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LISP for Satellite Networks
draft-farinacci-lisp-satellite-network-00

Abstract

This specification describes how the LISP architecture and protocols can be used over satellite network systems. The LISP overlay runs on earth using the satellite network system in space as the underlay.

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[1.](#) Introduction

This specification describes how a LISP overlay structure can run on top of a satellite network underlay. The approach is similar to how [[I-D.haindl-lisp-gb-atn](#)] is used in Aeronautical Telecommunications Networks and [[I-D.farinacci-lisp-mobile-network](#)] is used in cellular networks.

This satellite deployment use-case requires no changes to the LISP architecture or standard protocol specifications. In addition, any LISP implementations that run on a device with an existing satellite interface does not need to be upgraded.

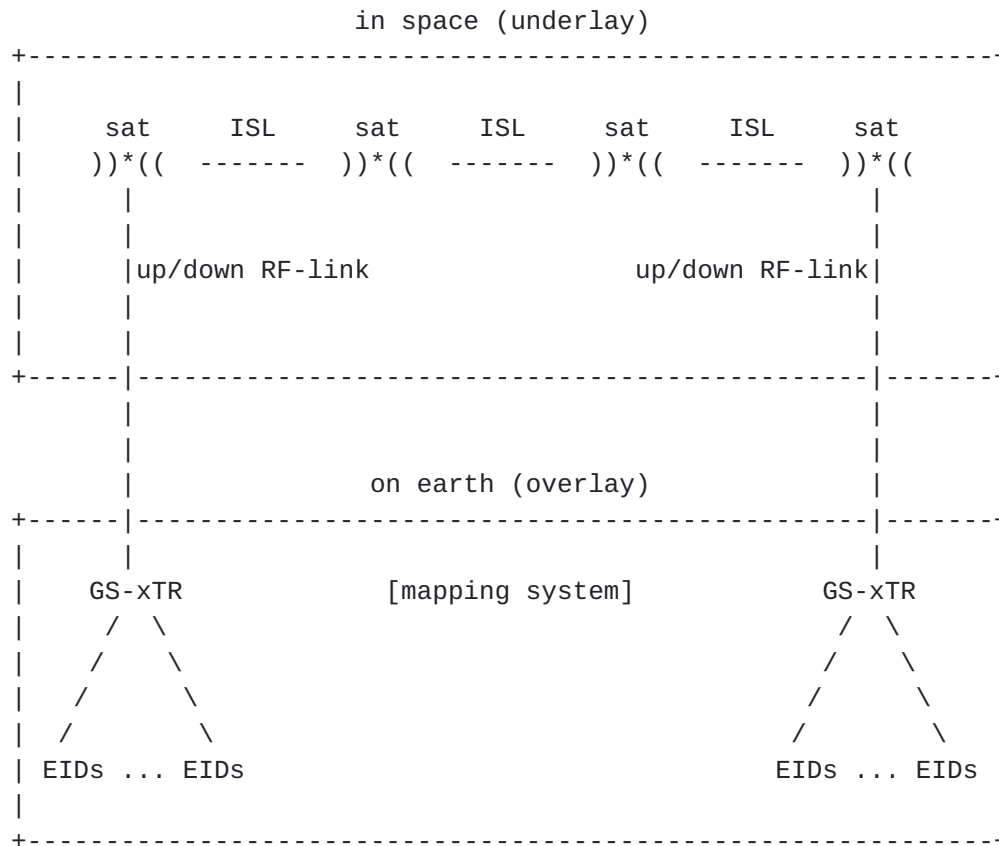
Even though an overlay should not concern itself with the operation of an underlay, the requirements from [[I-D.lhan-problems-requirements-satellite-net](#)] are considered but outside the scope of this document.

The LISP overlay requirements are:

1. There will be no EID state in the satellite network underlay.
2. The satellite underlay is completely unaware of the overlay running over it.
3. The overlay requires the underlay network to deliver packets to RLOC addresses.

4. The underlay network can transport IPv4 or IPv6 packets and can be dual-stack.
5. When path optimization in the underlay is available, an RLOC-record can be a source route of satellite hops.

The diagram below illustrates a 4 satellite system where each have Inter-Satellite-Links (ISLs) for connectivity between them and edge satellites with RF links to Ground Stations. The EID connectivity to the xTRs is achieved via typical IP network connectivity where EIDs can be directly connected, one or more switch hops away, one or more router hops away, or any combination.



Overlay on Earth, Underlay in Space

The LISP mapping system runs on the earth-resident Internet and requires reachability by xTRs before LISP encapsulation can occur over the satellite network underlay.

EIDs are known only to the overlay xTR nodes. EIDs are not routable or require state in the satellite network. This provides great value for scaling and EID mobility.

2. Definition of Terms

Inter-Satellite-Links (ISLs): are phased-array laser wireless links that transmit within or across orbits in space to other satellites. They are different than satellite downlinks which are RF links to Ground-Stations.

xTR: is a LISP data-plane device. xTR is the general term for ITR, ETR, or RTR. The formal and authoritative definition is in [\[I-D.ietf-lisp-rfc6830bis\]](#). When a LISP xTR runs on a ground station device, it is called a GS-xTR.

Ground-Station (GS): is a device on the ground that has wireless links to a satellite node in space [\[I-D.lhan-problems-requirements-satellite-net\]](#). When a Ground-Station is an LISP xTR, it encapsulates and decapsulates packets sent and received on satellite links according to the forwarding procedures in [\[I-D.ietf-lisp-rfc6830bis\]](#) and [\[I-D.ietf-lisp-rfc6833bis\]](#). A GS can also be part of the satellite network system but isn't deployed as a GS-xTR. In this scenario, the GS is part of the underlay and assumes the satellite network system, with its attached ground stations, deliver RLOC addressed packets. When a satellite is in relay mode (not using ISLs), a LISP RTR can be used to support traffic engineering where a GS-ITR encapsulates through a single satellite hop to a GS-RTR which decapsulates and re-encapsulates through another single satellite hop to a GS-ETR. See [\[I-D.ietf-lisp-te\]](#) for details, and how LISP-TE can also be used with multiple satellite hops.

source-GS-xTR: is the LISP ITR which does a mapping system lookup to obtain and cache the destination-RLOC for the destination-EID. It then encapsulates the packet and sends it on the uplink whatever satellite that is in coverage range.

destination-GS-xTR: is the LISP ETR which receives a LISP encapsulated packet on the downlink from the satellite that is in coverage range over it. The outer header is stripped and packet is delivered to local EID on the ground.

EID: defined as an Endpoint-ID in [\[I-D.ietf-lisp-rfc6830bis\]](#). An EID is assigned to devices that reside behind GS-xTRs and are registered to the LISP mapping system with a satellite network address which is used as an RLOC.

RLOC: defined as a Routing Locator in [\[I-D.ietf-lisp-rfc6830bis\]](#). Within the scope of this specification, the RLOC is the satellite network address of a GS-xTR where the satellite network knows how to forward packets to this RLOC address.

3. Overview

Here is how a packet flow sequence occurs from a source-EID to a destination-EID when the underlay is a satellite network:

1. source-EID originates an IP packet to a destination-EID. The addresses in the packet are EIDs.
2. The packet travels to the GS-xTR (source-GS-xTR) via traditional IP routing.
3. The source-GS-xTR does a map-cache lookup for destination-EID to obtain the RLOC for the destination-GS-xTR.
4. If map-cache lookup fails, a mapping system lookup is performed for destination-EID.
5. The source-GS-xTR LISP encapsulates the packet and sends it on the uplink to the satellite. The RLOC addresses in the outer header are source-GS-xTR and destination-GS-xTR.
6. The satellite network delivers the packet to Ground-Station addressed as destination-GS-xTR.
7. The destination-GS-xTR decapsulates the LISP packet by stripping the outer header and delivering the packet to the destination-EID on the ground.

4. Mapping System

The LISP mapping system holds EID-to-RLOC-set mappings. They are kept up to date by GS-xTRs and all the mechanisms from [\[I-D.ietf-lisp-rfc6833bis\]](#) are available for use. The mappings can contain RLOCs that are not GS-xTRs thereby allowing load-splitting between both satellite and terrestrial paths. The RLOC-set can also contain multicast RLOCs that can be reachable via satellite or terrestrial paths.

All of IPv4, IPv6, and MAC EIDs can be registered to the mapping system to create multi-address-family L3 overlays as well as L2 overlays on the satellite underlay. That is, GS-xTR RLOCs can be used with these EID address types.

Since the satellite network is not required to carry all routes that are earth-based, the LISP critical infrastructure will not be reachable by satellite nodes. Therefore, the mapping system must be earth-based so xTRs which are not GS-xTRs can register and lookup mappings. Note the satellite network is only required to carry routes for GS-xTR addresses.

When satellite connectivity changes from a GS-xTR within its coverage range, the RLOC of the GS-xTR does not change. Therefore, there is no need to update the mapping system when this happens. This provides more scale to the total system since the LISP overlay is providing a level of indirection.

5. EID Mobility

EID-mobility [\[I-D.ietf-lisp-eid-mobility\]](#) is supported so devices can roam to other xTRs and are found by mapping system updates for remote xTRs encapsulating to the EID. GS-xTRs learn EIDs on the ground dynamically via the mechanisms in [\[I-D.ietf-lisp-eid-mobility\]](#).

6. Satellite RLOCs and Underlay Routing

The address format of a GS-xTR RLOC depends on the design of the satellite network system. The LISP RLOC formatting is flexible to accommodate new address types such as GPS coordinate based addressing or other forms of satellite addressing [\[I-D.lhan-satellite-semantic-addressing\]](#). The only requirement is that they are routable by the satellite network system.

If the satellite network supports IP forwarding and IP addresses are assigned to the RF-links on the GS-xTRs, then the satellite network just needs to make these "attachment point addresses" routable in the satellite network routing system. And if the satellite network

desires to scale the route state in its routing system, it can use prefix aggregation, a local design matter to the satellite network routing system. When this is the case, the RLOC is a standard AFI encoded IPv4 or IPv6 address.

If the satellite network underlay supports a source-routing mechanism, as suggested in [[I-D.lhan-satellite-instructive-routing](#)], the same approach can be used as a LISP overlay on a terrestrial underlay running Segment Routing [[RFC8754](#)]. The source-route is encoded in an RLOC-record stored in the mapping system that is formatted as a list of satellite hop addresses.

7. Underlay Performance

The RLOC probing procedures in [[I-D.ietf-lisp-rfc6833bis](#)] can provide underlay telemetry measurement [[I-D.farinacci-lisp-telemetry](#)] so the overlay can tell how well the satellite network is performing. And if the underlay under performs or telemetry metrics change, the GS-xTR can select another RLOC, possibly to a terrestrial RLOC.

8. Security Considerations

There are no specific security considerations at this time for this use-case. However, existing LISP security functionality documented in [[I-D.ietf-lisp-rfc6833bis](#)], [[I-D.ietf-lisp-sec](#)], [[I-D.ietf-lisp-eid-anonymity](#)], and [[I-D.farinacci-lisp-ecdsa-auth](#)] can be used when the LISP overlay runs over a satellite network underlay.

Data-plane encryption can be used to make the satellite underlay more secure. See LISP Data-Plane Confidentiality [[RFC8061](#)] for more details. This solution can work when packets take multiple satellite hops and/or Ground-Station hops.

9. IANA Considerations

There are no requests for IANA at this time.

10. References

10.1. Normative References

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[Appendix A.](#) Acknowledgments

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[Appendix B.](#) Document Change Log**[B.1.](#) Changes to [draft-farinacci-lisp-satellite-network-00](#)**

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