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October 19, 2013

A Unified LISP Mapping Database for L2 and L3 Network Virtualization Overlays
draft-hertoghs-nvo3-lisp-controlplane-unified-00

Abstract

The purpose of this draft is to document how the Locator/ID Separation Protocol (LISP) Control Plane can be used to offer a unified (offering L2 AND L3) Overlay solution that matches the framework and requirements of Network Virtualization over L3 (NVO3). This information is provided as input to the NVO3 analysis of the suitability of existing IETF protocols to the NVO3 requirements.

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 RFC 2119 [RFC2119].

Status of This Memo

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1. Introduction

The purpose of this draft is to provide a mapping between the Network Virtualization over L3 (NVO3) framework [I-D.ietf-nvo3-framework] and the Locator/ID Separation Protocol (LISP) [RFC6830], and in particular how LISP components map to the reference models defined therein. This document extends the scope of[I-D.maino-nvo3-lisp-cp] to cover the case of a unified overlay that includes L2 and L3 services.

LISP is a flexible map and encap framework that can be used for overlay network applications, including Data Center Network Virtualization. The LISP framework provides two main tools for NVO3:

1. A Data Plane that specifies how Endpoint Identifiers (EIDs) are encapsulated in Routing Locators (RLOCs), and

2. A Control Plane that specifies the interfaces to the LISP Mapping System [RFC6833]. The LISP Mapping system provides the mapping between EIDs and RLOCs.

LISP can be leveraged to offer services to both Physical and Virtual endpoints, and is architecturally EID address family agnostic. Some flows will be across an L3 overlay (using IP addresses as EIDs), and other flows will be across an L2 overlay (using MAC addresses as EIDs).

If certain requirements are met within the architecture, the choice of whether a flow is sent across the L2 overlay versus across the L3 overlay is not mapped one to one to the choice between intra subnet (bridging) and inter subnet (routing) forwarding. This allows the network administrator to offer infrastructure spanning subnets to its tenants, while not forcing them to deploy infrastructure-wide broadcast domains.

This document will focus on how to offer a unified L2 and L3 overlay, where both L2 and L3 services can be offered to the tenant’s traffic simultaneously.

The draft will elaborate on achieving multi homing of Tenant Systems (TS), as well as optimal routing and forwarding, including how VM mobility is achieved and optimal traffic forwarding is achieved.

Although the LISP specification uses a specific data plane, its control plane can be decoupled fairly easily from the data plane and thus can support various data plane encapsulations. After describing the various data plane options, this document also addresses the NVO3 data plane requirements[I-D.ietf-nvo3-dataplane-requirements].

The document continues to lay out how the NVO3 control plane requirements [I-D.ietf-nvo3-nve-nva-cp-req] are addressed.

Finally this document will provide security considerations in Section 5

2. Definition of Terms

Flood-and-Learn: the use of dynamic (data plane) learning in VXLAN to discover the location of a given Ethernet/IEEE 802 MAC address in the underlay network.

For definition of NVO3 related terms, notably Tenant System (TS), Virtual Network (VN), Virtual Network Identifier (VNI), Network Virtualization Edge (NVE), Network Virtualization Authority (NVA), Data Center (DC), please consult [I-D.ietf-nvo3-framework].

For definitions of LISP related terms, notably Map-Request, Map-Reply, Ingress Tunnel Router (ITR), Egress Tunnel Router (ETR), Endstation IDentifier (EID), Routing LOCator (RLOC), Map-Server (MS) and Map-Resolver (MR) please consult the LISP specification [RFC6830].

3. NVO3 Framework and LISP

3.1. NVO3 Generic Reference Model

[I-D.maino-nvo3-lisp-cp] provides a mapping of the NVO3 generic reference model [I-D.ietf-nvo3-framework] onto the LISP architecture. In this document we will focus on the unified L2/L3 LISP control plane, and on how it will optimize forwarding .

3.2. NVE Reference Model

The LISP NVE Reference Model is described in [I-D.maino-nvo3-lisp-cp]. This section will look at the different types of NVEs: L2-only, L3-only, and unified L2/L3, as well as looking at VM Mobility, Multi-homing, optimal forwarding and external connectivity aspects. How TSes connect to the network is described in Section 3.4.3.

3.2.1. Types of NVE’s

[RFC6830] is defined as a L3 NVE, and it can be enhanced to support L2 NVEs.

The separation of the L2 NVE and L3 NVE functions can be based on the nature of the packets: bridged packets are assigned to the L2 NVE

function, while routed packets are assigned to the L3 NVE function. Therefore these discrete functions could live on discrete networking nodes.

However, it is possible to use LISP as an unified control plane, that combines and co-locates the function of L2/L3 NVE onto a single node. The network administrator can choose which traffic will be forwarded across each service type.

3.2.1.1. L2 only NVE

[I-D.smith-lisp-layer2] describes an encapsulation method for carrying Ethernet and IEEE 802 media access control (MAC) frames within the Locator/ID Separation Protocol (LISP). As described in [I-D.maino-nvo3-lisp-cp] MAC addresses are used as EIDs in an L2 only NVE. As control plane learning is used, only broadcast and multicast traffic needs mult-destination support from the underlay.

The frame format defined in [I-D.mahalingam-dutt-dcops-vxlan], has a header compatible with the LISP data path encapsulation header, when MAC addresses are used as EIDs, as described in section 4.12.2 of [I-D.ietf-lisp-lcaf].

The LISP control plane is extensible, and can support non-LISP data path encapsulations such as NVGRE [I-D.sridharan-virtualization-nvgre], or other encapsulations that provide support for network virtualization.

3.2.1.2. L3 only NVE

LISP is defined as a virtualized IP routing and forwarding service in [RFC6830], and as such can be used to provide L3 NVE services.

3.2.1.3. Unifed L2/L3 NVE

When using a unified L2/L3 NVE, IP EIDs are registered to the LISP mapping system with the MAC Address of the Tenant System (TS) as an additional RLOC (next to the NVE RLOC), through the methods defined in [I-D.ietf-lisp-lcaf], by encoding Key/Value Pairs. MAC Address based EIDs will also be registered for TSes that are transmitting non-IP based traffic. TSes that send out both IP and non-IP traffic will therefore be registered twice. For the L2 overlay the Virtual Networking Instance (VNI)/IID denotes a network-wide bridge domain, while for the L3 overlay the VNI/IID denotes a Virtual Routing Forwarding (VRF) instance.

Implementing an NVE with a unified L2 and L3 overlay support is beneficial for multiple reasons:

Primarily it allows the network administrator to choose which traffic traverses the L2 overlay versus the L3 overlay, not only on the basis of intra-subnet (bridged) versus inter-subnet (routed) traffic flows. As a matter of fact, it is highly beneficial to choose a policy where all IP traffic is forwarded across the L3 overlay (i.e. both intra- and inter-subnet traffic). Effectively this allows the 'spread' of subnets across the Datacenter(s) without leading to network wide broadcast and associated failure domains, while allowing free mobility of the end-stations.

Secondarily, when all the TS IP and MAC addresses are registered with the NVA/LISP Mapping system, optimisations in ARP and ND [RFC4861] forwarding and handling can be achieved. ARPs and IPv6 NDs for 'unknown' destinations are by default dropped, although a policy can allow for 'unknown' ARP/ND packets to be flooded across the underlay if so desired by the operator (e.g. when there is a desire to support 'silent hosts').

Finally, as all IP traffic is forwarded across a L3 overlay, and ARP/ ND operations do not need flooding services, the amount of traffic that needs to traverse the L2 overlay is limited to non-IP traffic only. This makes the registration of MAC-addresses as EIDs with the LISP control plane optional. The system in this case could use ingress replication and Flood-and-Learn to handle the non-IP traffic. Of course, the use of the LISP control plane for MAC address based EIDs is another option as well, but the choice is left to the network administrator.

However, in order to achieve the benefits of this model, there are some requirements of how TSs can connect to the unified L2/L3 NVE, and there are also requirements on how default gateway MAC/IP addresses are assigned to the NVE function, and how forwarding is done on the NVE function:

- The NVE MUST always do an IP lookup for IP based traffic, independent of whether the destination is within the same subnet or not, or whether the destination TS is attached to the same VLAN or L2 NVI as the source TS.

- The unified L2/L3 NVE NVI instance MUST have a uniform default gateway MAC-address and IP address across the entire NVO3 network. This is to make sure that a TS can always reach its default gateway, irrespective of location.

- A TS can connect across a L2 switched network to a unified L2/L3 NVE, but traffic forwarded MUST follow a simple rule, where all traffic from a TS MUST always be sent upstream to the unified L2/ L3 NVE, regardless of its destination MAC address, and traffic

from locally attached TS's MUST be switched through the NVE. Directly connecting a TS to a unified L2/L3 NVE automatically solves that requirement.

There are various options to provide unified L2 and L3 support for LISP in the data path.

[I-D.smith-lisp-layer2] extends LISP to support MAC addresses as EIDs, and can be used in combination with [RFC6830], using the destination UDP port in the outer LISP header for disambiguation.

Recently extensions to both LISP and VxLAN have been proposed to offer multiprotocol support across the same outer header format (i.e. using a single UDP port number), as described in [I-D.lewis-lisp-gpe], and [I-D.quinn-vxlan-gpe] respectively. It is to be noted that some functionality offered by native LISP is no longer available when using the [I-D.lewis-lisp-gpe]extension (namely nonce, echo-nonce, and map-versioning). These are optional control plane optimizations implemented in the data plane for [RFC6830], and their use is less relevant in DC applications.

The remainder of this document assumes a unified L2/L3 NVE deployment model.

3.2.2. Multihoming aspects

If the TSes are co-located with the xTR/NVE function, no support for multi-homing is needed.

If the network between the L2 device connecting the TSes and the LISP xTRs is a simple hub and spoke switched L2 topology using VLANs (this is a common assumption in DC networks), a multi-chassis Link Aggregation Group (LAG) solution can be used to offer redundancy, where both xTRs will be seen by the access device as one logical entity. xTRs connected to the same L2 switched access network are part of the same 'LISP site', and both of them can be used to send traffic to TSes behind them, as both xTRs are registering to the LISP mapping system for the EIDs behind them. Registrations performed by the individual xTR (as a result of detection of a new EID) part of the same site are performed using the RLOCs of all xTRs connected to that site. How the multi-chassis LAG solution is build is out of scope of this draft.

3.2.3. External connectivity aspects

External connectivity between a LISP enabled NVO3 DC, as well as any LISP site, and the external world can be handled through a gateway device.

In case the gateway device handles connectivity to VPNs or the Internet, LISP interworking will be employed at the gateway device as per [RFC6832].

In case the gateway device is used to interconnect to another DC part of the same administrative domain (one Mapping System governs both DCs), the only function needed on this device is routing within the RLOC address space.

In case separate LISP Mapping systems are used, interworking has to be established between them, as well as providing routing between the two administrative domain in between the RLOC address spaces of both DCs respectively. Today there is no described way of interworking between DDT based Mapping systems. An external controller could also insert new RLOC locations into a DDT based Mapping system when an EID has moved to a location not governed by this particular Mapping system.

3.2.4. Optimal Forwarding aspects

Implementing a co-located and unified L2 and L3 NVE, and placing that NVE as close as possible to the TSes, leads to the most optimal forwarding.

East-to-west traffic (from NVE to NVE) will always be mapped-and-encapped towards the 'right' NVE, as the NVA function (the LISP Mapping system) has knowledge about all of the TSes IP and MAC addresses.

North to South traffic (traffic ingress into the DC) will also be delivered to the right NVE, without traffic tromboning, as traffic is switched based on the EID IP address, which will always point to the correct ETR/RLOC.

Traffic going from TSes to external destinations will also not be affected by traffic tromboning as all NVE's part of an NVI are seen as the same default gateway, independent of location.

Traffic tromboning can occur if the last hop router is not in the same location as the egress NVE, and if only a single L2 NVE is deployed. In other words, the only way for a L2-only NVE based NVO3 system to avoid traffic tromboning for north-south traffic, is by

centralizing the default gateway for all VNI's in one location (that in some cases may be suboptimal).

3.2.5. VM Mobility aspects

This section shows how the LISP control plane deals with VM mobility when end systems are migrated from one NVE/DC to another.

We'll assume that a signaling protocol, as described in [I-D.kompella-nvo3-server2nve], signals to the NVE operations such as creating/terminating/migrating an end system. The signaling protocol consists of three basic messages: "associate", "disassociate", and "pre-associate". The signaling protocol for attach/detach is in addition and orthogonal to the LISP control plane.

Two approaches are laid out: An approach at L2, where MAC-addresses are used as EID, and an approach at L3, where both IP and MAC addresses are used as EIDs.

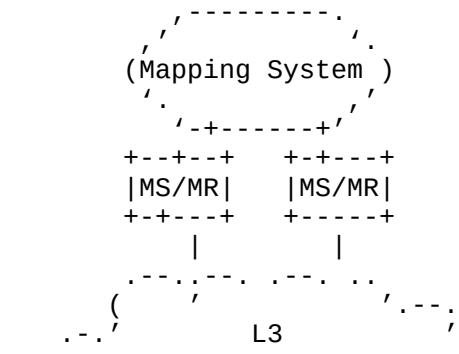
3.2.5.1. VM Mobility at L2

VM mobility at L2 is described in [I-D.maino-nvo3-lisp-cp]

It is to be noted that the approach of solving VM mobility at L2 introduces scalability problems in terms of failure domain, NVA scaling (as MAC addresses are a flat and non de-aggregatable address space) and BUM containment.

3.2.5.2. VM Mobility at L3

This approach solves the scaling problems of the L2 approach by assuming that the majority of traffic is IP based. End Systems are therefor registered with their IP addresses as EID and xTR IP address as an RLOC, while their MAC-address is registered as an additional RLOC for the same EID.



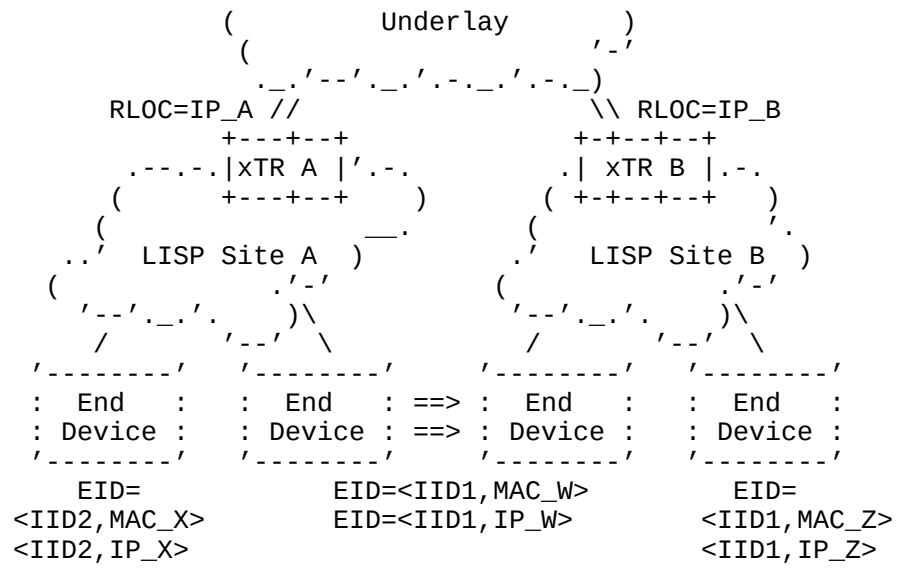


Figure 1: End System Mobility

It is assumed that the LISP xTRs have a unified L2 and L3 map-en-encap function, where IP packets, regardless of the fact they are switched intra- or inter subnet, are mapped-and-encapped across the L3 overlay. All other traffic (non-routable traffic, non-IP traffic) is mapped-and-encapped by the L2 overlay. It is also assumed that all XTRs offer the same default gateway IP and MAC address across the network, on a per VNI instance.

A unified L2/L3 overlay will lead in the xTRs registering two sets of EIDs for specific end systems, who deliver a mix of IP and non-IP traffic:

- A tuple of EID=<IID, IP> to use for IP traffic across the L3 overlay, whereby the IID maps to a VRF instance. It will register the EID to multiple RLOCs, one being the xTR IP address, and the other one being the TS MAC Address.

- A tuple EID= <IID,MAC> to use for non-routable, non-IP traffic, across the L2 overlay, whereby the IID maps to a network-wide Bridge Domain.

Assume the scenario described in Figure 1. Also assume that for the sake of this discussion, the VMs do not send out traffic that needs treatment by an L2 overlay.

As a result of the end system registration, the Mapping System contains the EID-to-RLOC mapping for end system W that associates EID=<IID1, IP_W> with the RLOC(s) associated with LISP site A (IP_A), as well as the RLOC associated with the MAC Address MAC_W of the end system W.

The process of migrating end system W from data center A to data center B is initiated.

ETR B receives a pre-associate message that includes EID=<IID1, IP_W>. ETR B sends a Map-Register to the mapping system registering RLOC=IP_B as an additional locator for end system W with priority set to 255. This means that the RLOC MUST NOT be used for unicast forwarding, but the mapping system is now aware of the new location.

During the migration process of end system W, ETR A receives a dissociate message, and sends a Map-Register with Record TTL=0 to signal the mapping system that end system W is no longer reachable at RLOC=IP_A. xTR A will also add an entry in its forwarding table that marks EID=<IID1, IP_W> as non-local.

When end system W has completed its migration, ETR B receives an associate message for end system W, and sends a Map-Register to the mapping system setting a non-255 priority for RLOC=IP_B. Now the mapping system is updated with the new EID-to-RLOC mapping for end system W with the desired priority.

The remote ITRs that were corresponding with end system W during the migration will keep sending packets to ETR A.

ETR A will keep forwarding locally those packets until it receives a dissociate message, and the entry in the forwarding table associated with EID=<IID1, IP_W> is marked as non-local.

Subsequent packets arriving at ETR A from a remote ITR, and destined to end system W will hit the entry in the forwarding table that will generate an exception, and will generate a Solicit-Map-Request (SMR) message that is returned to the remote ITR.

Upon receiving the SMR the remote ITR will invalidate its local map-cache entry for EID=<IID1, IP_W> and send a new Map-Request for that EID. The Map-Request will generate a Map-Reply that includes the new EID-to-RLOC mapping for end system W with RLOC=IP_B.

Similarly, unencapsulated packets arriving at ITR A from local end systems and destined to end system W will hit the entry in the forwarding table marked as non-local, and will generate an exception that by sending a Map-Request for EID=<IID1, IP_W> will populate the

map-cache of ITR A with an EID-to-RLOC mapping for end system W with RLOC=IP_B.

3.3. LISP dataplane options and NVO3 dataplane requirements

This section maps the NVO3 data plane requirements [I-D.ietf-nvo3-dataplane-requirements] to the various options available.

3.3.1. Native LISP Data Plane

Figure 2shows the LISP header defined in the LISP specification [RFC6830]. The UDP and LISP headers are shown below for reference. For header fields description see section 5.3 of [RFC6830].

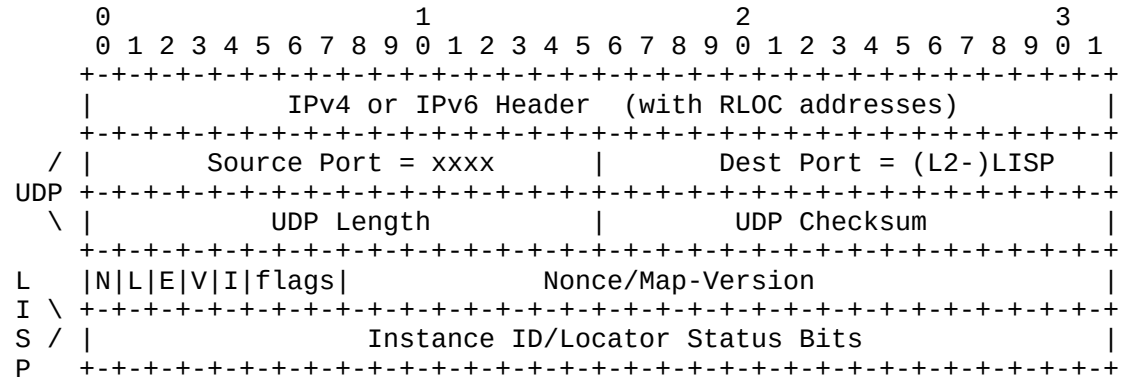


Figure 2: LISP Header

When the headers are used for encapsulating IP Packets, the UDP Destination Port is set to 4341. When the headers are used for encapsulating L2 frames, the UDP Destination Port is set to 8472 [I-D.smith-lisp-layer2].

When used in private DC and Enterprise networks, the 'I'-bit (Instance bit) is set, indicating the presence of an Instance ID (IID) inside the header. A Virtual Networking Instance (VNI) is indicated by the IID, a 24 bit field, which is used as a global identifier for the tenant in LISP. When used for L3 services, the IID can be seen as a VRF, when used for L2 services, the IID can be seen as a L2 Bridge Domain instance.

Virtual Access Point (VAP) identification is naturally supported by combining LISP and Integrated Routing and Bridging (IRB). IRB allows local ports or logical ports (ports instantiated on a local port, where frames are assigned based on some fields in the header like

VLAN IDs (VIDs)), to be added to a NVE-local bridge domain. That bridge domain instantiates the L2 Specific VNI. The bridge domain also connects to a virtual routed port, which instantiates the L3 specific VNI.

A L2 VNI provides an emulated Ethernet Multipoint service through the use of the LISP control plane, where it registers MAC addresses as EIDs.

Loop-avoidance is handled by control plane learning, and control plane enabled registration of all TS EIDs as soon as they send a first packet. Therefore unicast traffic will never result in loops, as there is no 'unknown' unicast. multi-destination traffic forwarding is performed using a multicast enabled underlay and LISP procedures laid out in [RFC6831] or through ingress replication to the list of participating NVEs in that NVI, and therefore is loop-free.

A L3 VNI behaves exactly as an IP VRF and therefore supports virtualized IP routing and forwarding, through per tenant forwarding with IP address isolation and L3 tunneling for interconnecting instances of the same VNI on NVEs.

Note that , within this document, it is assumed that a unified L2/L3 NVE is deployed and therefore all IP traffic will be forwarded using the L3 overlay, even intra-subnet traffic.

The LISP header performs the function of the NVO3 overlay header.

Through using the LISP control plane, the egress NVE can be looked up.

As the outer LISP header is an IPv4 or IPv6 header, differentiated forwarding can be supported naturally. Equally, as LISP uses IP/UDP as a transport, multipath over LAG and ECMP in the underlay are naturally supported, through the entropy introduced in the UDP header by selecting per flow source UDP port numbers. A LISP based NVO3 network can work in both uniform and pipe models [RFC2983] and fully supports ECN marking as per [RFC6040] .

As it does for L3 services, the LISP control plane replaces the use of dynamic data plane learning (Flood-and-Learn) for unicast traffic for L2 services. Packet replication in the underlay network to support L2 broadcast, unknown unicast (optional, as all MAC-address are learned by the control plane) and multicast L2 and L3 overlay services can be done by:

- Ingress replication, which reduces the need for multicast in the NVO3 underlay to zero.

- Use of underlay multicast trees. These trees can be aggregated globally, or per tenant (rather than per VNI).

[RFC6831] and [I-D.farinacci-lisp-mr-signaling]specifies how to map a multicast flow in the EID space during distribution tree setup and packet delivery in the underlay network. LISP, being an IP based map-and-encap protocol, does not require any specific data plane functionality to make this work.

LISP interworking is described in [RFC6832] and fully supports connectivity to the internet or VPN gateways through the use of Proxy xTR's.

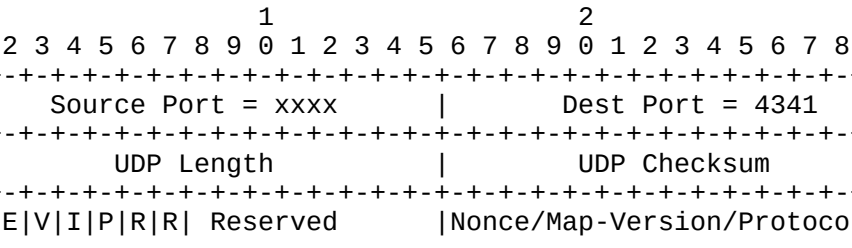
LISP, being an IP based protocol, supports ICMP-based MTU Path Discovery [RFC1191] , [RFC1981]as well as extended MTU Path Discovery techniques [RFC4821]. LISP also supports a stateless and stateful way of dealing with Large Encapsulated packets, see section 5.4 of [RFC6830].

Multi-homing is handled in the control plane, by allowing the LISP mapping system to have multiple RLOC entries for every EID, allowing the ITR to load balance across both ETR's. xTRs register a 'LISP site id' to the mapping system when they come online. When the LISP mapping system receives a registration for a given EID from a certain xTRs, it will install that EID entry pointing to all the RLOCs/xTR that have the same site-id. By performing LAG across multiple xTRs, multi-homing can be provided for the access or virtual switch that connects the TSs.

OAM can be performed across LISP in the same way as OAM is performed over IP routed, or Ethernet L2 switched environments.

3.3.2. LISP with Generic Protocol Extension (LISP-GPE)

[I-D.lewis-lisp-gpe] introduces multiprotocol support for LISP, by extending the LISP header, as shown in Figure 3 .



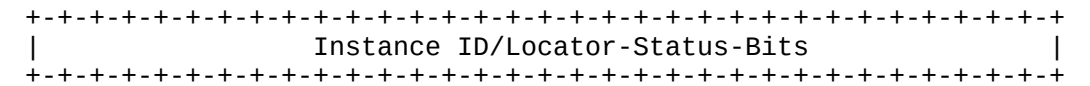


Figure 3: LISP with Generic Protocol Extension Header

A Protocol Bit (P-bit) is introduced, that when set, allows the insertion of a 16-bit Protocol Type. The UDP destination port number is 4341 for all protocol types.

Although the use of Nonce and Map-versioning are not allowed simultaneously with Protocol Type with this deployment, all of the solutions to the requirements described in Section 3.3.1 are exactly the same with this data plane encapsulation in an NVO3 context.

3.3.3. VxLAN-GPE

[I-D.quinn-vxlan-gpe] extends the VXLAN encapsulation with a Protocol Type, by introducing a Protocol Bit (P-bit) and a 16-bit Protocol Type in the VXLAN header, see Figure 4. Note that this data plane encapsulation is very similar to LISP-GPE, when used in an NVO3 context.

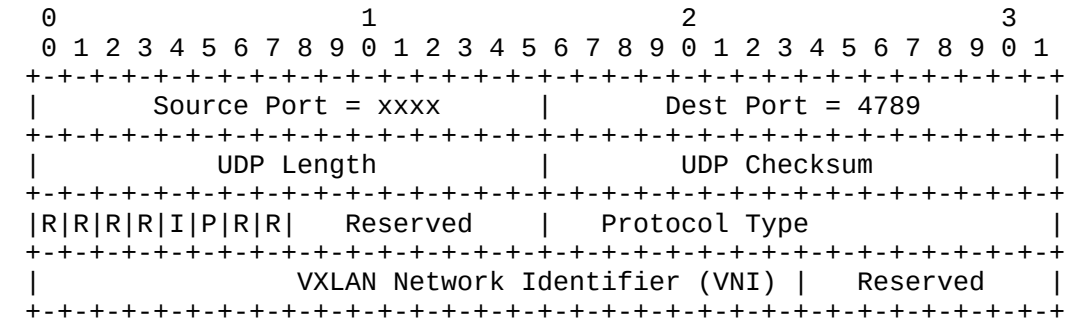


Figure 4: VXLAN with Generic Protocol Extension

All of the solutions to the requirements described in Section 3.3.1 are exactly the same with this data plane encapsulation.

3.3.4. L2 only solutions such as VxLAN and nvGRE

The LISP control plane can be leveraged to offer control plane learning for MAC Addresses for both the VXLAN [I-D.mahalingam-dutt-dcops-vxlan], as well as NVGRE [I-D.sridharan-virtualization-nvgre]. However, this solution offers sub-optimal support and hence will not be looked into further.

3.4. NVO3 control plane requirements and LISP

This section maps the NVO3 NVE to NVA control plane [I-D.ietf-nvo3-nve-nva-cp-req]requirements to the LISP control plane.

3.4.1. Inner to Outer Address Mapping

The LISP control plane, through the use of a Mapping service, provides inner to outer address mapping.

TS EIDs are registered to the LISP Mapping service by LISP ETRs within the context of a LISP instance ID, (i.e An NVO3 VNI).

A LISP based NVE will check its local cache if it needs to send a packet across the overlay. If there is a cache miss, it will request the EID to RLOC mapping from the LISP Mapping service. If there is a cache hit, it will use the local EID to RLOC mapping.

Cache entries are aged out when no traffic is being sent to those EIDs. The LISP control plane has ways of refreshing the local cache after the destination EID has moved to another RLOC. For more information, see Section 3.2.5 and [RFC6830]

3.4.2. Underlying network Multi-Destination Delivery

LISP supports delivering L2 and L3 multi-destination packets, independent of the underlying network multicast capabilities.

[RFC6831], [I-D.farinacci-lisp-mr-signaling] , more specifically section 6, describes how the LISP Control Plane is used by NVEs/ETRs to join a given EID multicast group by sending LISP Map-Requests rather than PIM Joins. Joining can be triggered by the receipt of a PIM or IGMP join in the EID space. In the case of a L2 overlay configuration on the NVE, the join is static.

In case the NVE/ETR is not multicast capable the ETR unicast RLOC will be registered, and will be added to the existing RLOC set for that given multicast EID, and the Map-Reply will contain the ITR from which the ETR wants to replicate. LISP ITRs will retrieve this list of ETRs from the Mapping System upon a Map-Request and will use this as a replication list.

In case the underlying network is multicast capable the Map-Reply will contain the multicast RLOC, which will be joined via PIM subsequently. All this state is stored on the Mapping system, or in the xTR caches per IID/VNI. In case ingress replication is deemed unscaleable, [I-D.farinacci-lisp-te] can be used, allowing a Re-encapsulating Tunnel Router (RTR) to be used as a distribution server to replicate to all the NVEs.

It is also important to point out that, in a unified L2/L3 NVE deployment, all IP traffic will get sent across the L3 overlay, and that ARP and ND packets are not handled using flooding.

In case non-IP traffic needs to be supported, L2 EIDs only need to use multicast or ingress replication for broadcast and multicast, as unicast flows are handled by the LISP control plane. This significantly reduces the multicast or ingress replication load.

3.4.3. VN connect/disconnect

We assume that a provisioning framework will be responsible for provisioning end systems (e.g. VMs) in each data center. The provisioning system configures each end system with an Ethernet/IEEE 802 MAC address and/or IP addresses and provisions the NVE with other end system specific attributes such as VLAN information, and TS/VLAN to VNI mapping information. LISP does not introduce new addressing requirements for end systems.

The provisioning infrastructure is also responsible to provide a network attach function, that notifies the NVE (the LISP site ETR) that the end system is attached to a given virtual network (identified by its VNI/IID) and that the end system is identified, within that virtual network, by a given Ethernet/IEEE 802 MAC address.

The LISP framework does not include mechanisms to provision the local NVE with the appropriate Tenant Instance for each Tenant Systems. Other protocols, such as VDP (in IEEE P802.1Qbg), should be used to implement a network attach/detach function, besides using link-up events for non-virtual end-systems. More-over it is quite common for devices to be able to ’sense’ new tenant end-systems dynamically by tracking new mac addresses and IP addresses in case a VDP or link-up event cant be relied upon.

The LISP control plane can take advantage of such a network attach/ detach function or the discovery of new MAC/IP addresses to trigger the registration of a Tenant System to the Mapping System. This is particularly helpful to handle mobility across the DC of the Tenant System.

Upon notification of end system network attach, the ETR sends a LISP Map-Register to the Mapping System. The Map-Register includes the EID and RLOCs of the LISP site. The EID-to-RLOC mapping is now available, via the Mapping System Infrastructure, to other LISP sites that are hosting end systems that belong to the same tenant.

For more details on end system registration see [RFC6833].

3.4.4. VN name to VN ID Mapping

The LISP Control Plane uses the Instance ID to identify the NVI. The VN Name to VNI mapping can be performed by the NVE as a result of local provisioning. Also, using LISP LCAF , it is possible to store ASCII Names in the Mapping Database, which can allow the system to resolve a VN Name to an IID/VNI.

3.4.5. LISP Control Plane Characteristics in an NVO3 context

LISP is a Control Plane solution that can scale very well to the NVO3 requirements:

1. LISP ETRs register destination EIDs into the LISP Mapping System. LISP ITRs pull destination EIDs from the LISP Mapping System and cache them for as long as traffic is being sent to those destinations. Hence a LISP Based NVE is only holding state for the active TS to TS flows, and only for the NVIs that are configured on those NVEs.

2. The LISP Control Plane is fast to acquire the needed state for a given destination through issuing a single Map-Request.

3. When an ETR (lets say ETR1) detects an EID it will also register this EID to the Mapping system. If that EID has moved from another ETR (lets say ETR2), it will update the Mapping system with a Map-Notify saying to no longer forward packets to it, and will install a ’non-local’ entry in the forwarding table. If an ITR has not updated its map-cache, and therefor sends a packet to ETR2, ETR will sent a Map-Notify directly to the ITR, updating its local cache. For further information see Section 3.2.5

4. As LISP support virtualization, the NVE running the LISP Control Plane will only be maintaining state for the Tenants VNIs that are configured on it.

5. Through leveraging the LISP DDT-based Mapping system [I-D.ietf-lisp-ddt], the necessary scaling can be achieved. The LISP DDT hierarchy can be based on address family, address family prefix, and IID, and scales in a very similar way as DNS.

6. The solution described in this document does not make use of multiple protocols, and hence is low in complexity.

7. Through the use of the LISP LCAF [I-D.ietf-lisp-lcaf] , extensibility is achieved. It is possible to add new address families (the MAC address family is the proof point). The LCAF format also allows lookups on a generic Key. This Key can be an identifier to an ACL or policy. A combination of multiple keys can be achieved by doing recursive lookups, where EID attributes are used as keys for a subsequent lookup. LCAF allows backwards compatibility between systems that use different LCAF implementations.

8. As the state is maintained in the LISP Mapping system acting as an NVA, adding another NVE/xTR to the network does not require any changes on existing NVEs.

9. LISP does not rely on Multicast in the underlay, while preserving the same Control Plane characteristics regardless of underlay multicast capability.

10. [I-D.barkai-lisp-nfv]documents one implementation of how the LISP Mapping System (NVA) can be programmed to create inner to outer address mappings. The LISP Control Plane will inform the xTR/NVE that hosts have moved, and if packets are attracted to those NVEs because of stale cache entries on other ITRs, packets will be routed to the right location, and the NVE will send a Solicited Map-Reply back to the ITR, clearing its cache, after which the ITR will request a new mapping. Obviously NVEs will be able to create inner to outer address mappings without the use of an orchestration solution.

11. See Section 5

3.5. NVO3 OAM Requirements and LISP

TBD

3.6. NVO3 Management Plane Requirements and LISP

TBD

3.7. Summary

The LISP Control Plane, makes a very good choice to implement NVO3 services due to the fact that it is agnostic to EID address families, and the fact that it provides an NVA in the form of the LISP Map Server with cache optimizations based on the pull-based LISP Map Cache on the LISP xTRs . The LISP control plane can be deployed across a set of different dataplane options as well. The usage of a unified L2 and L3 overlay , with the appropriate set of registrations in the LISP Mapping system, is recommended because of its optimal forwarding, scaling and IP centric characteristics, while supporting non-IP traffic as well.

4. IANA Considerations

This document makes no request of IANA.

Note to RFC Editor: this section may be removed on publication as an RFC.

5. Security Considerations

[I-D.ietf-lisp-sec] defines a set of security mechanisms that provide origin authentication, integrity and anti-replay protection to LISP's EID-to-RLOC mapping data conveyed via mapping lookup process. LISP-SEC also enables verification of authorization on EID-prefix claims in Map-Reply messages.

Additional security mechanisms to protect the LISP Map-Register messages are defined in [RFC6833].

The security of the Mapping System Infrastructure depends on the particular mapping database used. The [I-D.ietf-lisp-ddt] specification, as an example, defines a public-key based mechanism that provides origin authentication and integrity protection to the LISP DDT protocol.

6. Acknowledgements

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