and it used for data forwarding in the MPLS domain.

label encapsulation format

```
                +-----------+
                +   out     +
                +  label    +
                +-----------+
                +  inner    +
                +  lable    +
                +-----------+
                +   outer   +
                + IP Header +
                +-----------+
                +    UDP    +
                +-----------+
                +   LISP    +
                +-----------+
                +   Inner   +
                + IP Header +
                +-----------+
```

Figure 3

7.3. Multihoming deployment

The third scenario is a multihoming deployment solution. xTR locates in the custom site. ITR acts as the CE and multihomes to two or several PEs, such as PE1 and PE3 in the following figure. ITR does the LISP data encapsulation .ETR runs MPLS technology. The core network is MPLS network and the data packet forwards based on MPLS Label. ETR and PE1 establish the MP-BGP peer and take use of the inter-AS option B to distribute inner label from ETR to PE1. The outer label is distributed in MPLS domain. It is configured the static route from ITR to PE1 and PE3.

multihoming deployment

```
+----------+    +--------+   +-----+   +---------+    +-------------+
|site A CE +--+ITR1/PE1 +---+ p   +---+  ASBR1 +---ETR1/PE2 site B|
+----------+ |  +--------+   +-----+   +---------+    +-------------+
             |
             |
             |  +--------+   +-----+   +---------+    +-------------+
             +-+ITR2/PE3+---+ p   +---+  ASBR2 +---ETR2/PE4 site C|
                +--------+   +-----+   +---------+    +-------------+
```

Figure 4

8. Security Considerations

9. Acknowledgement

10. References

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