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R. Bush
Arrcus & IIJ
R. Austein
K. Patel
Arrcus

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Link State Over Ethernet
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Abstract

Used in Massive Data Centers (MDCs), BGP-SPF and similar protocols need link neighbor discovery, link encapsulation data, and Layer 2 liveness. The Link State Over Ethernet protocol provides link discovery, exchanges supported encapsulations (IPv4, IPv6, ...), discovers encapsulation addresses (Layer 3 / MPLS identifiers) over raw Ethernet, and provides layer 2 liveness checking. The interface data are pushed directly to a BGP API (for LSVR), obviating the need for centralized topology distribution architectures. This protocol is intended to be more widely applicable to other upper layer routing protocols which need link discovery and characterisation.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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This Internet-Draft will expire on August 22, 2019.

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1. Introduction

The Massive Data Center (MDC) environment presents unusual problems of scale, e.g. O(10,000) devices, while its homogeneity presents opportunities for simple approaches. Approaches such as Jupiter Rising [JUPITER] use a central controller to deal with scaling, while BGP-SPF [I-D.ietf-lsvr-bgp-spf] provides massive scale-out without centralization using a tried and tested scalable distributed control plane, offering a scalable routing solution in Clos and similar environments. But BGP-SPF and similar higher level device-spanning protocols need link state and addressing data from the network to build the routing topology.

Link State Over Ethernet (LSoE) provides brutally simple mechanisms for devices to

- Discover each other's Layer 2 (MAC) Addresses,
- Run Layer 2 keep-alive messages for session continuity,
- Discover each other's unique IDs (ASN, RouterID, ...),
- Discover mutually supported encapsulations, e.g. IP/MPLS,
- Discover Layer 3 and/or MPLS addressing of interfaces of the link encapsulations,
- Enable layer 3 link liveness such as BFD, and finally
- Present these data, using a very restricted profile of a BGP-LS [RFC7752] API, to BGP-SPF which computes the topology and builds routing and forwarding tables.

This protocol may be more widely applicable to a range of routing and similar protocols which need link discovery and characterisation.

2. Terminology

Even though it concentrates on the Ethernet layer, this document relies heavily on routing terminology. The following are some possibly confusing terms:

ASN: Autonomous System Number [RFC4271], a BGP identifier for an originator of Layer 3 routes, particularly BGP announcements.

BGP-LS: A mechanism by which link-state and TE information can be collected from networks and shared with external components using the BGP routing protocol. See [RFC7752].

BGP-SPF A hybrid protocol using BGP transport but a Dijkstra SPF decision process. See [I-D.ietf-lsvr-bgp-spf].

Clos: A hierarchic subset of a crossbar switch topology commonly used in data centers.

Datagram: The LSoE content of a single Ethernet frame. A full LSoE PDU may be packaged in multiple Datagrams.

Encapsulation: Address Family Indicator and Subsequent Address Family Indicator (AFI/SAFI). I.e. classes of addresses such as IPv4, IPv6, MPLS, ...

Frame: An Ethernet Layer 2 packet.

MAC Address: Media Access Control Address, essentially an Ethernet address, six octets. See [IEEE.802_2001].

MDC: Massive Data Center, commonly thousands of TORs.

MTU: Maximum Transmission Unit, the size in octets of the largest packet that can be sent on a medium, see [RFC1122] 1.3.3.

PDU: Protocol Data Unit, an LSoE application layer message. A PDU may need to be broken into multiple Datagrams to make it through MTU or other restrictions.

RouterID: An 32-bit identifier unique in the current routing domain, see [RFC4271] updated by [RFC6286].

Session: An established, via OPEN PDUs, session between two LSoE capable devices,

SPF: Shortest Path First, an algorithm for finding the shortest paths between nodes in a graph; AKA Dijkstra's algorithm.

TOR: Top Of Rack switch, aggregates the servers in a rack and connects to aggregation layers of the Clos tree, AKA the Clos spine.

ZTP: Zero Touch Provisioning gives devices initial addresses, credentials, etc. on boot/restart.

3. Background

LSoE assumes a datacenter scale and topology, but can accommodate richer topologies which contain potential cycles.

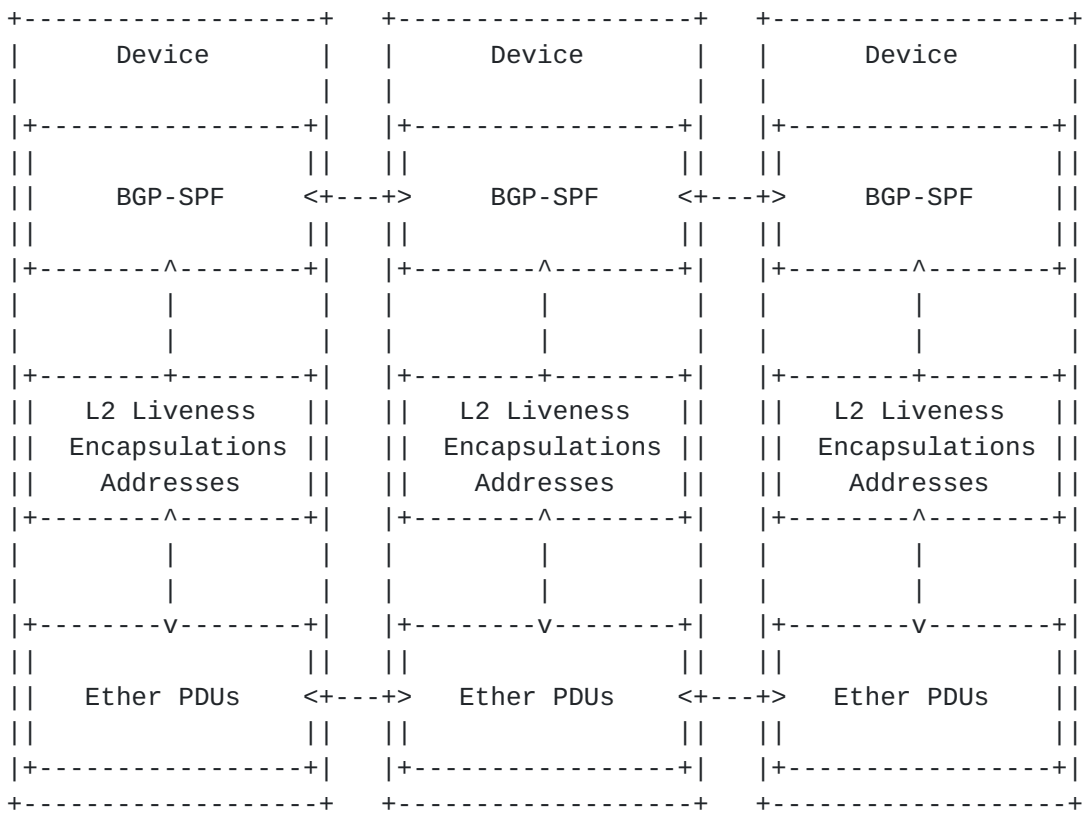
While LSoE is designed for the MDC, there are no inherent reasons it could not run on a WAN; though, as it is simply a discovery protocol, it is not clear that this would be useful. The authentication and authorisation needed to run safely on the WAN are not provided in detail in this version of the protocol, although future versions/ extensions could expand on them.

LSoE assumes a new IEEE assigned EtherType (TBD).

As encapsulations may have an inordinate number of addresses, and security will further add to the length of PDUs, LLDP's limitation to 1,500 octets is judged to be too limiting.

4. Top Level Overview

- Devices discover each other on Ethernet links
- MAC addresses and Link State are exchanged over Ethernet
- Layer 2 Liveness Checks are begun
- Encapsulation data are exchanged and IP-Level Liveness Checks done
- A BGP-like protocol is assumed to use these data to discover and build a topology database



There are two protocols, the Ethernet discovery and the interface to the upper level BGP-like protocol:

- Layer 2 Ethernet protocols are used to exchange Layer 2 data, i.e. MAC addresses, and layer 2.5 and 3 identifiers (not payloads), i.e. ASNs, Encapsulations, and interface addresses.

- A Link Layer to BGP API presents these data up the stack to a BGP protocol or an other device-spanning upper layer protocol, presenting them using the BGP-LS BGP-like data format.

The upper layer BGP family routing protocols cross all the devices, though they are not part of these LSoE protocols.

To simplify this document, Layer 2 Ethernet framing is not shown.

5. Ethernet to Ethernet Protocols

Two devices discover each other and their respective MAC addresses by sending multicast HELLO PDUs (Section 9). To allow discovery of new devices coming up on a multi-link topology, devices send periodic HELLOs forever, see Section 17.1.

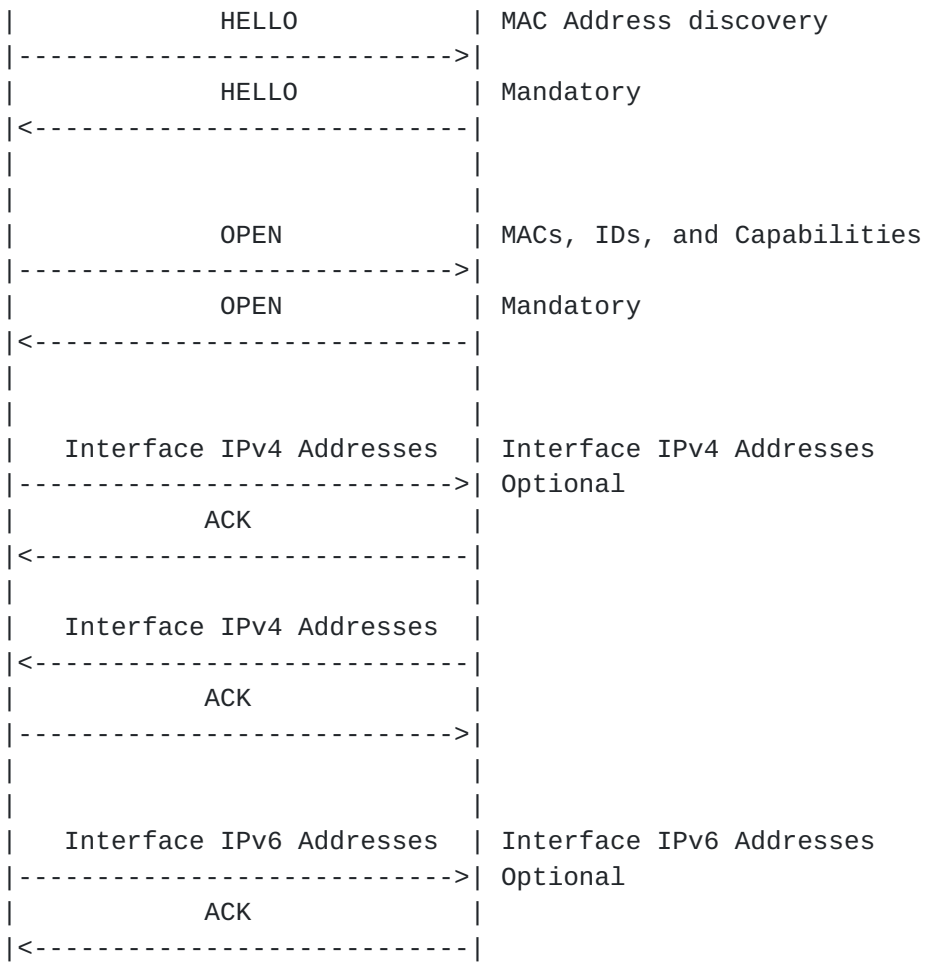
Once a new device is recognized, both devices attempt to negotiate and establish peering by sending unicast OPEN PDUs (Section 10). In an established peering, Encapsulations (Section 12) may be announced and modified. When two devices on a link have compatible Encapsulations and addresses, i.e. the same AFI/SAFI and the same subnet, the link is announced via the BGP-LS API.

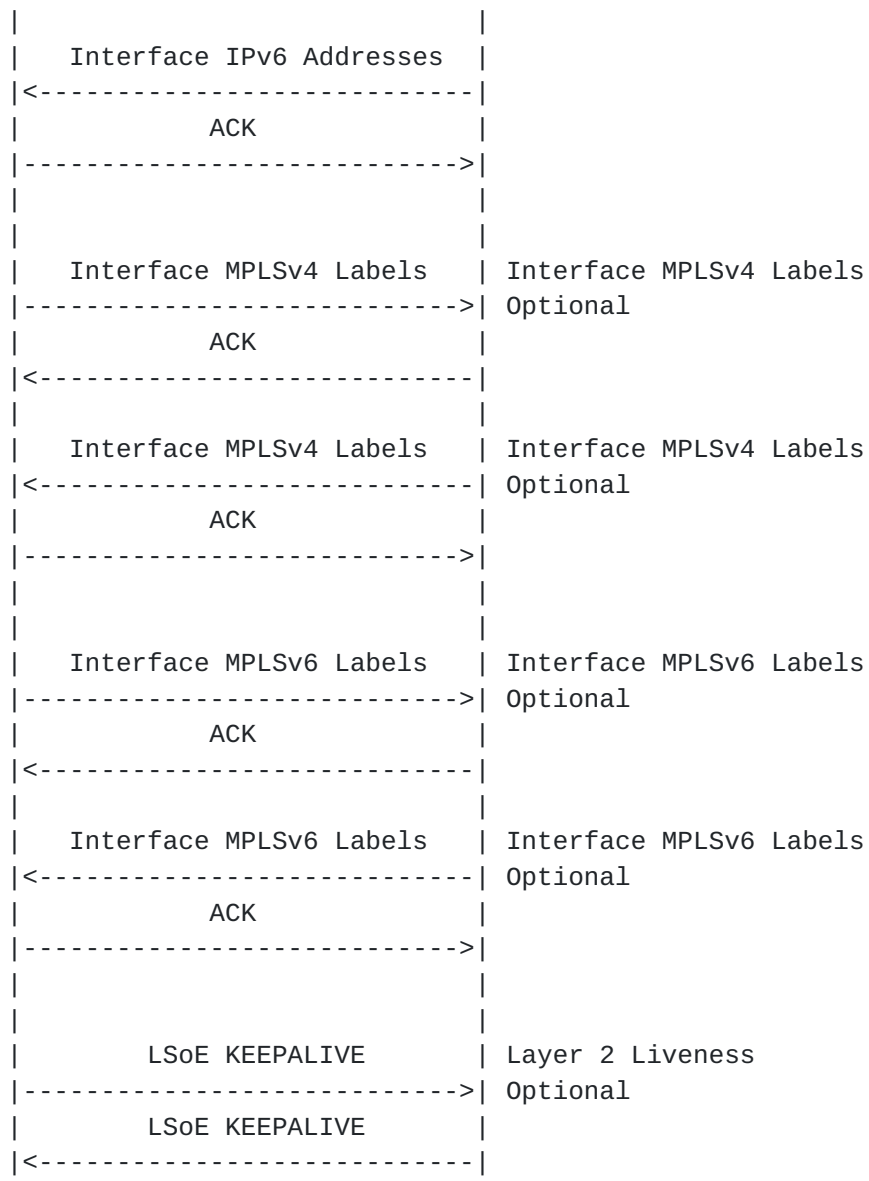
5.1. Inter-Link Ether Protocol Overview

The HELLO, Section 9, is a priming message. It is an Ethernet multicast frame with a small LSoE PDU with the simple goal of discovering the Ethernet MAC address(es) of devices reachable via an interface.

The HELLO and OPEN, Section 10, PDUs, which are used to discover and exchange MAC address and IDs, are mandatory; other PDUs are optional; though at least one encapsulation MUST be agreed at some point.

The following is a ladder-style sketch of the Ethernet protocol exchanges:

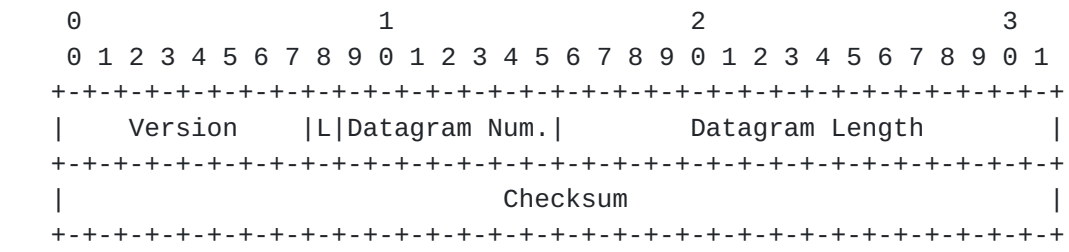




6. Transport Layer

LSoE PDU are carried by a simple transport layer which allows long PDUs to occupy multiple Ethernet frames. The LSoE data in each frame is referred to as a Datagram.

The LSoE Transport Layer encapsulates each Datagram using a common transport header.



The fields of the LSoE Transport Header are as follows:

Version: Version number of the protocol, currently 0. Values other than 0 are treated as errors.

L: A bit that set to 1 if this Datagram is the last Datagram of the PDU. For a PDU which fits in only one Datagram, it is set to one.

Datagram Number: 0..127, a monotonically increasing value, modulo 128, see [RFC1982].

Datagram Length: Total number of octets in the Datagram including all payloads and fields.

Checksum: A 32 bit hash over the Datagram to detect bit flips, see Section 7.

7. The Checksum

There is a reason conservative folk use a checksum in UDP. And as many operators stretch to jumbo frames (over 1,500 octets) longer checksums are the conservative approach.

For the purpose of computing a checksum, the checksum field itself is assumed to be zero.

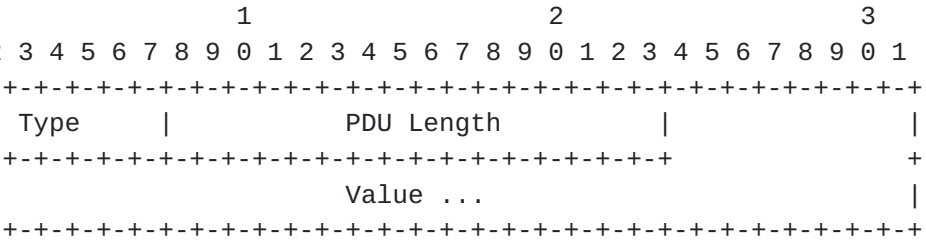
The following code describes the suggested algorithm.

Sum up 32-bit unsigned ints in a 64-bit long, then take the high-order section, shift it right, rotate, add it in, repeat until zero.

```
<CODE BEGINS>
#include <stddef.h>
#include <stdint.h>

/* The F table from Skipjack, and it would work for the S-Box. */
static const uint8_t sbox[256] = {
0xa3,0xd7,0x09,0x83,0xf8,0x48,0xf6,0xf4,0xb3,0x21,0x15,0x78,
0x99,0xb1,0xaf,0xf9,0xe7,0x2d,0x4d,0x8a,0xce,0x4c,0xca,0x2e,
0x52,0x95,0xd9,0x1e,0x4e,0x38,0x44,0x28,0x0a,0xdf,0x02,0xa0,
0x17,0xf1,0x60,0x68,0x12,0xb7,0x7a,0xc3,0xe9,0xfa,0x3d,0x53,
0x96,0x84,0x6b,0xba,0xf2,0x63,0x9a,0x19,0x7c,0xae,0xe5,0xf5,
0xf7,0x16,0x6a,0xa2,0x39,0xb6,0x7b,0x0f,0xc1,0x93,0x81,0x1b,
0xee,0xb4,0x1a,0xea,0xd0,0x91,0x2f,0xb8,0x55,0xb9,0xda,0x85,
0x3f,0x41,0xbf,0xe0,0x5a,0x58,0x80,0x5f,0x66,0x0b,0xd8,0x90,
0x35,0xd5,0xc0,0xa7,0x33,0x06,0x65,0x69,0x45,0x00,0x94,0x56,
0x6d,0x98,0x9b,0x76,0x97,0xfc,0xb2,0xc2,0xb0,0xfe,0xdb,0x20,
0xe1,0xeb,0xd6,0xe4,0xdd,0x47,0x4a,0x1d,0x42,0xed,0x9e,0x6e,
0x49,0x3c,0xcd,0x43,0x27,0xd2,0x07,0xd4,0xde,0xc7,0x67,0x18,
0x89,0xcb,0x30,0x1f,0x8d,0xc6,0x8f,0xaa,0xc8,0x74,0xdc,0xc9,
0x5d,0x5c,0x31,0xa4,0x70,0x88,0x61,0x2c,0x9f,0x0d,0x2b,0x87,
0x50,0x82,0x54,0x64,0x26,0x7d,0x03,0x40,0x34,0x4b,0x1c,0x73,
0xd1,0xc4,0xfd,0x3b,0xcc,0xfb,0x7f,0xab,0xe6,0x3e,0x5b,0xa5,
0xad,0x04,0x23,0x9c,0x14,0x51,0x22,0xf0,0x29,0x79,0x71,0x7e,
0xff,0x8c,0x0e,0xe2,0x0c,0xef,0xbc,0x72,0x75,0x6f,0x37,0xa1,
0xec,0xd3,0x8e,0x62,0x8b,0x86,0x10,0xe8,0x08,0x77,0x11,0xbe,
0x92,0x4f,0x24,0xc5,0x32,0x36,0x9d,0xcf,0xf3,0xa6,0xbb,0xac,
0x5e,0x6c,0xa9,0x13,0x57,0x25,0xb5,0xe3,0xbd,0xa8,0x3a,0x01,
0x05,0x59,0x2a,0x46
};

/* non-normative example C code, constant time even */

uint32_t sbox_checksum_32(const uint8_t *b, const size_t n)
{
  uint32_t sum[4] = {0, 0, 0, 0};
  uint64_t result = 0;
  for (size_t i = 0; i < n; i++)
    sum[i & 3] += sbox[*b++];
  for (int i = 0; i < sizeof(sum)/sizeof(*sum); i++)
    result = (result << 8) + sum[i];
  result = (result >> 32) + (result & 0xFFFFFFFF);
  result = (result >> 32) + (result & 0xFFFFFFFF);
  return (uint32_t) result;
}
<CODE ENDS>
```

8. TLV PDUs

The basic LSoE application layer PDU is a typical TLV (Type Length Value) PDU. It may be broken into multiple Datagrams, see Section 6



The fields of the basic LSoE header are as follows:

Type: An integer differentiating PDU payload types

0 - HELLO
1 - OPEN
2 - KEEPALIVE
3 - ACK
4 - IPv4 Announcement
5 - IPv6 Announcement
6 - MPLS IPv4 Announcement
7 - MPLS IPv6 Announcement
8-254 Reserved
255 - VENDOR

PDU Length: Total number of octets in the PDU including all payloads and fields

Value: Any application layer content of the LSoE PDU beyond the type.

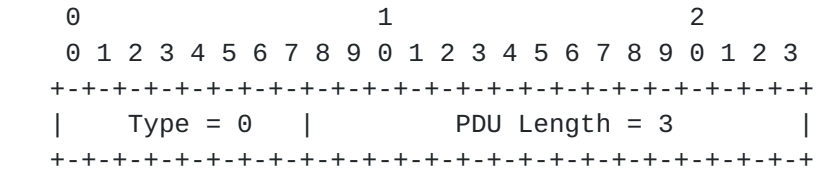
9. HELLO

The HELLO PDU is unique in that it is a multicast Ethernet frame. It solicits response(s) from other device(s) on the link. See Section 17.1 for why multicast is used. The multicast MACs to be used MUST be one of the following, See Clause 9.2.2 of [IEEE802-2014]:

01-80-C2-00-00-0E: Nearest Bridge = Propagation constrained to a single physical link; stopped by all types of bridges (including MPRs (media converters)).
01-80-C2-00-00-03: Nearest non-TPMR Bridge = Propagation constrained by all bridges other than TPMRs; intended for use within provider bridged networks.

All other LSoE PDUs are unicast Ethernet frames, as the peer's MAC Address is known after the HELLO exchange.

When an interface is turned up on a device, it SHOULD issue a HELLO periodically. The interval is set by configuration with a default of 60 seconds.



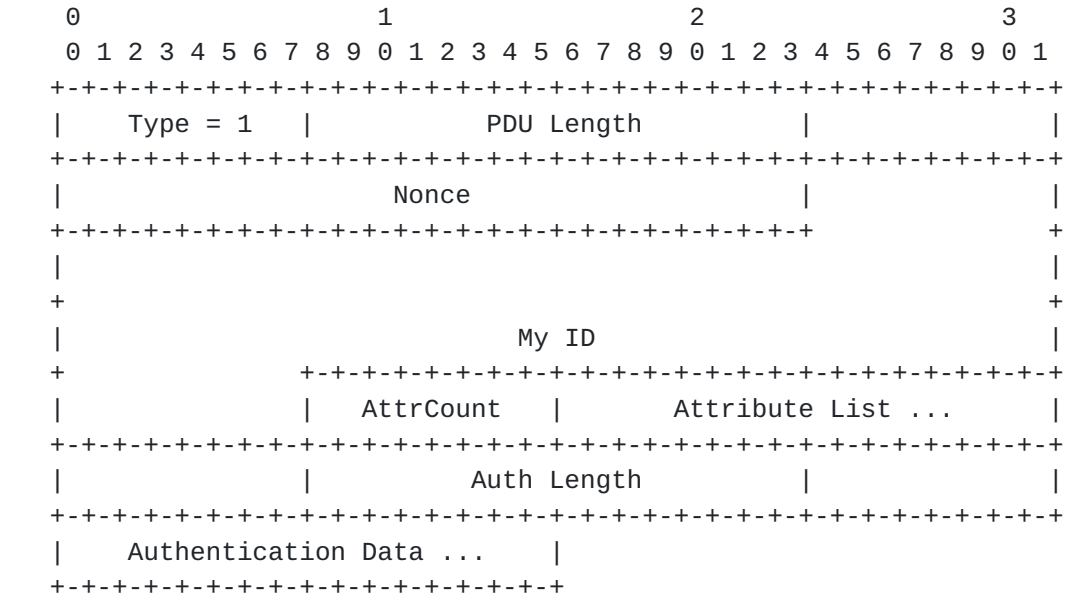
If more than one device responds, one adjacency is formed for each unique (source MAC address) response. LSoE treats the adjacencies as separate links.

When a HELLO is received from a source MAC Address with which there is no established LSoE adjacency, the receiver SHOULD respond with an OPEN PDU. The two devices establish an LSoE adjacency by exchanging OPEN PDUs.

The PDU Length is the octet count of the entire PDU, including the Type and the Datagram Length field itself.

10. OPEN

Each device has learned the other's MAC address from the HELLO exchange, see Section 9. Therefore the OPEN and subsequent PDUs are unicast, as opposed to the HELLO's multicast, Ethernet frames.



The Nonce enables detection of a duplicate OPEN PDU. It SHOULD be either a random number or time of day. It is needed to prevent session closure due to a repeated OPEN caused by a race or a dropped or delayed ACK.

My ID can be an ASN with high order bits zero, a classic RouterID with high order bits zero, a catenation of the two, a 80-bit ISO System-ID, or any other identifier unique to a single device in the topology. While a link is uniquely identified by a MAC pair, the same ID pair MAY occur on multiple links between the same two devices. IDs are big-endian.

AttrCount is the number of attributes in the Attribute List. Attributes are single octets whose semantics are user-defined.

A node may have zero or more user-defined attributes, e.g. spine, leaf, backbone, route reflector, arabica, ...

Attribute syntax and semantics are local to an operator or datacenter; hence there is no global registry. Nodes exchange their attributes only in the OPEN PDU.

Auth Length is a 16-bit field denoting the length in octets of the Authentication Data, not including the Auth Length itself. If there are no Authentication Data, the Auth Length MUST BE zero.

The Authentication Data are specific to the operational environment. A failure to authenticate is a failure to start the LSoE session, an ERROR PDU is sent (Error Code 2), and HELLOs MUST be restarted.

Once two devices know each other's MAC addresses, and have ACKed each other's OPEN PDUs, Layer 2 KEEPALIVEs (see Section 13) SHOULD be started to ensure Layer 2 liveness and keep the session semantics alive. The timing and acceptable drop of KEEPALIVE PDUs is discussed in Section 13.

If a sender of OPEN does not receive an ACK of the OPEN PDU Type, then they MUST resend the same OPEN PDU, with the same Nonce.

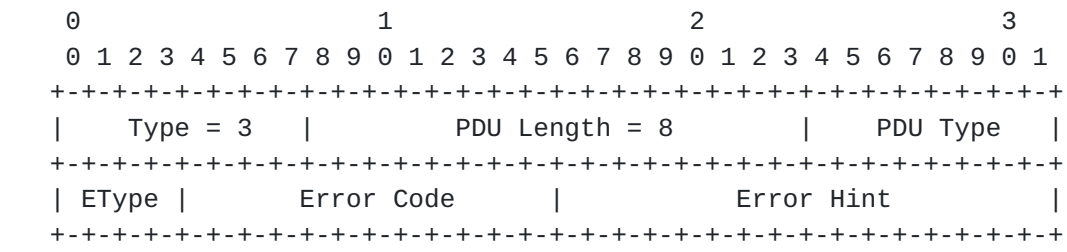
Resending an unacknowledged OPEN PDU, like other ACKed PDUs, SHOULD use exponential back-off, see [RFC1122].

If a properly authenticated OPEN arrives with a new Nonce from a device with which the receiving device believes it already has an LSoE session (OPENs have already been exchanged), the receiver MUST assume that the sending device has been reset. All discovered encapsulation date SHOULD be withdrawn via the BGP-LS API and the recipient MUST respond with a new OPEN. Then encapsulations SHOULD

NOT be kept because. while the new OPEN is likely to be followed by new encapsulation PDUs of the same data, the old session might have an encapsulation type not in the new session.

11. ACK

The ACK PDU acknowledges receipt of a PDU and reports any error condition which might have been raised.



The ACK acknowledges receipt of an OPEN, Encapsulation, VENDOR PDU, etc.

The PDU Type is the Type of the PDU being acknowledged, e.g., OPEN or one of the Encapsulations.

If there was an error processing the received PDU, then the EType is non-zero. If the EType is zero, Error Code and Error Hint MUST also be zero.

A non-zero EType is the receiver's way of telling the PDU's sender that the receiver had problems processing the PDU. The Error Code and Error Hint will tell the sender more detail about the error.

The decimal value of EType gives a strong hint how the receiver sending the ACK believes things should proceed:

0 - No Error, Error Code and Error Hint MUST be zero
1 - Warning, something not too serious happened, continue
2 - Session should not be continued, try to restart
3 - Restart is hopeless, call the operator
4-15 - Reserved

Someone stuck in the 1990s might think of the error codes as 0x1zzz, 0x2zzz, etc. They might be right. Or not.

The Error Code indicates the type of error.

The Error Hint is any additional data the sender of the error PDU thinks will help the recipient or the debugger with the particular error.

11.1. Retransmission

If a PDU sender expects an ACK, e.g. for an OPEN, an Encapsulation, a VENDOR PDU, etc., and does not receive the ACK for a configurable time (default one second), the sender resends the PDU using exponential back-off, see [RFC1122].. This cycle MAY be repeated a configurable number of times (default three) before it is considered a failure. The session is considered closed in case of this ACK failure.

12. The Encapsulations

Once the devices know each other's MAC addresses, know each other's upper layer identities, have means to ensure link state, etc., the LSoE session is considered established, and the devices SHOULD announce their interface encapsulations, addresses, (and labels).

The Encapsulation types the peers exchange may be IPv4 Announcement (Section 12.3), IPv6 Announcement (Section 12.4), MPLS IPv4 Announcement (Section 12.6), MPLS IPv6 Announcement (Section 12.7), and/or possibly others not defined here.

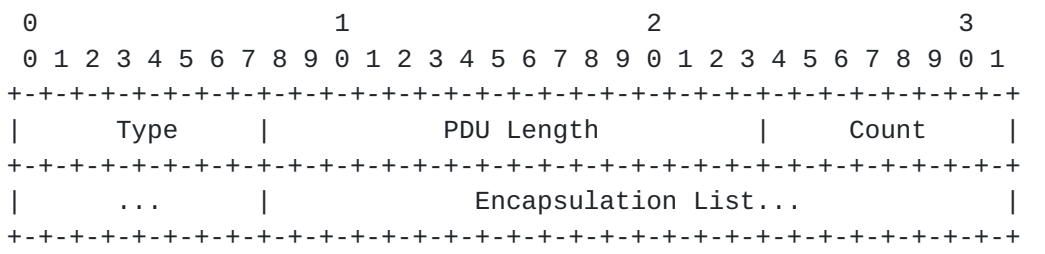
The sender of an Encapsulation PDU MUST NOT assume that the peer is capable of the same Encapsulation Type. An ACK (Section 11) merely acknowledges receipt. Only if both peers have sent the same Encapsulation Type is it safe to assume that they are compatible for that type.

A receiver of an encapsulation might recognize an addressing conflict, such as both ends of the link trying to use the same address. In this case, the receiver SHOULD respond with an ERROR (Error Code 1) instead of an ACK. As there may be other usable addresses or encapsulations, this error might log and continue, letting an upper layer topology builder deal with what works.

Further, to consider a link of a type to formally be established so that it may be pushed up to upper layer protocols, the addressing for the type must be compatible, e.g. on the same IPvX subnet.

12.1. The Encapsulation PDU Skeleton

The header for all encapsulation PDUs is as follows:



The 16-bit Count is the number of Encapsulations in the Encapsulation list.

If the length of an Encapsulation PDU exceeds the Datagram size limit on media, the PDU is broken into multiple Datagrams. See Section 8.

The Receiver MUST acknowledge the Encapsulation PDU with a Type=3, ACK PDU (Section 11) with the Encapsulation Type being that of the encapsulation being announced, see Section 11.

If the Sender does not receive an ACK in a configurable interval (default one second), they SHOULD retransmit. After a user configurable number of failures, the LSoE session should be considered dead and the OPEN process SHOULD be restarted.

An Encapsulation PDU describes zero or more addresses of the encapsulation type.

An Encapsulation PDU of Type T replaces all previous encapsulations of Type T.

To remove all encapsulations of Type T, the sender uses a Count of zero.

If an interface has multiple addresses for an encapsulation type, one and only one address SHOULD be configured to be marked as primary, see Section 12.2.

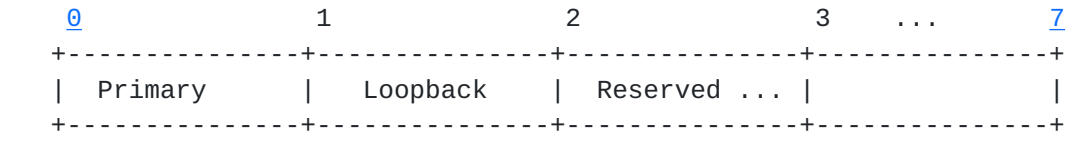
Loopback addresses are generally not seen directly on an external interface. One or more loopback addresses MAY be exposed by configuration on one or more LSoE speaking external interfaces, e.g. for iBGP peering. They SHOULD be marked as such, see Section 12.2.

If there is exactly one non-loopback address for an encapsulation type on an interface, it SHOULD be marked as primary.

If a sender has multiple links on the same interface, separate data, ACKs, etc. must be kept for each peer.

Over time, multiple Encapsulation PDUs may be sent for an interface as configuration changes.

12.2. Prim/Loop Flags

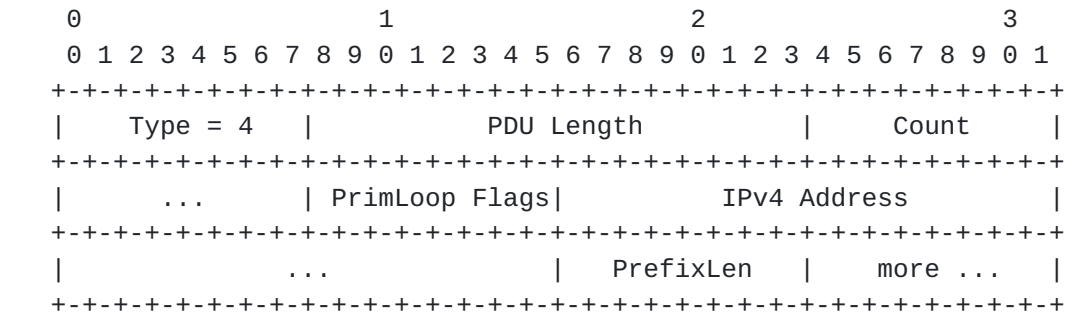


Each Encapsulation interface address MAY be marked as a primary address, and/or a loopback, in which case the respective bit is set to one.

Only one address MAY be marked as primary for an encapsulation type.

12.3. IPv4 Encapsulation

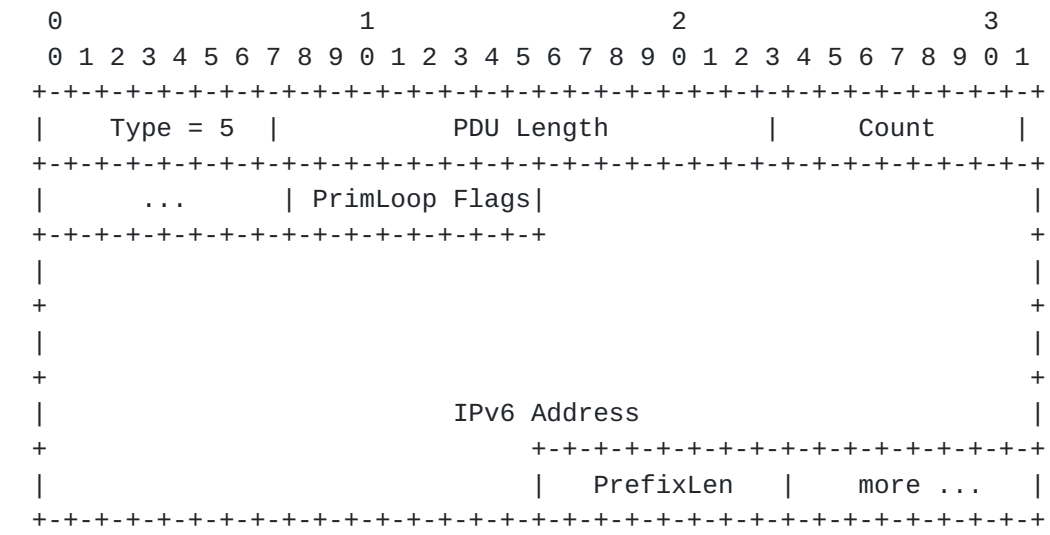
The IPv4 Encapsulation describes a device's ability to exchange IPv4 packets on one or more subnets. It does so by stating the interface's addresses and the corresponding prefix lengths.



The 16-bit Count is the number of IPv4 Encapsulations.

12.4. IPv6 Encapsulation

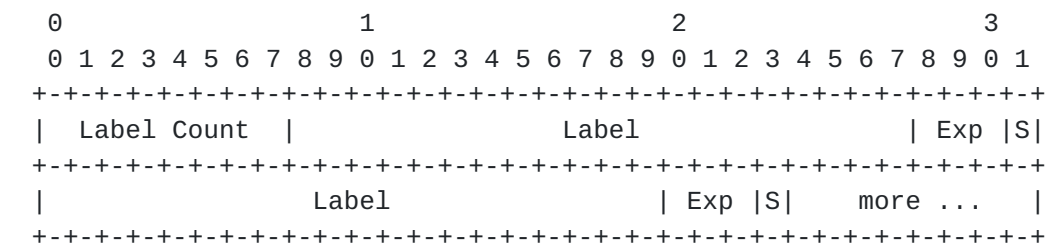
The IPv6 Encapsulation describes a device's ability to exchange IPv6 packets on one or more subnets. It does so by stating the interface's addresses and the corresponding prefix lengths.



The 16-bit Count is the number of IPv6 Encapsulations.

12.5. MPLS Label List

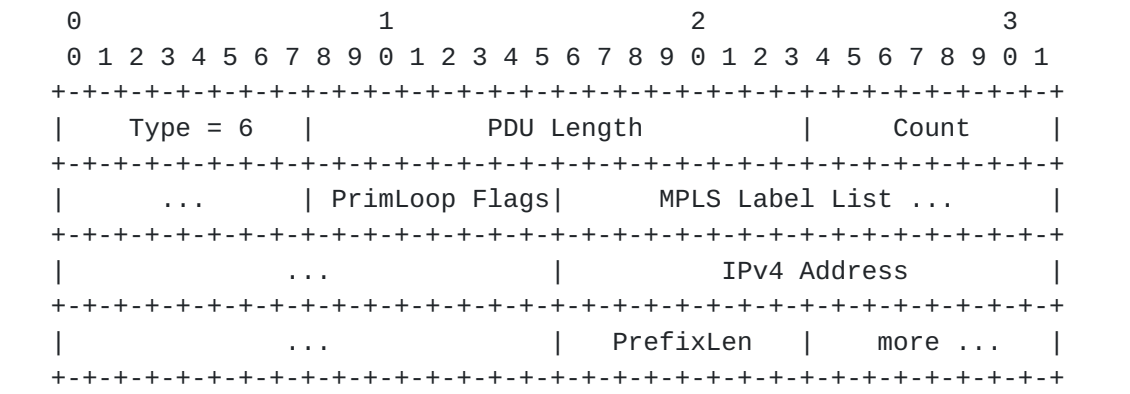
As an MPLS enabled interface may have a label stack, see [RFC3032], a variable length list of labels is needed.



A Label Count of zero is an implicit withdraw of all labels for that prefix on that interface.

12.6. MPLS IPv4 Encapsulation

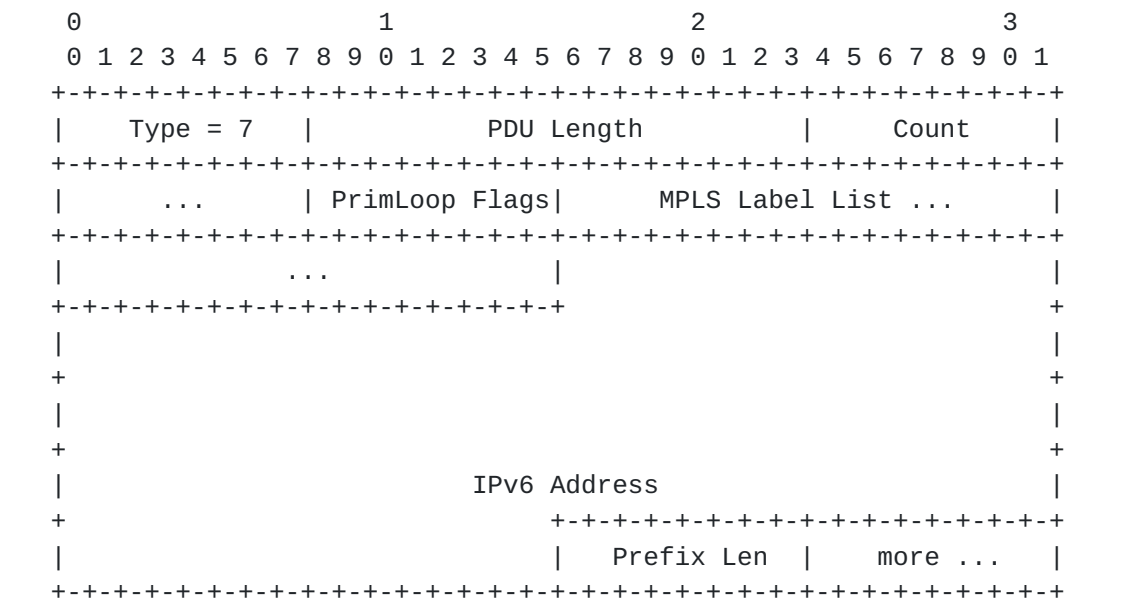
The MPLS IPv4 Encapsulation describes a device's ability to exchange labeled IPv4 packets on one or more subnets. It does so by stating the interface's addresses the corresponding prefix lengths, and the corresponding labels.



The 16-bit Count is the number of MPLSv6 Encapsulations.

12.7. MPLS IPv6 Encapsulation

The MPLS IPv6 Encapsulation describes a device's ability to exchange labeled IPv6 packets on one or more subnets. It does so by stating the interface's addresses, the corresponding prefix lengths, and the corresponding labels.



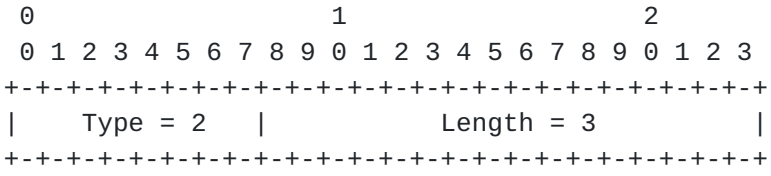
The 16-bit Count is the number of MPLSv6 Encapsulations.

13. KEEPALIVE - Layer 2 Liveness

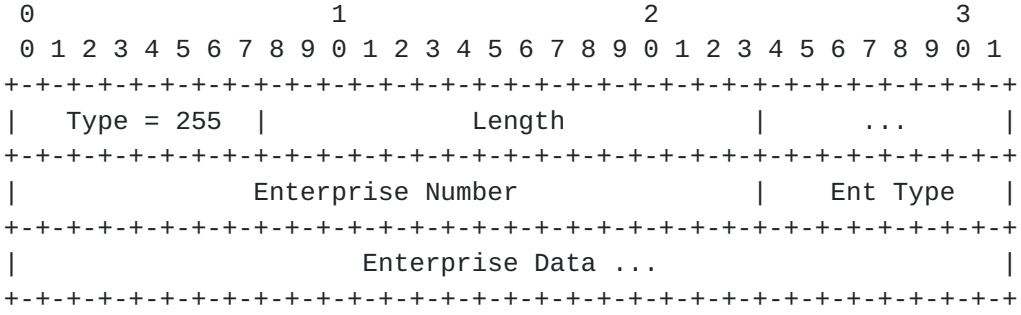
LSoE devices MUST beacon occasional Layer 2 KEEPALIVE PDUs to ensure session continuity.

They SHOULD be beaconed at a configured frequency. One per second is the default. Layer 3 liveness, such as BFD, will likely be more aggressive.

If a KEEPALIVE is not received from a peer with which a receiver has an open session for a configurable time (default one minute), the session SHOULD BE presumed closed. The devices MAY keep configuration state until a new session is established and new Encapsulation PDUs are received.



14. VENDOR - Vendor Extensions



Vendors or enterprises may define TLVs beyond the scope of LSoE standards. This is done using a Private Enterprise Number [IANA-PEN] followed by free form data.

Ent Type allows a VENDOR PDU to be sub-typed in the event that the vendor/enterprise needs multiple PDU types.

As with Encapsulation PDUs, a receiver of a VENDOR PDU MUST respond with an ACK or an ERROR PDU. Simarly, a VENDOR PDU MUST only be sent over an open session.

15. Layers 2.5 and 3 Liveness

Ethernet liveness is continuously tested by KEEPALIVE PDUs, see Section 13. As layer 2.5 or layer 3 connectivity could still break, liveness above layer 2 SHOULD be frequently tested using BFD ([RFC5880]) or a similar technique.

This protocol assumes that one or more Encapsulation addresses will be used to ping, BFD, or whatever the operator configures.

16. The North/South Protocol

Thus far, a one-hop point-to-point link discovery protocol has been defined.

The nodes know the unique node identifiers (ASNs, RouterIDs, ...) and Encapsulations on each link interface.

Full topology discovery is not appropriate at the Ethernet layer, so Dijkstra a la IS-IS etc. is assumed to be done by higher level protocols.

Therefore the node identifiers, link Encapsulations, and state changes are pushed North via a small subset of the BGP-LS API. The upper layer routing protocol(s), e.g. BGP-SPF, learn and maintain the topology, run Dijkstra, and build the routing database(s).

For example, if a neighbor's IPv4 Encapsulation address changes, the devices seeing the change push that change Northbound.

16.1. Use BGP-LS as Much as Possible

BGP-LS [RFC7752] defines BGP-like Datagrams describing link state (links, nodes, link prefixes, and many other things), and a new BGP path attribute providing Northbound transport, all of which can be ingested by upper layer protocols such as BGP-SPF; see Section 4 of [I-D.ietf-lsvr-bgp-spf].

For IPv4 links, TLVs 259 and 260 are used. For IPv6 links, TLVs 261 and 262. If there are multiple addresses on a link, multiple TLV pairs are pushed North, having the same ID pairs.

16.2. Extensions to BGP-LS

The Northbound protocol needs a few minor extensions to BGP-LS. Luckily, others have needed the same extensions.

Similarly to BGP-SPF, the BGP protocol is used in the Protocol-ID field specified in table 1 of [I-D.ietf-idr-bgpls-segment-routing-epe]. The local and remote node descriptors for all NLRI are the ID's described in Section 10. This is equivalent to an adjacency SID or a node SID if the address is a loopback address.

Label Sub-TLVs from [I-D.ietf-idr-bgp-ls-segment-routing-ext] Section 2.1.1, are used to associate one or more MPLS Labels with a link.

17. Discussion

This section explores some trade-offs taken and some considerations.

17.1. HELLO Discussion

There is the question of whether to allow an intermediate switch to be transparent to discovery. We consider that an interface on a device is a Layer 2 or a Layer 3 interface. In theory it could be a Layer 3 interface with no encapsulation or Layer 3 addressing currently configured.

A device with multiple Layer 2 interfaces, traditionally called a switch, may be used to forward frames and therefore packets from multiple devices to one interface, I, on an LSoE speaking device. Interface I could discover a peer J across the switch. Later, a prospective peer K could come up across the switch. If I was not still sending and listening for HELLOs, the potential peering with K could not be discovered. Therefore, interfaces MUST continue to send HELLOs as long as they are turned up.

17.2. HELLO versus KEEPALIVE

Both HELLO and KEEPALIVE are periodic. KEEPALIVE might be eliminated in favor of keeping only HELLOs. But currently KEEPALIVE is unicast, and thus less noisy on the network, especially if HELLO is configured to transit layer-2-only switches.

This warrants discussion.

18. VLANs/SVIs/Sub-interfaces

One can think of the protocol as an instance (i.e. state machine) which runs on each link of a device.

As the upper routing layer must view VLAN topologies as separate graphs, LSoE treats VLAN ports as separate links.

LSoE PDUs learned over VLAN-ports may be interpreted by upper layer-3 routing protocols as being learned on the corresponding layer-3 SVI interface for the VLAN.

As Sub-Interfaces each have their own MAC, they act as separate interfaces, forming their own links.

19. Implementation Considerations

An implementation SHOULD provide the ability to configure an interface as LSoE speaking or not.

An implementation SHOULD provide the ability to configure whether HELLOs on an LSoE enabled interface send Nearest Bridge or Nearest non-TPMR Bridge multicast frames from that interface; see Section 9.

An implementation SHOULD provide the ability to distribute one or more loopback addresses or interfaces into LSoE on an external LSoE speaking interface.

An implementation SHOULD provide the ability to configure one of the addresses of an encapsulation as primary on an LSoE speaking interface. If there is only one address for a particular encapsulation, the implementation MAY mark it as primary by default.

20. Security Considerations

The protocol as it is MUST NOT be used outside a datacenter or similarly closed environment due to lack of formal definition of the authentication and authorisation mechanism. These will be worked on in a later effort, likely using credentials configured using ZTP or similar configuration automation.

Many MDC operators have a strange belief that physical walls and firewalls provide sufficient security. This is not credible. All MDC protocols need to be examined for exposure and attack surface.

It is generally unwise to assume that on the wire Ethernet is secure. Strange/unauthorized devices may plug into a port. Mis-wiring is very common in datacenter installations. A poisoned laptop might be plugged into a device's port.

Malicious nodes/devices could mis-announce addressing, form malicious sessions, etc.

If OPENs are not being authenticated, an attacker could forge an OPEN for an existing session and cause the session to be reset.

For these reasons, the OPEN PDU's authentication data exchange SHOULD be used. [A mandatory to implement authentication is in development.]

21. IANA Considerations

This document requests the IANA create a registry for LSoE PDU Type, which may range from 0 to 255. The name of the registry should be LSoE-PDU-Type. The policy for adding to the registry is RFC Required per [RFC5226], either standards track or experimental. The initial entries should be the following:

PDU Code	PDU Name
0	HELLO
1	OPEN
2	KEEPALIVE
3	ACK
4	IPv4 Announce / Withdraw
5	IPv6 Announce / Withdraw
6	MPLS IPv4 Announce / Withdraw
7	MPLS IPv6 Announce / Withdraw
8-254	Reserved
255	VENDOR

This document requests the IANA create a registry for LSoE PL Flag Bits, which may range from 0 to 7. The name of the registry should be LSoE-PL-Flag-Bits. The policy for adding to the registry is RFC Required per [RFC5226], either standards track or experimental. The initial entries should be the following:

Bit	Bit Name
0	Primary
1	Loopback
2-7	Reserved

This document requests the IANA create a registry for LSoE Error Codes, a 16 bit integer. The name of the registry should be LSoE-Error-Codes. The policy for adding to the registry is RFC Required per [RFC5226], either standards track or experimental. The initial entries should be the following:

Error Code	Error Name
0	Reserved
1	Link Addressing Conflict
2	Authorisation Failure in OPEN

22. IEEE Considerations

This document requires a new EtherType.

23. Acknowledgments

The authors thank Cristel Pelsser for multiple reviews, Jeff Haas for review and comments, Joe Clarke for a useful review, John Scudder for deeply serious review and comments, Larry Kreeger for a lot of layer 2 clue, Martijn Schmidt for his contribution, Neeraj Malhotra for review, Russ Housley for checksum discussion and sBox, and Steve Bellovin for checksum advice.

24. References

24.1. Normative References

[I-D.ietf-idr-bgp-ls-segment-routing-ext]
Previdi, S., Talaulikar, K., Filsfils, C., Gredler, H., and M. Chen, "BGP Link-State extensions for Segment Routing", draft-ietf-idr-bgp-ls-segment-routing-ext-11 (work in progress), October 2018.

[I-D.ietf-idr-bgpls-segment-routing-epe]
Previdi, S., Talaulikar, K., Filsfils, C., Patel, K., Ray, S., and J. Dong, "BGP-LS extensions for Segment Routing BGP Egress Peer Engineering", draft-ietf-idr-bgpls-segment-routing-epe-17 (work in progress), October 2018.

[I-D.ietf-lsvr-bgp-spf]
Patel, K., Lindem, A., Zandi, S., and W. Henderickx, "Shortest Path Routing Extensions for BGP Protocol", draft-ietf-lsvr-bgp-spf-04 (work in progress), December 2018.

[IANA-PEN]
"IANA Private Enterprise Numbers", <https://www.iana.org/assignments/enterprise-numbers/enterprise-numbers>.

[IEEE.802_2001]
IEEE, "IEEE Standard for Local and Metropolitan Area Networks: Overview and Architecture", IEEE 802-2001, DOI 10.1109/ieeestd.2002.93395, July 2002, <http://ieeexplore.ieee.org/servlet/opac?punumber=7732>.

[IEEE802-2014]
Institute of Electrical and Electronics Engineers, "Local and Metropolitan Area Networks: Overview and Architecture", IEEE Std 802-2014, 2014.

[RFC1982] Elz, R. and R. Bush, "Serial Number Arithmetic", RFC 1982, DOI 10.17487/RFC1982, August 1996, <http://www.rfc-editor.org/info/rfc1982>.

[RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, DOI 10.17487/RFC2119, March 1997, <http://www.rfc-editor.org/info/rfc2119>.

[RFC3032] Rosen, E., Tappan, D., Fedorkow, G., Rekhter, Y., Farinacci, D., Li, T., and A. Conta, "MPLS Label Stack Encoding", RFC 3032, DOI 10.17487/RFC3032, January 2001, <http://www.rfc-editor.org/info/rfc3032>.

[RFC4271] Rekhter, Y., Ed., Li, T., Ed., and S. Hares, Ed., "A Border Gateway Protocol 4 (BGP-4)", RFC 4271, DOI 10.17487/RFC4271, January 2006, <http://www.rfc-editor.org/info/rfc4271>.

[RFC5226] Narten, T. and H. Alvestrand, "Guidelines for Writing an IANA Considerations Section in RFCs", RFC 5226, DOI 10.17487/RFC5226, May 2008, <http://www.rfc-editor.org/info/rfc5226>.

[RFC5880] Katz, D. and D. Ward, "Bidirectional Forwarding Detection (BFD)", RFC 5880, DOI 10.17487/RFC5880, June 2010, <http://www.rfc-editor.org/info/rfc5880>.

[RFC6286] Chen, E. and J. Yuan, "Autonomous-System-Wide Unique BGP Identifier for BGP-4", RFC 6286, DOI 10.17487/RFC6286, June 2011, <http://www.rfc-editor.org/info/rfc6286>.

[RFC7752] Gredler, H., Ed., Medved, J., Previdi, S., Farrel, A., and S. Ray, "North-Bound Distribution of Link-State and Traffic Engineering (TE) Information Using BGP", RFC 7752, DOI 10.17487/RFC7752, March 2016, <http://www.rfc-editor.org/info/rfc7752>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, DOI 10.17487/RFC8174, May 2017, <http://www.rfc-editor.org/info/rfc8174>.

24.2. Informative References

[JUPITER] Singh, A., Germano, P., Kanagala, A., Liu, H., Provost, J., Simmons, J., Tanda, E., Wanderer, J., HAP.lzle, U., Stuart, S., Vahdat, A., Ong, J., Agarwal, A., Anderson, G., Armistead, A., Bannon, R., Boving, S., Desai, G., and B. Felderman, "Jupiter rising", Communications of the ACM Vol. 59, pp. 88-97, DOI 10.1145/2975159, August 2016.

[RFC1122] Braden, R., Ed., "Requirements for Internet Hosts - Communication Layers", STD 3, RFC 1122, DOI 10.17487/RFC1122, October 1989, <http://www.rfc-editor.org/info/rfc1122>.

Authors' Addresses

Randy Bush
Arrcus & IIJ
5147 Crystal Springs
Bainbridge Island, WA 98110
United States of America

Email: randy@psg.com

Rob Austein
Arrcus, Inc

Email: sra@hactrn.net

Keyur Patel
Arrcus
2077 Gateway Place, Suite #400
San Jose, CA 95119
United States of America

Email: keyur@arrcus.com