Hewlett Packard Enterprise

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LLDP Between LSVR Routers

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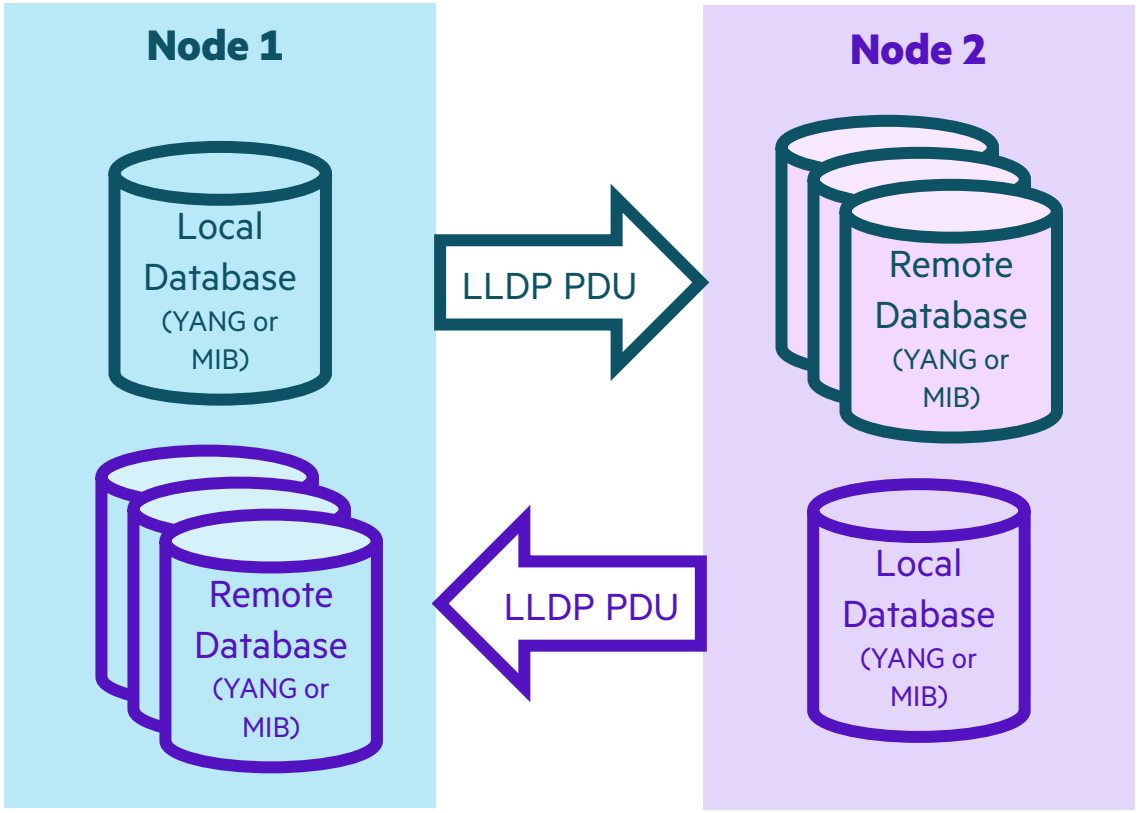
Recap

- The IEEE 802.1 WG has sent Liaison Statements (LSs) to the IETF LSVR WG
  - https://datatracker.ietf.org/liaison/1985/ (2025-03-16)
  - https://datatracker.ietf.org/liaison/1637/ (2019-03-28)
    - in response to LSVR WG's LS: https://datatracker.ietf.org/liaison/1621/ (2019-01-10)
  - The IEEE 802.1 LSs suggest the use of decades old, widely deployed Layer 2 (Link Layer) standards specified by IEEE 802.1 instead of the IETF specifying new Layer 2 protocols for the same purpose
    - The Link Layer Discovery Protocol (LLDP) for discovery
    - Continuity Check Messages (CCMs) of Connectivity Faut Management (CFM) for Layer 2 liveliness

- The IEEE 802.1 WG has amended the LLDP standard for the requirements of the IETF LSVR WG
  - **IEEE 802.1ABdh-2021**: IEEE Standard for Local and metropolitan area networks – Station and Media Access Control Connectivity Discovery Amendment 2: **Support for Multiframe Protocol Data Units**
  - https://standards.ieee.org/ieee/802.1ABdh/7667/
    - free access vie the IEEE Get Program (https://ieeexplore.ieee.org/browse/standards/get-program/page)

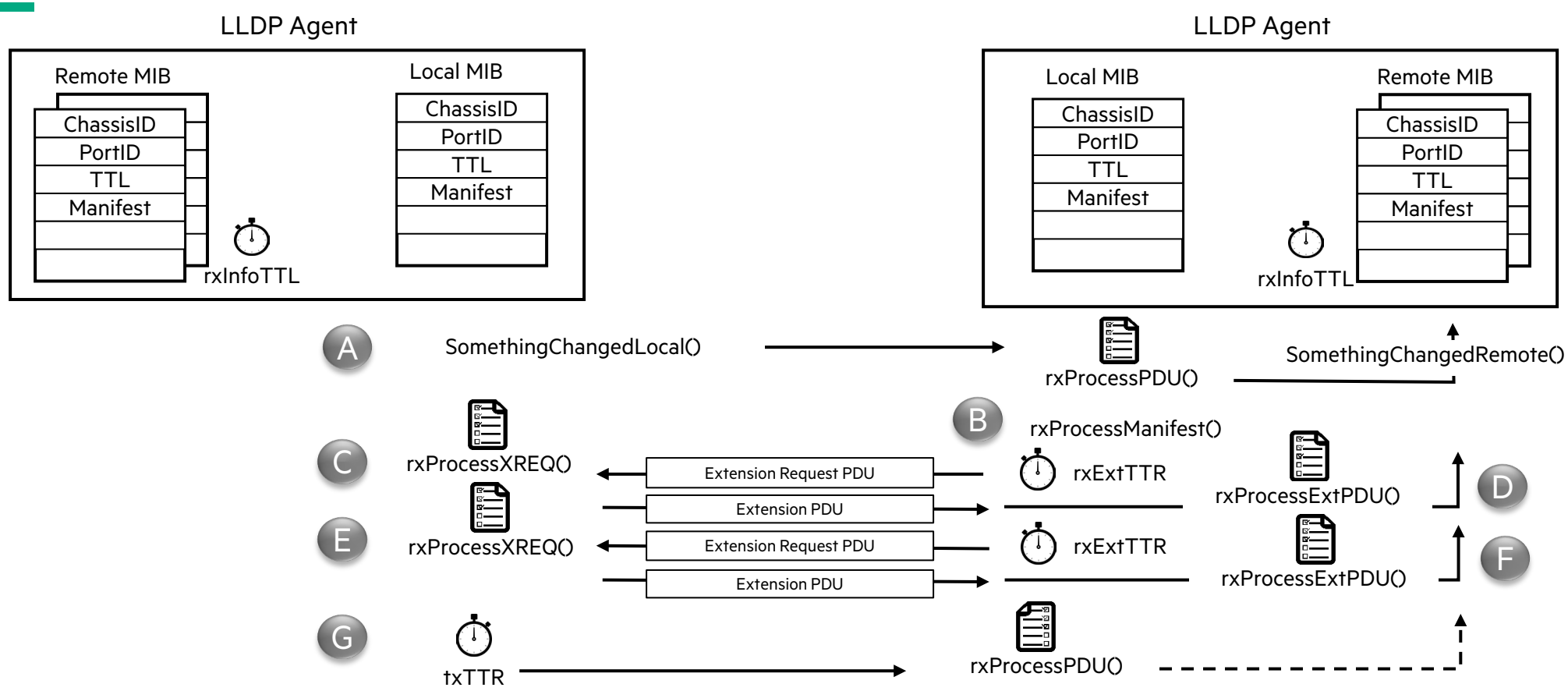
- LLDP-based contributions to the LSVR WG so far:
  - https://datatracker.ietf.org/doc/draft-bottorff-lsvr-lldp-tlvs/00/ (2025-04-30)
  - https://datatracker.ietf.org/doc/draft-congdon-lsvr-lldp-tlvs/00/ (2019-10-22)
  - https://datatracker.ietf.org/meeting/104/materials/slides-104-lsvr-3-update-ieee-ietf-liaison-response-and-intro-to-lldpv2-proposal-01
  - https://datatracker.ietf.org/meeting/105/materials/slides-105-lsvr-2-ieee-lldpv2-update-00
  - https://datatracker.ietf.org/meeting/106/materials/slides-106-lsvr-3-update-lsvr-ietf-organizationally-specific-tlvs-for-ieee-std-8021ab-00
  - https://datatracker.ietf.org/meeting/106/materials/slides-106-lsvr-4-status-update-lsvr-ieee-p8021abdh-lldpv2-00

LLDP is an extremely simple database exchange protocol



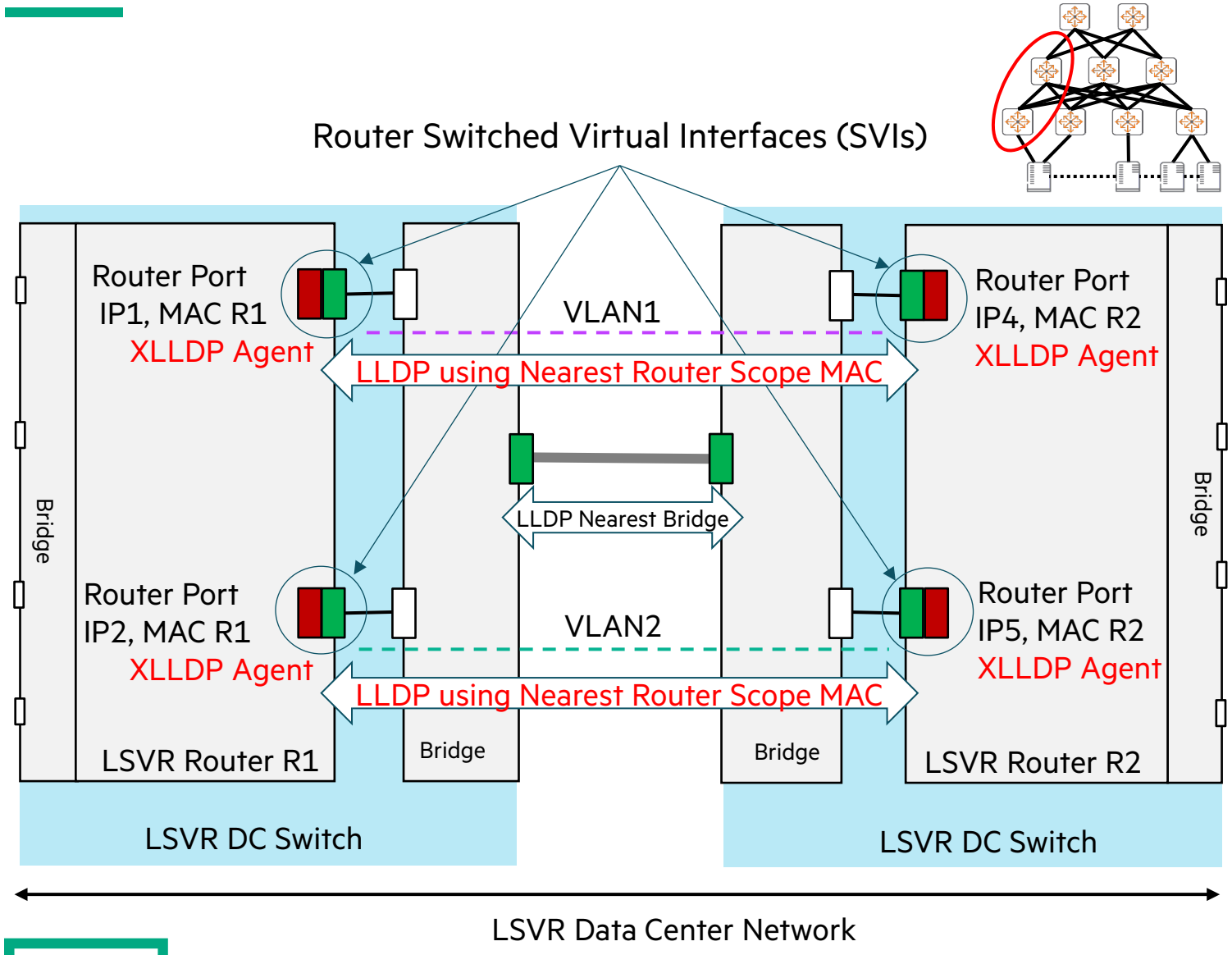
- Nodes periodically advertise information from its local database to all of its neighbors in LLDP Protocol Data Units (PDUs)
- Nodes extract the information from the received LLDP PDUs and store it in a remote database for each neighbor
- The databases can be retrieved by a management entity or an application to gather a view on the network topology and the details of network nodes
- LLDP is designed to be easily extendible
  - LLDP PDUs carry TLVs
  - New TLVs can be defined to carry nodal information not yet covered by existing TLVs
  - For instance, IETF can specify new TLVs under IETF IANA OUI

Extended LLDP operation (IEEE 802.1ABdh-2021) reliability

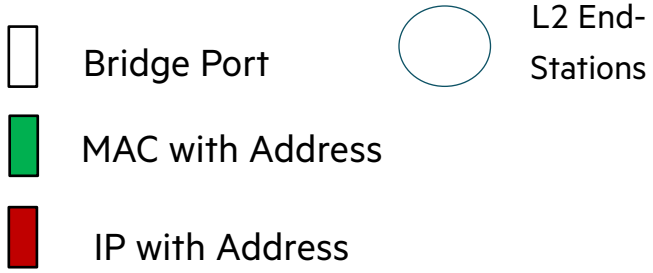


- Base LLDP PDU (single frame) is multicast periodically and repeats fast whenever something changes
- Extension LLDP PDU are only sent when requested by receiver (receiver retries request if necessary)
- Receiver only requests an extension LLDP PDU if the manifest TLV indicates the PDU has changed

LLDP addressing for data center switch, SVI example



- Router Switched Virtual Interfaces (SVIs) each have MAC and IP addresses.
- VLANs are coupled to router SVIs by the bridging layer of the switch.
- LLDP can be extended between SVIs by using a “Nearest Router Multicast Address” for the LLDP destination address (Scope MAC Address).
- The Nearest Router Multicast Address must not be one of the bridge reserved addresses.
- The router SVIs subscribe to the Nearest Router Multicast Address, however it passes through the bridge layer as an ordinary multicast which is contained in a VLAN.
- Non-LSVR End Stations disregard the Nearest Router Multicast since they are not subscribed.
- The Nearest Router Multicast becomes a reserved address for routers.
- Router directly attached to tagged and untagged (subinterfaces) physical ports (no bridge layer) can use the same addressing mechanism.
- Nearest Router Multicast also works if there are bridges between the routers.



LLDP ChassisID + PortID = L3DL Logical Link Endpoint Identifier (LLEI)

Chassis ID TLV Format

TLV type = 1 (7 bits)	TLV information String length (9 bits)	Chassis ID subtype (8 bits)	Chassis ID (1-255 octets)

Port ID TLV Format

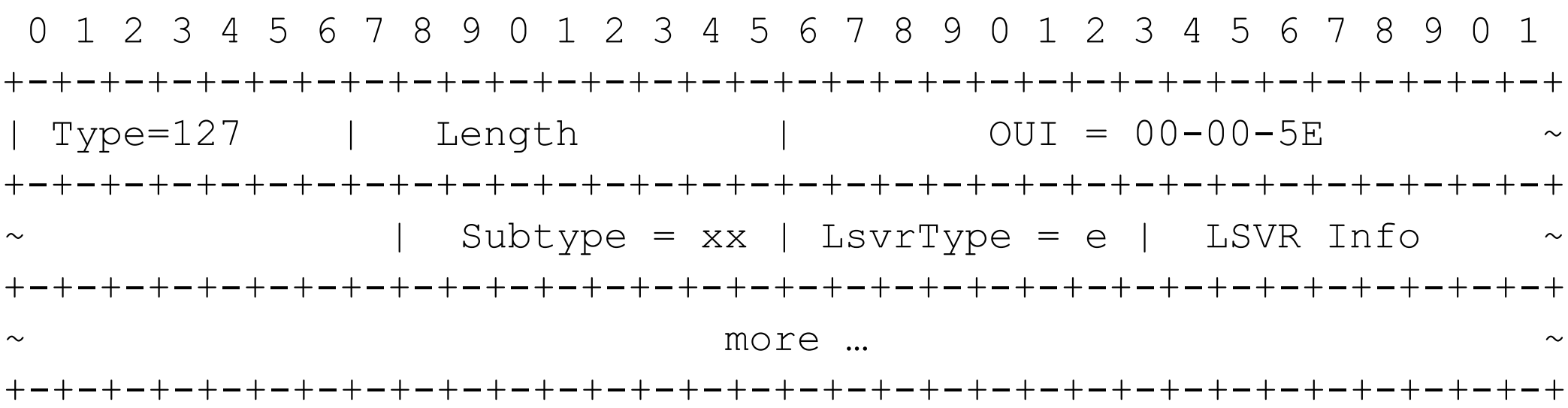
TLV type = 2 (7 bits)	TLV information String length (9 bits)	Port ID subtype (8 bits)	Port ID (1-255 octets)

- The Chassis ID and Port ID are the first two TLVs in all LLDP PDUs (frames). They identify the data base element this LLDP PDU is associated with.
- The ChassisID provides a unique system identifier which can be a MAC address, any IANA network address (such as an NSAP, IP, etc), a management identifier, or any locally defined string identifier.
- The PortID provides a unique identifier for the interface within the system which can be an IfIndex, a port number, or any locally defined string identifier.

- Together the ChassisID+PortID are the same function as the l3dl Logical Link Endpoint Identifier (LLEI)

LLDP IETF Organizationally Specific TLVs for LSVR

Defines TLVs supporting encapsulations, addressing, and upper layer attributes for LSVR



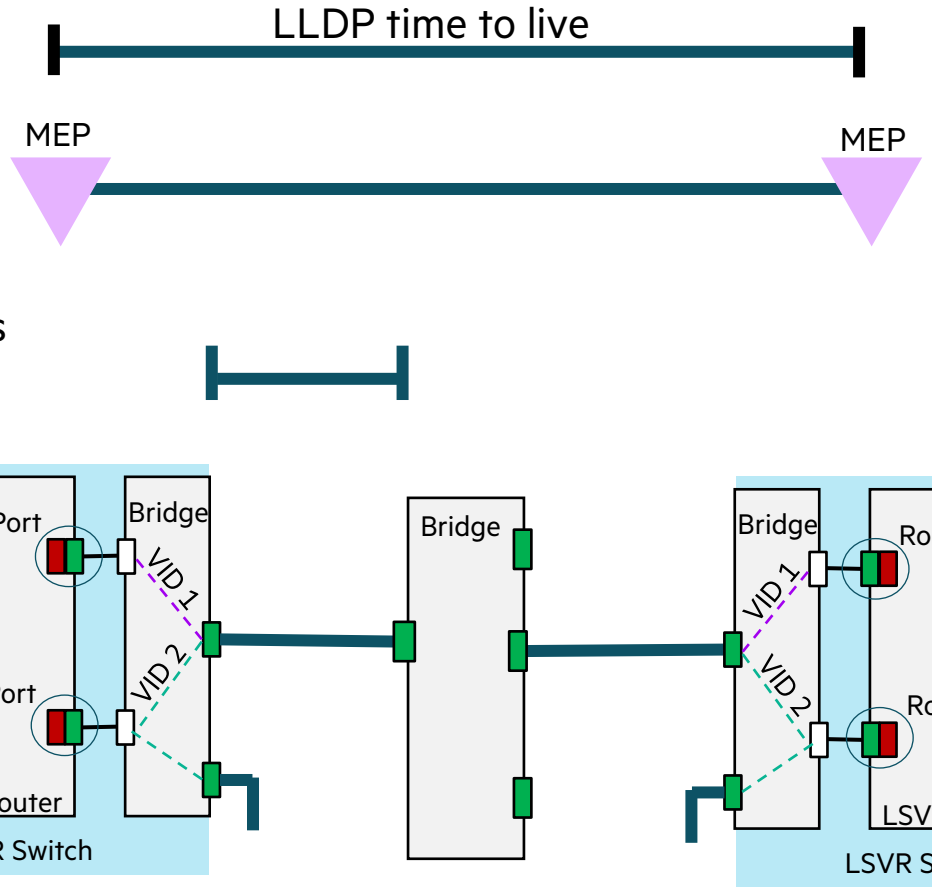
- Type = 127: designates this as an Organizationally Specific TLV
- Length: is the total length starting after the length field. The length is from 5-511.
- Organizationally Unique Identifier (OUI): IETF IANA OUI from RFC 7042. Value 00-00-5E
- Subtype = xx: To be determined by IANA for LSVR (refer to I-D.acee-idr-lldp-peer-discovery)
- LsvrType = e: The LSVR TLV type
- LSVR Info: The LSVR information field

L2 liveliness supported by IEEE 802.1 LLDP, CFM, and 802.3 OAM

LLDP Liveliness
In seconds

CFM Liveliness
In milliseconds

802.3 OAM Liveness
In microseconds



- CFM provides OAM for paths extending through L2 networks.
- Maintenance Domains (MDs) provide a hierarchical management space with 8 possible levels (0-7)
- For the LSVR application MD level 5 seems most appropriate.
- For data center LSVR link discovery it is possible for router interfaces to be connected to a provider L2 service and therefore the MD level should be in the customer domain.
- It is also possible data center LSVR routers provide L2 services over the data center such as EVPNs. In this case the LSVR discover should be a service below network extended by an EVPN.
- Within a MD Maintenance Associations (MAs) are established between Maintenance association End Points (MEPs)
- MD internal points are identified by Maintenance domain Intermediate Points (MIPs)

Summary Applying LLDP to LSVR Discovery and Configuration

- Discovery can be achieved by running LLDP at each LSVR Logical Link Endpoint (LLE)
  - Enabled by using a (to be assigned) Nearest Router Group Address for the LLDP Scope MAC Address
  - The Logical Link Endpoint Identifier (LLEI) is then encoded in the LLDP ChassisID + PortID
- Discovery of L3 and L2.5 encapsulations and addressing can be achieved by using LLDP to advertise a set of LLDP Organizationally Specific TLVs which encode the encapsulation and addressing available at each Logical Link Endpoint
  - LLDP builds a database at each LLE containing all the remote information from each discovered LLE
  - An LSVR LLDP application then determines available Logical Links, compatible encapsulations, and addresses by comparing the information in the local and remote databases at each LLE
- The LSVR LLDP application can use any interface desired to present the information to BGP-SPF
- L3 liveness can be enabled using Organizationally Specific TLVs
- L2 liveness can be supported using both the LLDP time-to-live and Connectivity Fault Management (CFM)
  - LLDP always provides time-to-live for each element of the remote database using the LLDP Time-To-Live TLV
  - CFM (IEEE Std 802.1Q cl 18-22) Connectivity Check Messages (CCMs) can be used for fast link failure detection
- LLDP can communicate the parameters for BGP (and other) protocols using Organizationally Specific TLVs
  - I-D.acee-idr-lldp-peer-discovery specifies LLDP configuration TLVs for BGP
- LLDP can be secured using the MACsec (IEEE Std 802.1AE)
- Requesting adoption of draft-bottorff-lsvr-lldp for lsvr discovery

Thank You

Backup

Summary

- LLDP (IEEE Std 802.1AB) is a mature, tested, and widely implemented protocol
- The IEEE has enhanced Classic LLDP through amendments supporting:
  - Large database sizes (IEEE Std 802.1ABdh-2021)
  - Modern YANG data models (IEEE Std 802.1ABcu-2021)
- The LLDP protocol is capable of addressing the LSVR discovery and configuration requirements
- Additional L2 liveliness support can be obtained by using Connectivity Fault Management (IEEE Std 802.1Q cl 18-22) Connectivity Check Messages (CCMs)
- LLDP-based contributions to the LSVR WG so far:
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  - https://datatracker.ietf.org/doc/draft-congdon-lsvr-lldp-tlvs/00/ (2019-10-22)
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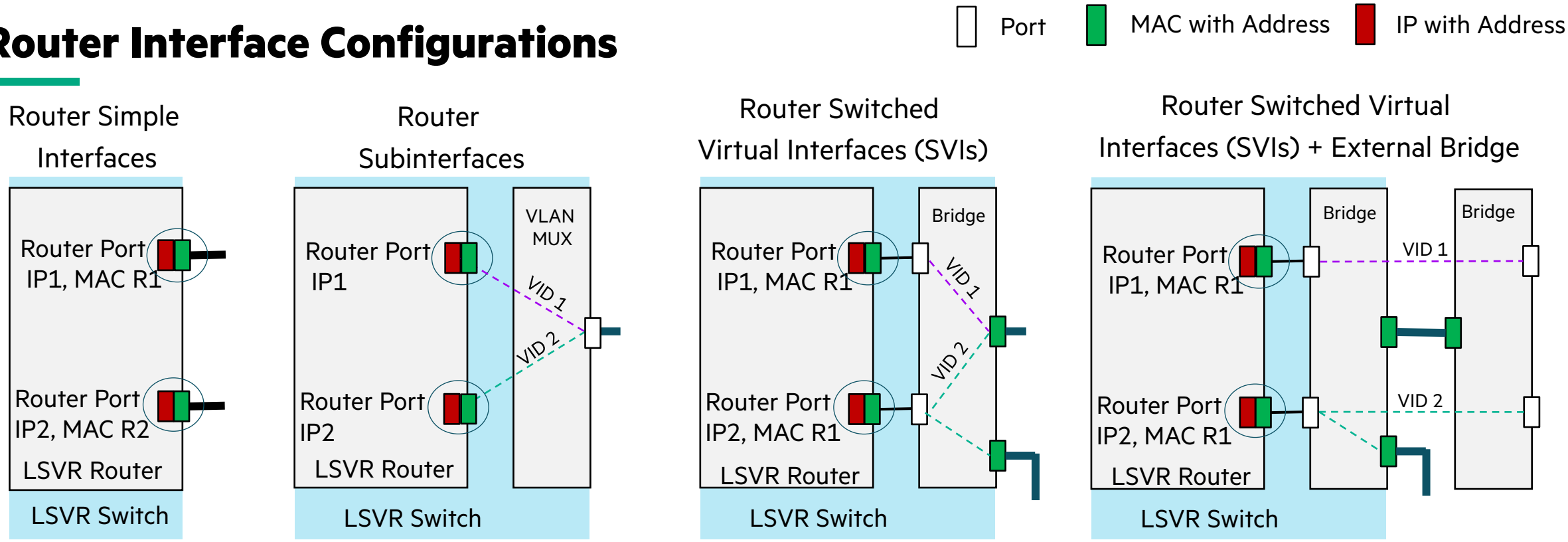
  - https://datatracker.ietf.org/meeting/105/materials/slides-105-lsvr-2-ieee-lldpv2-update-00
  - https://datatracker.ietf.org/meeting/106/materials/slides-106-lsvr-3-update-lsvr-ietf-organizationally-specific-tlvs-for-ieee-std-8021ab-00
  - https://datatracker.ietf.org/meeting/106/materials/slides-106-lsvr-4-status-update-lsvr-ieee-p8021abdh-lldpv2-00
- The IEEE 802.1 suggests the use of LLDP rather than IETF specifying a new Layer 2 protocols for the same purpose

Router Interface Configurations



- Three distinct types of router interfaces are possible. These are:
  - Simple interface were the router has a direct attachment to a physical MAC port
  - Subinterfaces were multiple router interfaces share a MAC through a VLAN multiplexer
  - Switched Virtual Interfaces (SVIs) where multiple router interfaces have a virtual MAC connected to an internal bridge
- Any of the three router interface types can also be attached to other routers through an external bridge