Technical Specification

MEF 45

Multi-CEN L2CP

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1 List of Contributing Members

The following members of the MEF participated in the development of this document and have requested to be included in this list.

- Allstream
- Bell Canada
- Calix
- Carrier Ethernet Academy
- Ciena Corporation
- Cogeco Cable Inc.
- Colt
- Comcast
- Huawei Technologies
- Infinera Corporation
- Iometrix
- KDDI
- PLDT (Phillipines Long Distance Phone Company)
- RAD Data Communications

2 Abstract

This document specifies the service attributes and requirements for handling Layer 2 Control Protocol (L2CP) Frames in a Carrier Ethernet Network.

3 Terminology

This section defines the terms used in this document. In many cases, the normative definitions to terms are found in other documents. In these cases, the third column is used to provide the reference that is controlling, in other MEF or external documents.

Terms defined in MEF 4 [16], MEF 6.2 [17], MEF 10.3 [19], and MEF 26.1 [24] are included in this document by reference and, hence, not repeated in table below.

Term	Definition	Ref
Discard	An action taken at a L2CP Decision Point where a L2CP frame is neither delivered to a protocol entity, nor delivered to the External Interface where the L2CP Decision Point is located, nor propagated to L2CP Decision Points at other External Interfaces.	This document
Filter	An action that prevents a frame from being propagated within a bridge or within a network.	This document
Layer 2 Control Protocol Decision Point	The fundamental element of the L2CP Behavioral Model that determines how a L2CP Frame is processed at an External Interface	This document
Layer 2 Control Protocol Frame	A L2CP Service Frame or L2CP ENNI Frame	This document

Term	Definition	Ref
Pass	An action taken at a L2CP Decision Point where a L2CP frame is either delivered to the External Interface where the L2CP Decision Point is located, or propagated to the L2CP Decision Points located at all other External Interfaces associated by the EVC or OVC.	This document
Peer	An action taken at a L2CP Decision Point where a L2CP frame is delivered to a protocol entity determined by the Protocol Identifier in the L2CP Frame.	This document

Table 1 – Terminology

4 Compliance Level Definitions (MUST, SHOULD, MAY)

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 [15]. All key words must be in upper case, bold text.

Items that are **REQUIRED** (contain the words **MUST** or **MUST NOT**) are labeled as **[Rx]** for required. Items that are **RECOMMENDED** (contain the words **SHOULD** or **SHOULD NOT**) are labeled as **[Dx]** for desirable. Items that are **OPTIONAL** (contain the words **MAY** or **OPTIONAL**) are labeled as **[Ox]** for optional**.**

5 Scope

This document specifies the processing of Layer2 Control Protocol (L2CP) Frames for services spanning one or more Carrier Ethernet Networks (CEN). A L2CP Frame is defined as any frame containing a destination address that is one of the 32 addresses reserved for control protocols by IEEE Std 802.1Q-2011 [5] (see Table 2 of this document). This does not include SOAM Frames, nor does it include proprietary or standardized control protocols that use other addresses for a destination address (these could be considered for a future phase of the document).

The specification develops a behavior model of L2CP treatment for services delivered across multiple CENs that supersedes the single CEN requirements in MEF 6.1.1 [18]. The model includes the attributes and basic requirements for passing, peering, or discarding L2CP Frames at a UNI [19], VUNI [25], and ENNI [24], as well as detailed peering requirements for selected protocols and/or services. The model is developed with a goal of promoting interoperability by minimizing configuration and providing testable requirements.

An informative annex summarizes relevant information about common protocols.

Requirements on customer equipment are not within the scope of this document. Nonetheless, proper configuration of the customer equipment with respect to L2CP is necessary to achieve proper operation of the protocols. Such configuration is typically protocol specific. One example is that if Link Aggregation is enabled at a UNI, both the customer equipment and provider equipment need to use the same Destination Address in Link Aggregation Control Protocol (LACP, [2]) frames. Another example is that if an EP-LAN service passes Rapid Spanning Tree Protocol (RSTP, [4]) frames at all UNIs, the service will look like shared media to the protocol, and therefore the customer equipment should configure the RSTP port connected to the UNI as a port to shared media rather than a point-to-point link.

5.1 Comparison with MEF 6.1.1

This document supersedes MEF 6.1.1[18] for specifying L2CP processing requirements. It maintains as much consistency with the requirements in MEF 6.1.1 as possible given the expanded scope of covering multiple CENs. The primary differences from MEF 6.1.1 are:

- Rather than treat the L2CP processing within the CEN as a monolithic whole, this document focuses on L2CP processing requirements at External Interfaces. This allows specification of different processing requirements at different types of interfaces and in different operator networks within the CEN. A notable consequence of this is the avoidance of the word "Tunnel", which is defined as a behavior of the network and is difficult to use as a description of behavior at an interface. In this document the word "Pass" is used for the analogous interface behavior, and if all interfaces associated by a service Pass an L2CP frame then the end-to-end service behavior is the same as "Tunnel".

- This document does not suppose that service agreements between a Subscriber and Service Provider or Operator and Service Provider will specify the treatment of every imaginable Layer 2 Control Protocol. Rather, this document provides a service attribute for listing which L2CP frames are to be Peered at a given External Interface. Treatment of L2CP Frames that are not Peered is determined algorithmically, based largely on the type of interface and the Destination Address in the L2CP Frame.

- Both this document and MEF 6.1.1 specify L2CP behavior that is consistent with IEEE 802.1 L2CP processing rules, with the exception of EPL services with EPL Option 2 L2CP processing. The specification of EPL Option 2 L2CP processing in this document is taken directly from MEF 6.1.1, but updated to support a multi-CEN environment. Recommendations are added for the processing of L2CP Frames not covered by the MEF 6.1.1 specification of EPL Option 2 L2CP processing.

- The treatment of L2CP Frames with MRP Addresses (section 6.3) is expanded to allow (but not require) Peering of these protocols.

6 Background information for L2CP

The L2CP processing specified in this document is based largely on the IEEE 802.1Q [5] specification for handling L2CP Frames. IEEE 802.1Q provides a mechanism for separating the Layer 2 control plane into multiple customer and provider control planes. It allows a protocol to operate solely within a provider network, or solely within a customer network, or to allow interaction between the customer and provider network. It additionally provides a mechanism for customer L2CP Frames to pass transparently through a provider network while maintaining isolation from the control plane of other customer networks. It provides a set of forwarding rules, based on a set of reserved addresses, that allow a L2CP Frame using one of those addresses to be properly forwarded or filtered without requiring protocol-specific configuration. Most Layer 2 Control Protocols have been defined to use these addresses and to operate according to the IEEE 802.1Q rules. This document abstracts the IEEE 802.1Q rules for bridges to specifications for handling L2CP Frames at the External Interfaces of a CEN. This provides a high probability that control protocols, and the customer equipment using those protocols, will interoperate with the CEN.

The remainder of this section provides background on the IEEE 802.1Q mechanisms for handling L2CP Frames. The subsequent sections adapt this to a CEN model based on service attributes and requirements for the External Interfaces of the CEN.

6.1 L2CP Frames and L2CP Addresses

This document defines an L2CP Frame as any frame with a Destination Address that is from one of two blocks of multicast addresses, shown in Table 2, that have been reserved by the IEEE 802.1 Working Group[1]. These addresses have special forwarding rules in IEEE 802.1 Bridges that facilitate the deployment and operation of Layer 2 Control Protocols. While a protocol that affects the configuration or operation of a Layer 2 network can use frames with ordinary unicast or multicast addresses, those protocols that are considered Layer 2 Control Protocols use these reserved addresses to take advantage of the special forwarding rules. Note that although the MEF does not specify what Layer 2 technology is used within a CEN, non-802.1 technologies can adopt these forwarding rules to assure correct operation of protocols using these addresses.

L2CP MAC Destination Addresses[2]	Description
01-80-C2-00-00-00 through 01-80-C2-00-00-0F	Bridge Block of protocols
01-80-C2-00-00-20 through 01-80-C2-00-00-2F	MRP Block of protocols

Table 2 – List of Standardized L2CP Destination MAC Addresses

6.2 Bridge Reserved Addresses

The IEEE 802.1 Bridge Reserved Addresses[3] are shown in Table 3. The special forwarding rule for L2CP Frames with a Destination Address from this block is that a bridge, de-

[1] MEF 10.3 allows a Service Provider to define additional addresses that result in frames containing those addresses to be considered L2CP Frames. Such frames are beyond the scope of this document.
[2] Hexadecimal canonical format
[3] All LANs Bridge Management Group Address (01-80-C2-00-00-10) was deprecated in IEEE Std 802.1Q-2005 (subclause 8.13.7) and there are no longer any special filtering requirements for this address.

pending on the bridge type, will filter the frame. That is, the bridge will not propagate the frame from the ingress port to any other port of the bridge. The significance of this rule is that a protocol entity in one device can send a frame intended to reach a peer protocol entity in a neighboring device and be confident that the frame will not propagate beyond the neighboring device even if the neighbor does not actually recognize the protocol. This prevents the frame from propagating through the network to other devices where the information could be misinterpreted. Many protocols, including Link Aggregation Control Protocol (LACP, [2]), Link Layer Discovery Protocol (LLDP, [1]), Link Operation Administration and Management (Link OAM, [12]), and others rely on this forwarding behavior.

Different types of devices filter different subsets of the Bridge Reserved Addresses. End Stations, bridges that do not recognize VLAN tags (MAC Bridges) and bridges that recognize and respond to C-VLAN tags (Customer Bridges and Provider Edge Bridges) apply the special forwarding rule to all of the addresses in the block. Bridges that recognize and respond only to S-VLAN tags (Provider Bridges) apply the special forwarding rule to a subset of these addresses as shown in Table 3. Two Port MAC Relays (TPMRs) apply the special forwarding rule to a smaller subset of these addresses as shown in Table 3. The different subsets allow a sending device to select the type of device intended to receive the frame by the choice of destination address. For example, a frame with the Nearest Bridge address (01-80-C2-00-00-0E) will only traverse a single link before it is filtered by the neighboring device. On the other hand a frame with the Nearest Customer Bridge address (01-80-C2-00-00-00) will be forwarded through any TPMRs and Provider Bridges, including an entire Provider Network, and will not be peered or discarded until it reaches a Customer Bridge (or a device that does not forward layer2 frames such as a server or router).

Address	Assignment	Filtered by:		
		End Station, MAC Bridge, Customer Bridge, Provider Edge Bridge	Provider Bridge	Two Port MAC Relay
01-80-C2-00-00-00	Nearest Customer Bridge	X		
01-80-C2-00-00-01	IEEE MAC Specific Control Protocols	X	X	X
01-80-C2-00-00-02	IEEE 802 Slow Protocols	X	X	X
01-80-C2-00-00-03	Nearest non-TPMR Bridge	X	X	
01-80-C2-00-00-04	IEEE MAC Specific Control Protocols	X	X	X
01-80-C2-00-00-05	Reserved for Future Standardization	X	X	
01-80-C2-00-00-06	Reserved for Future Standardization	X	X	
01-80-C2-00-00-07	MEF Forum ELMI	X	X	
01-80-C2-00-00-08	Provider Bridge Group	X	X	

Address	Assignment	Filtered by:		
		End Station, MAC Bridge, Customer Bridge, Provider Edge Bridge	Provider Bridge	Two Port MAC Relay
01-80-C2-00-00-09	Reserved for Future Standardization	X	X	
01-80-C2-00-00-0A	Reserved for Future Standardization	X	X	
01-80-C2-00-00-0B	Reserved for Future Standardization	X		
01-80-C2-00-00-0C	Reserved for Future Standardization	X		
01-80-C2-00-00-0D	Provider Bridge MVRP	X		
01-80-C2-00-00-0E	Nearest Bridge, Individual LAN Scope	X	X	X
01-80-C2-00-00-0F	Reserved for Future Standardization	X		

Table 3 – Bridge Block of Reserved L2CP Addresses

In many cases a single network device can run multiple instances of the same protocol, each transmitting and receiving frames with different destination addresses to communicate with devices in different parts of a network. For example, consider running LLDP between devices supporting the EPL service shown in Figure 1. The Customer Edge (CE, [16]) equipment could run an instance of LLDP using the Nearest Bridge address to communicate with Provider Edge (PE, [16]) equipment across a UNI, and another instance of LLDP using the Nearest Customer Bridge address to communicate with CE equipment at a remote UNI.

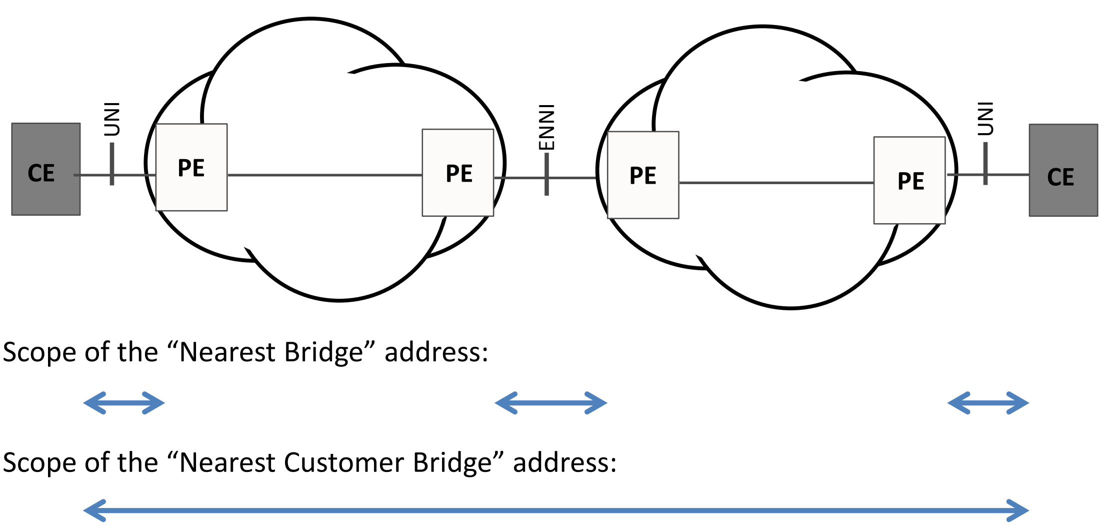

Figure 1 – Scope of Reserved MAC Addresses for an EPL

In other cases a single protocol running in different regions of a network will use a different address to maintain separation between protocol operation in the respective regions. For example, RSTP running in the Subscriber network will use the Nearest Customer Bridge address, and RSTP running in the CENs will use the Provider Bridge Group address.

Note that each of the Bridge Reserved Addresses can be used by many different protocols. Initially, when the number of L2CPs was small, the IEEE specified different addresses for use by each protocol. Unfortunately this implied the address was specific to the protocol, and caused confusion as the number of L2CPs grew and the IEEE began to specify the same address for use by several different protocols. It is important to recognize that the Protocol Identifier[4] in an L2CP frame is what identifies the protocol. The destination address determines the intended recipient device for the frame.

6.3 MRP Reserved Addresses

The IEEE 802.1 Multiple Registration Protocol (MRP) Addresses are a block of 16 addresses in the second row of Table 2. The special forwarding rule for any frame with one of these addresses as a destination is that a bridge will Pass (section 7.1.3) the frame only if it does not Peer (section 7.1.2) any protocol using this address. If the bridge Peers any protocol using this address then it will either Peer the frame (if the Protocol ID matches the Peered protocol) or Discard the frame (if the Protocol ID does not match the Peered protocol). This forwarding rule allows a protocol entity to send a frame to the nearest device that understands the protocol. Any intervening devices that do not understand the protocol will forward the frame. This is in contrast with the Bridge Reserved address forwarding rule which calls for some types of intervening devices that do not understand the protocol to discard the frame. The MRP address forwarding rule is useful for protocols such as Multiple MAC Registration Protocol (MMRP) that propagate information hop by hop between devices that run the protocol, but are tolerant of intervening devices that do not run the protocol.

7 The L2CP Behavioral Model

MEF specifications describe the characteristics of a service on a CEN in terms of attributes and requirements of the interfaces (UNI or ENNI) and the virtual connections (EVC or OVC) used to construct the service. The purpose of the L2CP behavioral model is to describe how the CEN handles L2CP Frames in these terms. Note that this model describes the behavior of the CEN per L2CP Frame, not per protocol.

The behavioral model needs to describe the behavior of the CEN from two distinctly different viewpoints. One is the Subscriber/SP viewpoint, from which the CEN is a monolithic network observable only at the UNIs. The other is the Operator/SP viewpoint, from which the overall network can be seen to consist (potentially) of multiple operator CENs and is observable at ENNIs as well as at UNIs. If the model were only concerned with

[4] The Protocol Identifier can be a LLC Address or an Ethertype, and in some cases may include a sub-type field.

the Subscriber/SP viewpoint it would be sufficient to describe the overall behavior of the network simply in terms of the end results observable at UNIs. It would not be important to know specifically where in the network the actions occurred that resulted in the observed behavior. From the Operator/SP viewpoint however, it is important to know where actions are taken on L2CP Frames.

There are several reasons why it is important to know where actions are taken on L2CP Frames on a service that spans multiple operator networks interconnected by ENNIs. These include:

- In a multi-CEN network it is necessary to know which operator is responsible for Peering or Discarding an L2CP Frame when that is the expected behavior from the Subscriber/SP viewpoint. In some cases it might be the responsibility of the operator with the ingress UNI, but in a scenario with a UNI Tunnel Access (UTA) service, for example, it might make more sense for it to be the responsibility of the operator with the VUNI [25].

- Clear identification of the actions expected from each Operator's network in a multi-CEN service will enable MEF to specify certification guidelines that promote interoperability and facilitate CEN interconnect.

- A multi-CEN network has different types of interfaces (UNIs, ENNIs, and potentially VUNIs), and the L2CP actions can be different depending on the interfaces involved. For example, an ingress L2CP ENNI Frame might be delivered unchanged as an egress L2CP ENNI Frame at an ENNI associated by the OVC, but Peered or Discarded at an egress UNI.

- At an ENNI it can be necessary to specify how provider L2CP Frames are handled, such as when Link Aggregation is used for link failure protection at an ENNI, and how the provider protocol frames are differentiated from customer protocol frames.

The L2CP Behavioral Model resolves these issues by describing behavior as ingress actions or egress action that take place at an external interface. It is important to recognize that the model is a tool used to describe the expected behavior, not a specification of how an operator network is implemented. An action that the model describes as an ingress action at a UNI need not be implemented in the actual device that provides the physical interface for the UNI. The only constraint on the operator or service provider is that the externally observable behavior matches the behavior described by the model.

7.1 The L2CP Decision Point

The basic construct of the L2CP behavioral model is a Decision Point that determines how an L2CP Frame is processed at an External Interface. Figure 2 shows the representation of this Decision Point in L2CP behavioral model diagrams. L2CP Frames that enter the Decision Point from the External Interface will either be Passed to the EVC (or OVC), or Peered by redirecting the frame to a Protocol Entity, or Discarded. The black dots in Figure 2 represent these three options. L2CP Frames that enter the Decision Point from the EVC (or OVC) will either be Passed to the External Interface, or Peered by redirecting the frame to a Protocol Entity, or Discarded. The white dots in Figure 2 represent these three options.There is one Decision Point for each UNI, ENNI and VUNI within a CEN.

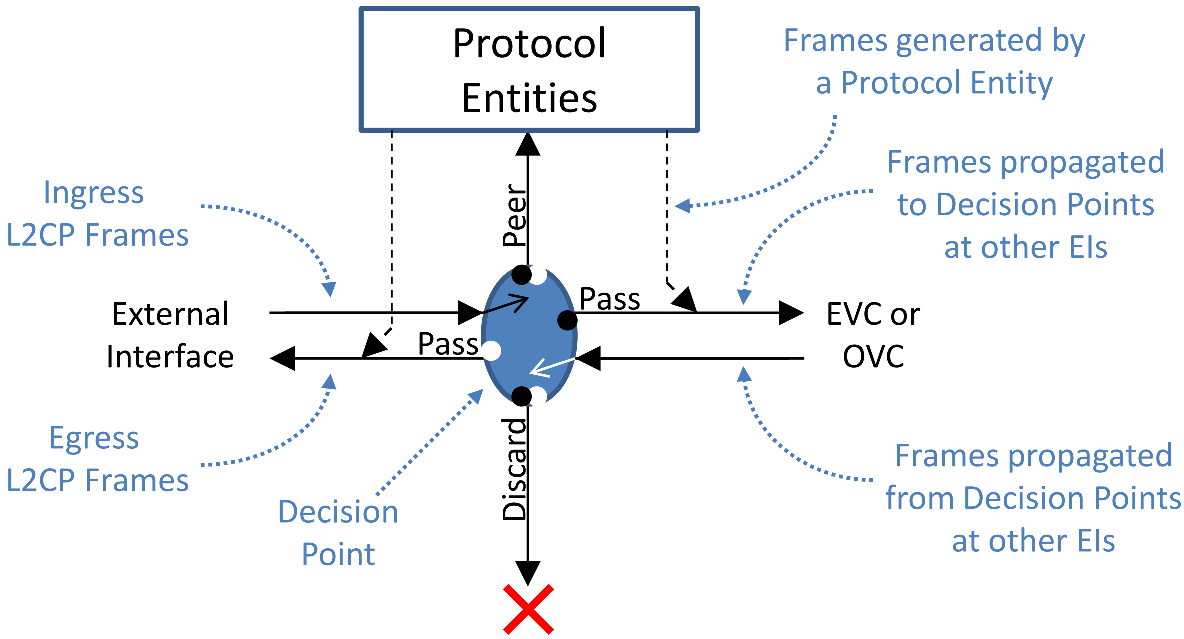

Figure 2 – L2CP Decision Point

The action taken for a given L2CP Frame at a given Decision Point depends upon the Destination Address and the Protocol Identifier within the frame, and upon the configured values of the L2CP Service Attributes. The service attributes used by an L2CP Decision Point are determined by the location of that Decision Point as summarized in Table 4.

Decision Point location	L2CP Service Attributes used by Decision Point
UNI	• UNI L2CP Peering service attribute • UNI L2CP Address Set service attribute
VUNI	• VUNI L2CP Peering service attribute • VUNI L2CP Address Set service attribute
ENNI	• ENNI L2CP Peering service attribute • ENNI Tagged L2CP Frame Processing service attribute • OVC L2CP Address Set service attribute (for each OVC with an OVC End Point at the ENNI)

Table 4 – Decision Point Service Attributes

The definitions and associated requirements of the L2CP Service Attributes are specified in section 8. The detailed description of how the Decision Point determines the action taken for a given L2CP Frame is specified in the flow charts and requirements in section 9. For the purposes of understanding the model it is sufficient to know that the three possible actions at a Decision Point are Discard, Peer[5], or Pass[6]:

7.1.1 Discard

Discard means the L2CP Frame is neither Peered nor propagated toward any External Interface (EI). As an ingress action at an EI this means the frame will not be propagated to any EI. As an egress action at an EI this means the frame will not result in an egress L2CP Frame at that EI.

7.1.2 Peer

Peer means the L2CP Frame is delivered to a protocol entity that participates in the specific Layer 2 Control Protocol determined by the Protocol Identifier (Ethertype or LLC Address) in the frame. The protocol entity qualifies and potentially processes the frame according to the specification of the particular protocol. (These protocol specifications are typically published by other standards organizations, and are beyond the scope of this document.) Qualifying the frame is protocol specific and can include validating the Destination Address, VLAN ID, protocol identifier, version number length, TLV format, etc. Processing the frame is also protocol specific and can include:

[5] Note that "Peer" is used as a verb in the context of L2CP processing.
[6] In MEF 10.2 there is a fourth option that is "Peer and Pass to the EVC". In MEF 10.2 these were actions taken per protocol, and for some protocols it was allowable to Peer some frames and Pass others depending on the destination address. Since the model in this document specifies per frame behavior, the "Peer and Pass" option is not necessary.

- changing local state information,
- invoking actions based on the contents of the frame,
- generating an egress L2CP Frame at the External Interface,
- generating a L2CP Frame that is propagated on an EVC or OVC to all External Interfaces associated by that EVC or OVC or
- ignoring the frame (taking no action).

Note that the protocol entity typically does not process a L2CP Frame by generating an identical L2CP Frame, however that behavior is not explicitly prohibited.

7.1.3 Pass

Pass means the L2CP Frame is handled in the same manner as a Data Frame with an multicast destination address. As an egress action at an EI this results in an egress L2CP Frame at that EI. As an ingress action at an EI this results in the propagation of the frame to the L2CP Decision Point at all other UNIs associated by the EVC (when all UNIs are in a single CEN), or all other OVC End Points associated by the OVC (when not all UNIs are in a single CEN), to which the L2CP Frame is mapped. The mechanism of mapping of L2CP Frames to an EVC or OVC End Point is the same as the mapping of Data Frames. The propagation of L2CP Frames within the CEN[7] is subject to the same constraints as Data Frames[8]. For example:

- Frames at a UNI with a CE-VLAN ID that does not map to any EVC or OVC End Point, and frames at a ENNI with an S-VID that does not map to any End Point, are not propagated.
- For Rooted Multipoint EVCs [19] and OVCs [24], frames that ingress at a Leaf are not propagated to another Leaf.
- Frames that are declared Red by an Ingress Bandwidth Profile or discarded in order to comply with an Egress Bandwidth Profile are not propagated.

7.2 Subscriber/SP view of the L2CP Behavioral Model

Figure 3 shows the Subscriber/SP view of the L2CP Behavioral Model. This figure represents a simple case where there are two UNIs associated by a single EVC, but more complex examples are easily constructed. There is a L2CP Decision Point for each UNI. How the model is used to specify L2CP behavior can be seen by following a L2CP frame through the network.

[7] MEF does not mandate how the content of a Service Frame is forwarded within a CEN. For simplicity of discourse, we say that the frame (or a copy of the frame) is propagated but any method of forwarding the content of the ingress frame is acceptable.

[8] Note that the performance objectives for L2CP Frames may differ from Data Frames since L2CP Frames can map to a different CoS Name than Data Frames.

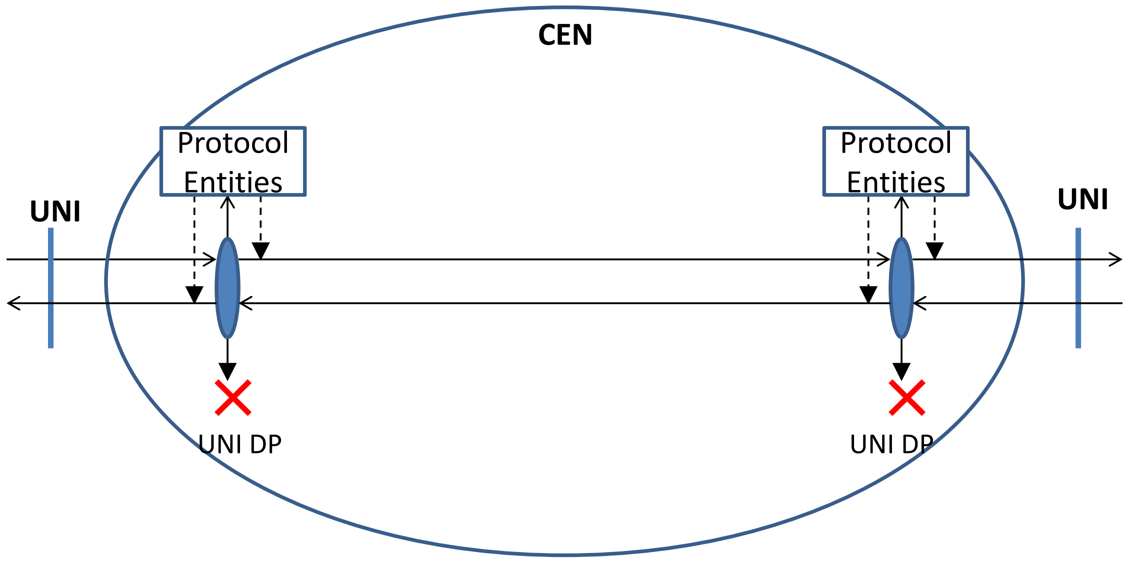

Figure 3 – L2CP Behavioral Model for Subscriber/SP

When an ingress L2CP Service Frame enters the network at one of the UNIs, it is evaluated by a UNI L2CP Decision Point that determines whether the frame is to be Discarded, Peered, or Passed. The Decision Point at the ingress UNI is referred to as the ingress Decision Point for the frame. If the determination of the ingress Decision Point is to Pass the frame, it will be mapped to an EVC and the frame will be propagated to the L2CP Decision Point at all other UNIs associated by that EVC. These Decision Points are referred to as the egress Decision Points for the frame, and the frame at this point is referred to as a potential egress frame. The egress Decision Point evaluates the potential egress frame and determines whether it is to be Discarded, Peered, or Passed. If the frame is Passed then it results in an egress L2CP Service Frame at that UNI.

The behavior observed between any pair of UNIs is the combination of the determinations made by the ingress and egress Decision Points. If either Decision Point Discards the frame then the ingress L2CP Service Frame does not result in an egress L2CP Service Frame. If either Decision Point Peers the frame then the ingress L2CP Service Frame is not delivered to any other EI, however there could be indirect protocol specific results of the Peering that would be observable as described in Section 7.1.2. If both Decision Points Pass the frame then the ingress L2CP Service Frame at one UNI can result in an egress L2CP Service Frame at the other UNI. Note that an ingress L2CP Service Frame that is Passed at all UNI Decision Points associated by an EVC results in the behavior described as "Tunnel" in earlier MEF specifications.

The model can also be used to describe L2CP behavior not directly triggered by an ingress L2CP Service Frame at a UNI. For example, when there is a protocol entity for a particular protocol at a UNI Decision Point, that protocol entity can generate frames that are subsequently observed as egress L2CP Service Frames at that UNI. Some protocols propagate information within the network by generating frames that are propagated to the L2CP Decision Points at all other UNIs associated by the EVC. Unless these frames are Passed at an egress UNI Decision Point they will never be observable as an egress L2CP Service Frame, but in a multi-CEN network they could be observable at an ENNI.

7.3 Operator/SP view of the L2CP Behavioral Model

Figure 4 shows the Operator/SP view of the L2CP Behavioral Model. This figure represents a simple case where there are two UNIs associated by a single EVC that spans two CENs via a single ENNI, but more complex examples are easily constructed. There are Decision Points for each UNI and each ENNI in each CEN. How the model is used to specify L2CP behavior can be seen by following a L2CP frame through the network.

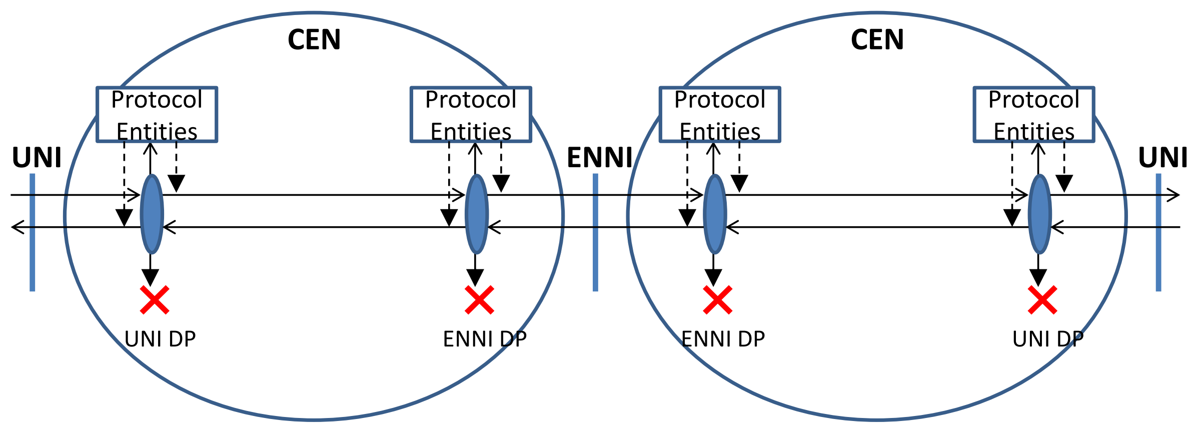

Figure 4 – L2CP Behavioral Model for Operator/SP

When an ingress L2CP Service Frame enters the network at one of the UNIs, it is evaluated by a UNI L2CP Decision Point that determines whether the frame is to be Discarded, Peered, or Passed. If the determination of the ingress Decision Point is to Pass the frame, it will be mapped to an OVC and propagated to the L2CP Decision Point at all other OVC End Points associated by that OVC. These Decision Points are referred to as the egress Decision Points, and a frame at an egress decision point is referred to as a potential egress frame. The egress Decision Point then evaluates the frame and determines whether it is to be Discarded, Peered, or Passed. If the frame is Passed at an egress ENNI Decision Point then it results in an egress L2CP ENNI Frame at that ENNI, which in turn results in an ingress L2CP ENNI Frame in the other operator network. The ingress L2CP ENNI Frame is evaluated at an ENNI L2CP Decision Point, and the process described for the first operator network repeats in the second operator network. The L2CP Frame can be Peered or Discarded at any of the L2CP Decision Points, but as long as it is Passed it continues to propagate just as a Data Frame would through the interconnected operator networks.

Focusing on a single operator network, the behavior observed between any pair of External Interfaces is the combination of the determinations made by the ingress and egress

Decision Points within that operator network. If either Decision Point Discards the frame then the ingress L2CP Frame does not result in an egress L2CP Frame. If either Decision Point Peers the frame then the ingress L2CP Frame does not result in an egress L2CP Frame, however there could be indirect protocol specific results of the Peering that would be observable. If both Decision Points Pass the frame then the ingress L2CP Frame at one EI can result in an egress L2CP Frame at the other EI.

The behavior observed between any pair of UNIs associated by an EVC that spans multiple operator networks is the combination of the determinations made by all of the L2CP Decision Points encountered in each of the operator networks between the UNIs. The L2CP service attributes in the Operator/SP agreements are specified such that the behavior observed between the UNIs is the same as the behavior determined by the specification of the L2CP service attributes in the Subscriber/SP agreement.

Note that L2CP Frames observed at ENNIs could have resulted from an ingress L2CP Service Frames at one of the UNIs, or could have resulted from a L2CP frame generated by a Protocol Entity in a operator network. The latter case includes frames associated with provider Layer2 Control Protocols, used to control some aspect of the CEN operation, that are not associated with any customer Layer2 Control Protocols carried on a service within the CEN. A typical example of a provider protocol is LACP running at an ENNI to provide active and standby links for the ENNI. The L2CP behavioral model, together with the service attributes, flow charts and requirements of sections 8 and 9, determine the behavior related to both customer and provider L2CP Frames.

7.3.1 L2CP Behavioral Model with a VUNI

Figure 5 shows the L2CP Behavioral Model for a CEN with a VUNI. The figure shows a simple case with a single VUNI at the ENNI and a single OVC End Point at the VUNI, but more complex examples are easily constructed. At an ENNI with one or more VUNI End Points in the End Point Map, there is a VUNI L2CP Decision Point for each VUNI End Point in addition to the ENNI L2CP Decision Point.

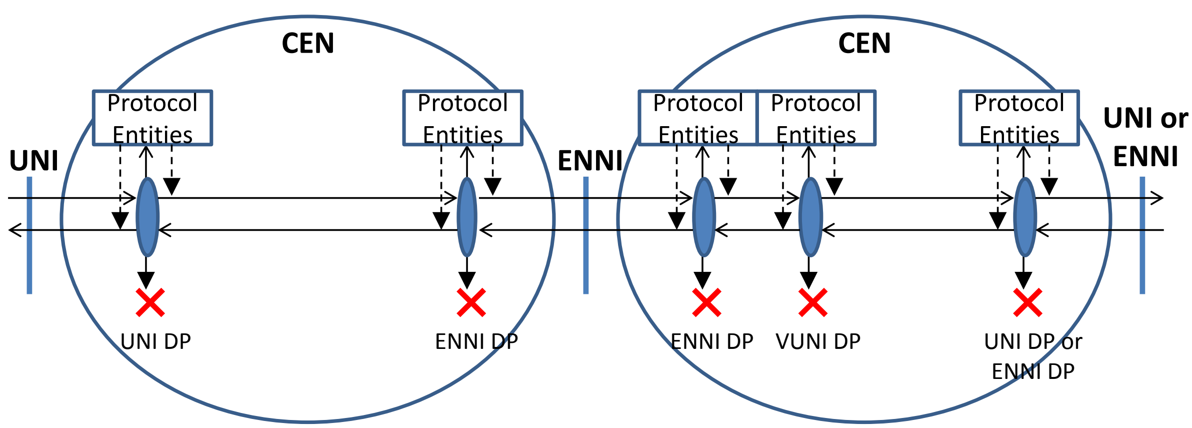

Figure 5 – L2CP Behavioral Model for Operator with a VUNI

An ingress L2CP ENNI Frame with an S-VID that maps to a VUNI End Point is first evaluated by the ENNI Decision Point and subsequently evaluated by the VUNI Decision Point. Either Decision Point can Peer or Discard the frame. If it is Passed by both Decision Points then it is propagated, subject to the same propagation constraints as Data Frames, to all other OVC End Points associated by the OVC.

An L2CP Frame received at another External Interface and propagated to an OVC End Point at a VUNI is first evaluated by the VUNI Decision Point and subsequently evaluated by the ENNI Decision Point. Either decision point can Peer or Discard the frame. If it is Passed by both Decision Points then it can result in an egress L2CP ENNI Frame.

8 L2CP Service Attributes

8.1 L2CP Address Set Service Attribute

The L2CP Address Set Service Attribute specifies the subset of the Bridge Reserved Addresses that are filtered (i.e. L2CP Frames with this destination address are Peered or Discarded but not Passed) at a L2CP Decision Point. In the description of the Bridge Reserved Addresses in section 6.2 it is noted that different types of 802.1 Bridges filter different subsets of these addresses. There is an MEF analog to this where different types of MEF services filter the different subsets of these addresses.

Ethernet Virtual Private Services associate UNIs that are aware of C-VLAN tags and therefore filter the same subset as a Provider Edge Bridge. Ethernet Private Services associate UNIs that are blind to C-VLAN tags and therefore generally filter the same subset as a Provider Bridge. The service types are differentiated in the Subscriber/SP agreement by the UNI All-to-One Bundling Service Attribute, however there are two problems with using this same attribute to control which subset of Bridge Reserved Addresses are filtered. One is that the UNI All-to-One Bundling Service Attribute is not included in the Operator/SP agreement when a service spans multiple CENs. The other is that MEF Service Definitions include a special case of L2CP processing that can be selected for EPL services (known as EPL Option 2 L2CP processing) where yet a different subset of the Bridge Reserved Addresses are filtered. The L2CP Address Set Service Attribute is introduced to explicitly specify the subset of addresses to be filtered.

The values for the L2CP Address Set Service Attribute are defined as follows:

- C-VLAN Tag Aware (CTA), for VLAN-based services where the CE-VLAN ID is used to map a frame to a service.
- C-VLAN Tag Blind (CTB), for Port-based services where the CE-VLAN ID is not used to map a frame to a service.
- C-VLAN Tag Blind Option 2 (CTB-2), for point-to-point Port-based services that support the EPL Option 2 L2CP processing

[R1] The value of a L2CP Address Set Service Attribute **MUST** be CTA or CTB or CTB-2.

The subsets of the Bridge Reserved Addresses filtered for each of these values is defined in Table 5. The application of Table 5 and the L2CP Address Set Service Attribute values is determined by the flow diagrams in sections 9.1 and 9.2. Use of the CTB-2 column is somewhat different than the CTA and CTB columns in that the EPL Option 2 L2CP processing in section 9.1.1 takes precedence over the flow diagrams.

L2CP Destination Address	802.1Q Assignment	Filtered by:		
		CTA	CTB	CTB-2
01-80-C2-00-00-00	Nearest Customer Bridge	X		
01-80-C2-00-00-01	IEEE MAC Specific Control Protocols	X	X	X
01-80-C2-00-00-02	IEEE 802 Slow Protocols	X	X	
01-80-C2-00-00-03	Nearest non-TPMR Bridge	X	X	
01-80-C2-00-00-04	IEEE MAC Specific Control Protocols	X	X	
01-80-C2-00-00-05	Reserved for Future Standardization	X	X	
01-80-C2-00-00-06	Reserved for Future Standardization	X	X	
01-80-C2-00-00-07	MEF Forum ELMI	X	X	
01-80-C2-00-00-08	Provider Bridge Group	X	X	
01-80-C2-00-00-09	Reserved for Future Standardization	X	X	
01-80-C2-00-00-0A	Reserved for Future Standardization	X	X	
01-80-C2-00-00-0B	Reserved for Future Standardization	X		
01-80-C2-00-00-0C	Reserved for Future Standardization	X		
01-80-C2-00-00-0D	Provider Bridge MVRP	X		
01-80-C2-00-00-0E	Nearest Bridge, Individual LAN Scope	X	X	
01-80-C2-00-00-0F	Reserved for Future Standardization	X		

Table 5 – L2CP Address Sets

There is an L2CP Address Set Service Attribute for each UNI, VUNI, and OVC. The OVC L2CP Address Set Service Attribute supplants the need for an ENNI L2CP Address Set Service Attribute. Were it not for the need to support EPL services with EPL Option 2 L2CP processing at an ENNI then an ENNI would always have behavior corresponding to an L2CP Address Set value of CTB. Having an L2CP Address Set per OVC allows an ENNI to support EPL services with EPL Option 2 L2CP processing for OVCs supporting such services.

The constraints on the UNI L2CP Address Set Service Attribute in a Subscriber/SP agreement are specified in [R2] through [R4]:

[R2] When All-to-One Bundling is Disabled at a UNI the UNI L2CP Address Set Service Attribute **MUST** have a value of CTA.

[R3] When All-to-One Bundling is Enabled at a UNI, and the service supported at that UNI is not an EPL service with the EPL Option 2 L2CP processing, the UNI L2CP Address Set Service Attribute **MUST** have a value of CTB.

[R4] When All-to-One Bundling is Enabled at a UNI, and the service supported at that UNI is an EPL service with the EPL Option 2 L2CP processing, the UNI L2CP Address Set Service Attribute **MUST** have a value of CTB-2.

The constraints on the UNI, VUNI, and OVC L2CP Address Set Service Attributes in an Operator/SP agreement are specified in [R5] through [R9]:

[R5] When not all CE-VLAN IDs map to a single OVC End Point at a UNI the UNI L2CP Address Set Service Attribute **MUST** have a value of CTA.

[R6] When not all CE-VLAN IDs map to a single OVC End Point at a VUNI the VUNI L2CP Address Set Service Attribute **MUST** have a value of CTA.

The condition of not all CE-VLAN IDs mapping to a single OVC End Point includes the case where there are multiple OVC End Points at the UNI or VUNI as well as the case where some CE-VLAN IDs do not map to any OVC End Point. When all CE-VLAN IDs map to a single OVC End Point the UNI L2CP Address Set service attribute can take any value. The value is only constrained when the OVC supports a service with EPL Option 2 L2CP processing:

[R7] When an OVC supports an EPL service with the EPL Option 2 L2CP processing, the OVC L2CP Address Set Service Attribute **MUST** have a value of CTB-2.

[R8] When an OVC supports an EPL service with EPL Option 2 L2CP processing, the OVC **MUST** only support EPL services with EPL Option 2 L2CP processing.

[R9] When an OVC has an OVC End Point at a UNI, the values of the UNI L2CP Address Set Service Attribute and the OVC L2CP Address Set Service Attribute **MUST** be the same.

Note that [R8] applies only to the case of multiple EVCs bundled into a point-to-point OVC between two ENNIs. The rationale for [R8] is that if an EPL with EPL Option 2 L2CP processing is bundled with another service on an OVC, the result of [R7] is the possibility that some tagged provider L2CP Frames will be Passed that should be Discarded on the non-Option 2 service. Such behavior is contrary to the IEEE 802.1 architecture, and could cause protocols depending upon the Discard action to fail.

Note that the implication of [R9] is that when an OVC associates OVC End Points at multiple UNIs, the value of the UNI L2CP Address Set Service Attribute will be the same at all of those UNIs.

Note that for any given UNI, the value of the UNI L2CP Address Set Service Attribute in the Subscriber/SP agreement can be different than the value of the UNI L2CP Address Set Service Attribute in the Operator/SP agreement.

8.2 L2CP Peering Service Attribute

The L2CP Peering Service Attribute is a list of Layer 2 Control Protocols that will be Peered by a protocol entity at a UNI, VUNI, or ENNI. Each entry in the list specifies the Protocol Identifier and the Destination Address in use by the protocol entity. An example is shown in Table 6. Notice that the Protocol Identifier is either an LLC Address or an Ethertype, and that it could have subtypes. The list specifies only the L2CP Frames that are to be Peered. Any L2CP Frame that is not Peered will either be Discarded or Passed as a result of the flow charts and requirements specified in Section 9.

When Link Aggregation is used at an EI, its purpose is to make the multiple physical links appear to be a single logical link to the attached devices and thus a single EI to the CEN. Most Layer 2 Control Protocols operate over the EI as a single logical link and hence are agnostic to the individual physical link selected to carry the protocol frames, however some (e.g. LLDP, ESMC) can operate over the individual physical links. It is even possible that a protocol (e.g. ESMC) could operate on some, but not all, of the physical links. In this situation the entry in the L2CP Peering service attribute can include a link identifier. If no link identifier is specified then the list entry will apply to all links. Requirements on the format of the Link Identifier are beyond the scope of this document.

[R10] The L2CP Peering service attribute value **MUST** be an empty list, or a list of entries identifying protocols to be Peered where each entry consists of {Destination Address, Protocol Identifier} or {Destination Address, Protocol Identifier, Link Identifier}.

There is an L2CP Peering Service Attribute for each UNI, VUNI, and ENNI.

Protocol to be Peered	Protocol Identifier	L2CP Destination Address
Link Aggregation (LACP)	Ethertype: 0x8809 Subtypes: 01,02	01-80-C2-00-00-02
Link OAM	Ethertype: 0x8809 Subtype: 03	01-80-C2-00-00-02
E-LMI	Ethertype: 0x88EE	01-80-C2-00-00-07
Spanning Tree (RSTP/MSTP)	LLC Address: 0x82	01-80-C2-00-00-00

Table 6 – Example L2CP Peering Service Attribute

Table 7 contains a list of some Layer 2 Control Protocols and a reference to the standard that specifies the protocol. The Protocol Identifiers and L2CP Destination Addresses in the table are specified by the cited references. This document does not preclude the use of addresses other than those listed in this table. The protocols may generate VLAN-tagged, priority-tagged, or un-tagged frames as specified in the cited references.

Layer 2 Control Protocol	Protocol Identifier	L2CP Destination Addresses	Ref
Link Aggregation Control/Marker Protocol (LACP)	Ethertype: 0x8809 Subtypes: 0x01, 0x02	01-80-C2-00-00-00 01-80-C2-00-00-02 01-80-C2-00-00-03	[2][3]
802.3 Operations, Administration, and Maintenance (Link-OAM)	Ethertype: 0x8809 Subtype: 0x03	01-80-C2-00-00-02	[12]
Ethernet Synchronization Messaging Channel (ESMC)	Ethertype: 0x8809 Subtype: 0x0A	01-80-C2-00-00-02	[14]
Precision Time Protocol Peer-Delay (PTP)	Ethertype: 0x88F7	01-80-C2-00-00-0E	[13]
Ethernet Local Management Interface (E-LMI)	Ethertype: 0x88EE	01-80-C2-00-00-07	[20]
Link Layer Discovery Protocol (LLDP)	Ethertype: 0x88CC	01-80-C2-00-00-00 01-80-C2-00-00-03 01-80-C2-00-00-0E	[1]
Virtual Station Interface Discovery and Configuration Protocol (VDP)	Ethertype: 0x8940 Subtype: 0x0001	01-80-C2-00-00-00	[9]
Port Extender Control and Status Protocol (PE-CSP)	Ethertype: 0x8940 Subtype: 0x0002	01-80-C2-00-00-03	[10]
Port-Based Network Access Control	Ethertype: 0x888E	01-80-C2-00-00-00 01-80-C2-00-00-03 01-80-C2-00-00-0E	[11]
802.3 MAC Control: PAUSE	Etherype: 0x8808 Subtype: 0x0001	01-80-C2-00-00-01	[12]
802.3 MAC Control: Priority Flow Control (PFC)	Etherype: 0x8808 Subtype: 0x0101	01-80-C2-00-00-01	[7]
802.3 MAC Control: Multipoint MAC Control	Etherype: 0x8808 Subtype: 0x0002-0x0006	01-80-C2-00-00-01	[12]
802.3 MAC Control: Organization Specific Extensions	Etherype: 0x8808 Subtype: 0xFFFE	01-80-C2-00-00-01	[12]
Rapid/Multiple Spanning Tree Protocol (RSTP/MSTP)	LLC Address: 0x42	01-80-C2-00-00-00 01-80-C2-00-00-08	[4][5]
Shortest Path Bridging (SPB)	LLC Address: 0xFE	01-80-C2-00-00-2E 01-80-C2-00-00-2F	[8]
Multiple MAC Registration Protocol (MMRP)	Ethertype: 0x88F6	01-80-C2-00-00-20	[4][5]
Multiple VLAN Registration Protocol (MVRP)	Ethertype: 0x88F5	01-80-C2-00-00-21 01-80-C2-00-00-0D	[5]
Multiple Stream Registration Protocol (MSRP)	Ethertype: 0x22EA	01-80-C2-00-00-0E	[5]
Multiple ISID Registration Protocol (MIRP)	Ethertype: 0x8929	01-80-C2-00-00-00	[6]

Table 7 – Selected Layer 2 Control Protocols

All recommendations and requirements for EPL services with EPL Option 2 L2CP processing are to either Discard or Pass L2CP Frames at all UNIs (section 9.1.1). Therefore the following constraint is placed on the L2CP Peering service attribute:

[D1] When the UNI L2CP Address Set service attribute is CTB-2, the UNI L2CP Peering Service Attribute **SHOULD** be an empty list.

For Ethernet Private Services other than EPL with EPL Option 2 L2CP processing, any L2CP Frame with a Bridge Reserved Address in Table 5 but not in the CTB subset of Table 5 is to be Passed at all Decision Points. Therefore the following constraints are placed on the L2CP Peering service attribute:

[R11] When the UNI or VUNI L2CP Address Set service attribute is CTB, any entry in the UNI or VUNI L2CP Peering Service Attribute **MUST NOT** have a Destination Address that is in Table 5 but not in the CTB subset of Table 5.

[R12] Any entry in the ENNI L2CP Peering service attribute **MUST NOT** have a Destination Address that is in Table 5 but not in the CTB subset of Table 5.

8.2.1 Requirements for peering specific Layer 2 Control Protocols

MEF 10.3 requires Peering LACP when the UNI Resiliency service attribute has a value of "2-Link Aggregation".

[R13] When the value of the UNI Resiliency service attribute is "2-Link Aggregation", the UNI L2CP Peering service attribute at that UNI **MUST** list LACP with a "Slow Protocols" destination address (01-80-C2-00-00-02), and a Protocol Identifier consisting of the "Slow Protocols" Ethertype value (0x8809) and the LACP and LAMP sub-types (01, 02).

MEF 26.1 requires Peering LACP when there are two physical links at the ENNI using Link Aggregation as the protection mechanism.

[R14] When Link Aggregation is used as the protection mechanism for two physical links at an ENNI, the ENNI L2CP Peering service attribute **MUST** list LACP with a "Slow Protocols" destination address (01-80-C2-00-00-02), and a Protocol Identifier consisting of the "Slow Protocols" Ethertype value (0x8809) and the LACP and LAMP sub-types (01, 02).

MEF 10.3 requires Peering Link-OAM when the UNI Link-OAM service attribute is Enabled.

[R15] When the UNI Link-OAM service attribute is Enabled, the UNI L2CP Peering service attribute at that UNI **MUST** list Link-OAM with a "Slow Protocols" destination address (01-80-C2-00-00-02), and a Protocol Identifier consisting of the "Slow Protocols" Ethertype value (0x8809) and the Link-OAM sub-type (03).

MEF 10.3 requires Peering E-LMI when the UNI E-LMI service attribute is Enabled.

[R16] When the UNI E-LMI service attribute is Enabled, the UNI L2CP Peering service attribute at that UNI **MUST** list E-LMI with a E-LMI destination address (01-80-C2-00-00-07), and a Protocol Identifier consisting of the E-LMI Ethertype value (0x88EE).

MEF 10.3 requires Peering ESMC when the UNI Synchronous Mode service attribute is Enabled. The Synchronous Mode service attribute is a list of links at the UNI with an Enabled or Disabled value for each link.

[R17] When the UNI Synchronous Mode service attribute is Enabled for a link at a UNI, the UNI L2CP Peering service attribute at that UNI **MUST** list ESMC with a “Slow Protocols” destination address (01-80-C2-00-00-02), a Protocol Identifier consisting of the “Slow Protocols” Ethertype value (0x8809) and the ESMC sub-type (0A).

[R18] When there are more than one link at the UNI and the UNI Synchronous Mode service attribute is Enabled for some but not all links, the UNI L2CP Peering service attribute at that UNI **MUST** have an ESMC entry for each link that is Enabled and includes the Link Identifier.

8.3 ENNI Tagged L2CP Frame Processing Service Attribute

The ENNI Tagged L2CP Frame Processing Service Attribute reflects the capability of the ENNI to process S-VLAN-tagged L2CP Frames in an 802.1 compliant manner. Although almost all Layer 2 Control Protocols generate untagged L2CP Frames, some generate tagged L2CP Frames (e.g. MMRP). L2CP Frames will also be tagged at an ENNI when they result from L2CP Service Frames that ingress at a UNI and are subsequently Passed by L2CP Decision Points. The special forwarding rules for the Bridge and MRP Reserved Addresses specified in 802.1Q and discussed in section 5 apply to both tagged and untagged L2CP Frames, however the EPL with EPL Option 2 L2CP processing requirements conflict with these rules. It can be difficult for some ENNI implementations to apply the special forwarding rules for some OVCs but not for others. Therefore this specification recommends applying the special forwarding rules to tagged frames on OVCs supporting a service other than EPL with EPL Option 2 L2CP processing, but allows implementations to simply Pass any tagged L2CP.

The allowed values for the ENNI Tagged L2CP Frame Processing Service Attribute are “802.1 compliant” or “802.1 non-compliant”. A value of 802.1 compliant means the ENNI will apply the special forwarding rules to tagged L2CP Frames that map to a VUNI End Point or an OVC End Point supporting a service other than EPL with EPL Option 2 L2CP processing. A value of 802.1 non-compliant means the ENNI will Pass any tagged L2CP Frames. There is a ENNI Tagged L2CP Frame Processing Service Attribute for each ENNI.

[D2] An ENNI Tagged L2CP Frame Processing Service Attribute **SHOULD** be 802.1 compliant.

When the value of the ENNI Tagged L2CP Processing Service Attribute is "802.1 non-compliant," it is possible that some tagged provider L2CP Frames will be Passed that are mandated to be Discarded by the IEEE 802.1 architecture. This could cause protocols that depend upon the Discard action to fail.

9 L2CP Processing Requirements

9.1 UNI and VUNI L2CP Frame Processing Requirements

The flow chart in Figure 6 specifies the action taken on a L2CP Frame at a UNI or VUNI L2CP Decision Point when the L2CP Address Set service attribute has a value of CTA or CTB. When the L2CP Address Set service attribute has a value of CTB-2 the actions taken at a UNI L2CP Decision Point are specified in 8.1.2.

The flow chart is used to determine both ingress actions in response to an Ingress L2CP Service Frame, and egress actions in response to a potential egress L2CP Frame propagated to this UNI from a Decision Point at another EI. L2CP Frames generated by a Protocol Entity at the UNI are not processed according to the flow chart.

At a UNI L2CP Decision Point the inputs to the flow chart are the UNI L2CP Address Set and UNI L2CP Peering service attributes and the Destination Address and Protocol Identifier in the L2CP Frame.

[R19] When the UNI L2CP Address Set is CTA or CTB, the flow chart in Figure 6 **MUST** be used to determine whether the action for a L2CP Frame at a UNI Decision Point will be Peer, Pass, or Discard.

At a VUNI L2CP Decision Point the inputs to the flow chart are the VUNI L2CP Address Set and VUNI L2CP Peering service attributes and the Destination Address and Protocol Identifier in the L2CP Frame. At a VUNI L2CP Decision Point the S-tag in the L2CP ENNI Frame is ignored, and if the action taken is Peer then the contents of the frame without the S-tag are acted upon by the appropriate protocol entity.

[R20] When the VUNI L2CP Address Set is CTA or CTB, the flow chart in Figure 6 **MUST** be used to determine whether the action for a L2CP Frame at a VUNI Decision Point will be Peer, Pass, or Discard.

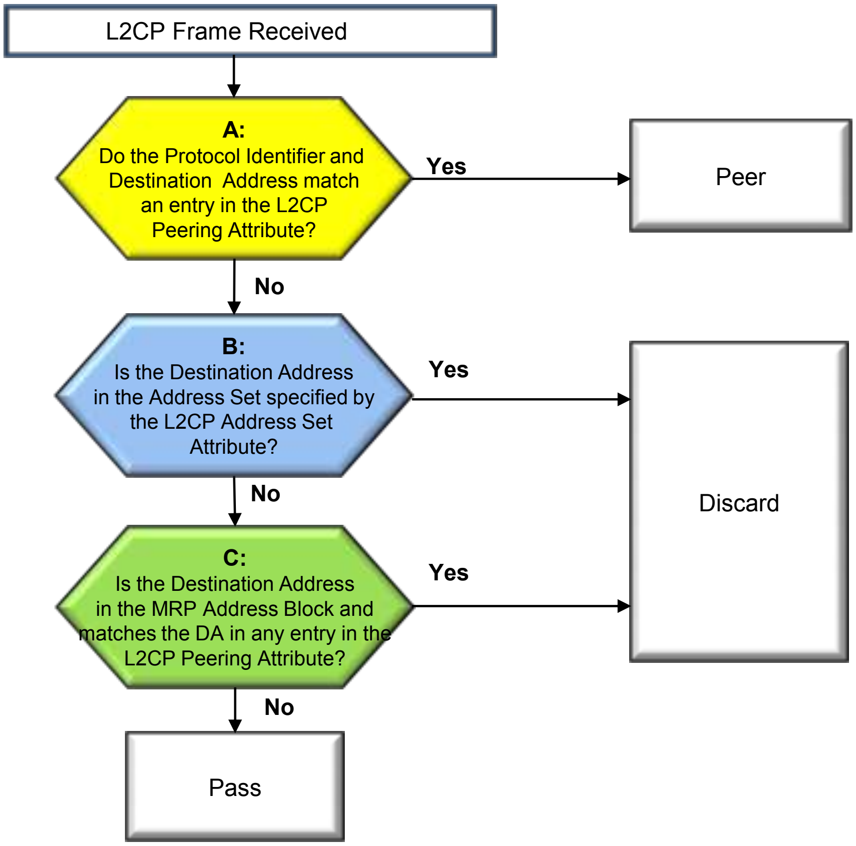

Figure 6 – Flow Chart for UNI and VUNI Decision Points

The first decision block in the flow chart (A) determines whether the L2CP Frame will be Peered by comparing the Destination Address and Protocol Identifier in the L2CP Frame with the list entries configured in the UNI (or VUNI) L2CP Peering service attribute.

If the L2CP Frame is not Peered, the second decision block (B) determines whether it will be Discarded by comparing the Destination Address of the L2CP Frame with the specific set of Reserved Addresses checked in the column of Table 5 that corresponds to the configured value of the L2CP Address Set service attribute.

As described in section 6.3, the special forwarding rule for MRP Reserved Addresses is that if any protocol using an MRP address is Peered, then no frames with that address will be Passed. The first decision block (A) assures that frames with an MRP Address and PID that are listed in the L2CP Peering service attribute will be Peered (and therefore not Passed). The third decision block (C) assures that frames with that MRP Address but a different PID will be Discarded (and therefore not Passed).

If the L2CP Frame is not Peered or Discarded then it will be Passed.

Recall from section 7.1.3 that a L2CP Frame that is Passed is still subject to the same propagation constraints as a Data Frame, and in particular any L2CP Frame with an C-VID value that does not map to any EVC or OVC End Point will not be propagated to Decision Points at other External Interfaces.

9.1.1 UNI L2CP Frame Processing for EPL Option 2 L2CP Processing

When the end-to-end service supported at a UNI is EPL with EPL Option 2 L2CP processing, the L2CP Address Set service attribute value will be CTB-2. In this case Table 8 and Table 9 specify the action taken on a L2CP Frame at a UNI L2CP Decision Point. Note that the EPL Option 2 L2CP processing has L2CP processing requirements that are NOT in line with the current IEEE standards: 1588-2008 [13], 802.1Q-2011 [5], 802.1AB-2009 [1], and 802.1X-2010 [11].

The first column of Table 8 and Table 9 identifies the protocol requiring special action for EPL Option 2 L2CP processing. The second column is the Protocl Identifier. The third column is the Destination Address. The Fourth column specifies the required UNI L2CP Decision Point action[9] for a frame with matching Protocol Identifier and Destination Address.

[R21] If the value of the UNI L2CP Address Set service attribute is CTB-2, and a L2CP Frame at a UNI L2CP Decision Point has a Destination Address and Protocol Identifier matching an entry in Table 8, then the frame **MUST** be processed as specified in Table 8.

Protocol Type	Protocol Identifier	L2CP Destination Address	L2CP Action
STP[3]/RSTP[3]/MSTP[4]	LLC Address: 0x42	01-80-C2-00-00-00	**MUST** Pass
E-LMI[9]	Ethertype: 0x88EE	01-80-C2-00-00-07	**MUST** Pass[10]
LLDP[8]	Ethertype: 0x88CC	01-80-C2-00-00-0E	**MUST** Pass
PTP Peer Delay[13][5]	Ethertype: 0x88F7	01-80-C2-00-00-0E	**MUST** Pass
GARP[4]/MRP[17] Block	any	01-80-C2-00-00-20 through 01-80-C2-00-00-2F	**MUST** Pass

Table 8 – EPL Option 2 L2CP Processing Requirements

[D3] If the value of the UNI L2CP Address Set service attribute is CTB-2, then a L2CP Frame at a UNI L2CP Decision Point has a Destination

[9] Table 8 and Table 9is the same as Table K of MEF 6.1.1 except that "Tunnel" has been replaced with "Pass" to make the table consistent with actions taken by a L2CP Decision Point. Recall that when all Decision Points encountered by a L2CP Frame propagating through a network Pass the frame, the end-to-end result is the same as "Tunnel" as defined in MEF 6.1.1.

[10] When using EPL Option 2, it is recommended for the Subscriber to turn off E-LMI in the equipment that is attached to the UNI. Trying to run E-LMI with EPL Option 2 in this equipment may lead to unpredictable results.

Address and Protocol Identifier matching an entry in Table 9, then the frame **SHOULD** be processed as specified in Table 9.

Protocol Type	Protocol Identifier	L2CP Destination Address	L2CP Action
PAUSE[5]	Etherype: 0x8808 Subtype: 0x0001	01-80-C2-00-00-01	**SHOULD** Discard
LACP/LAMP[5]	Ethertype: 0x8809 Subtypes: 0x01, 0x02	01-80-C2-00-00-02	**SHOULD** Pass
Link OAM[5]	Ethertype: 0x8809 Subtype: 0x03	01-80-C2-00-00-02	**SHOULD** Pass
Port Authentication[7]	Ethertype: 0x888E	01-80-C2-00-00-03	**SHOULD** Pass
ESMC[14][8]	Ethertype: 0x8809 Subtype: 0x0A	01-80-C2-00-00-02	**SHOULD** Pass[11]

Table 9 – EPL Option 2 L2CP Processing Recommendations

Table 8 and Table 9 only specify actions for selected combinations of Protocol Identifier and Destination Address. It is recommended that the flow chart in Figure 6 be used to determine the UNI Decision Point action for L2CP Frames with other combinations of Protocol Identifier and Destination Address.

[D4] If the value of the UNI L2CP Address Set service attribute is CTB-2, and an L2CP Frame at a UNI Decision Point has a combination of Protocol Identifier and Destination Address not listed in Table 8 or Table 9, the flow chart in Figure 6 **SHOULD** be used to determine whether the action for a L2CP Frame at a UNI Decision Point will be Peer, Pass, or Discard.

9.1.2 Example L2CP Frame evaluation at a UNI L2CP Decision Point

For example, consider an ingress L2CP Service Frame that is a Link Layer Discovery Protocol (LLDP) frame with the Nearest Customer Bridge destination address (01-80-C2-00-00-00) being evaluated by the L2CP Decision Point at a UNI.

If the UNI L2CP Address Set is CTB-2 then the LLDP frame will be processed according to Table 8, however Table 8 does not have an entry for LLDP frames with this destination address. Therefore [D4] recommends the frame be processed according to the flow chart in Figure 6. If the UNI L2CP Address set is CTA or CTB then the LLDP frame will always be processed according the flow chart in Figure 6.

[11] When using EPL Option 2, it is recommended for the Subscriber to turn off ESMC in the equipment that is attached to the UNI. Trying to run ESMC with EPL Option 2 in this equipment may lead to unpredictable results. Tunneled ESMC frames may not accurately represent the state of the timing attributes of the physical interface the Subscriber interface is attached to.

If this protocol with this destination address is listed in the UNI L2CP Peering service attribute then the frame will be Peered as a result of decision block A. Note that [R11] forbids this PID and DA combination from being listed when the L2CP Address Set is CTB.

If the LLDP Frame was not Peered as a result of decision block A, then the evaluation process continues with decision block B. If the UNI L2CP Address Set service attribute value is CTA then, since the destination address is in the CTA subset of Table 5, the LLDP Frame will be Discarded. If the UNI L2CP Address Set service attribute value is CTB or CTB-2 then, since the destination address is not in the CTB or CTB-2 subset of Table 5, the evaluation will continue with decision block C.

The LLDP frame will not be Discarded at decision block C since the destination address is not an MRP address. Therefore if it is not Peered as a result of decision block A, or Discarded as a result of decision block B, then the LLDP frame will be Passed.

9.2 ENNI L2CP Processing Requirements

The action taken on a L2CP Frame by an ENNI L2CP Decision Point is described by the flow chart in Figure 7. The flow chart uses the configuration of the L2CP Peering, L2CP Address Set and ENNI Tagged L2CP Frame Processing service attributes, and the Destination Address, Protocol Identifier and S-VID in the L2CP Frame, to determine whether the action taken will be to Peer, Discard or Pass the L2CP Frame.

The flow chart is used to determine both ingress actions in response to an Ingress L2CP ENNI Frame, and egress actions in response to a potential egress L2CP Frame propagated to this ENNI from another Decision Point. L2CP Frames generated by a Protocol Entity for the ENNI Decision Point are not processed according to the flow chart. For egress actions, the potential egress frame is assumed to be S-VLAN tagged with an S-VID value determined by the ENNI End Point Map.

> **[R22]** The flow chart in Figure 7 **MUST** be used to determine whether the action for a L2CP Frame at a ENNI Decision Point will be Peer, Pass, or Discard.

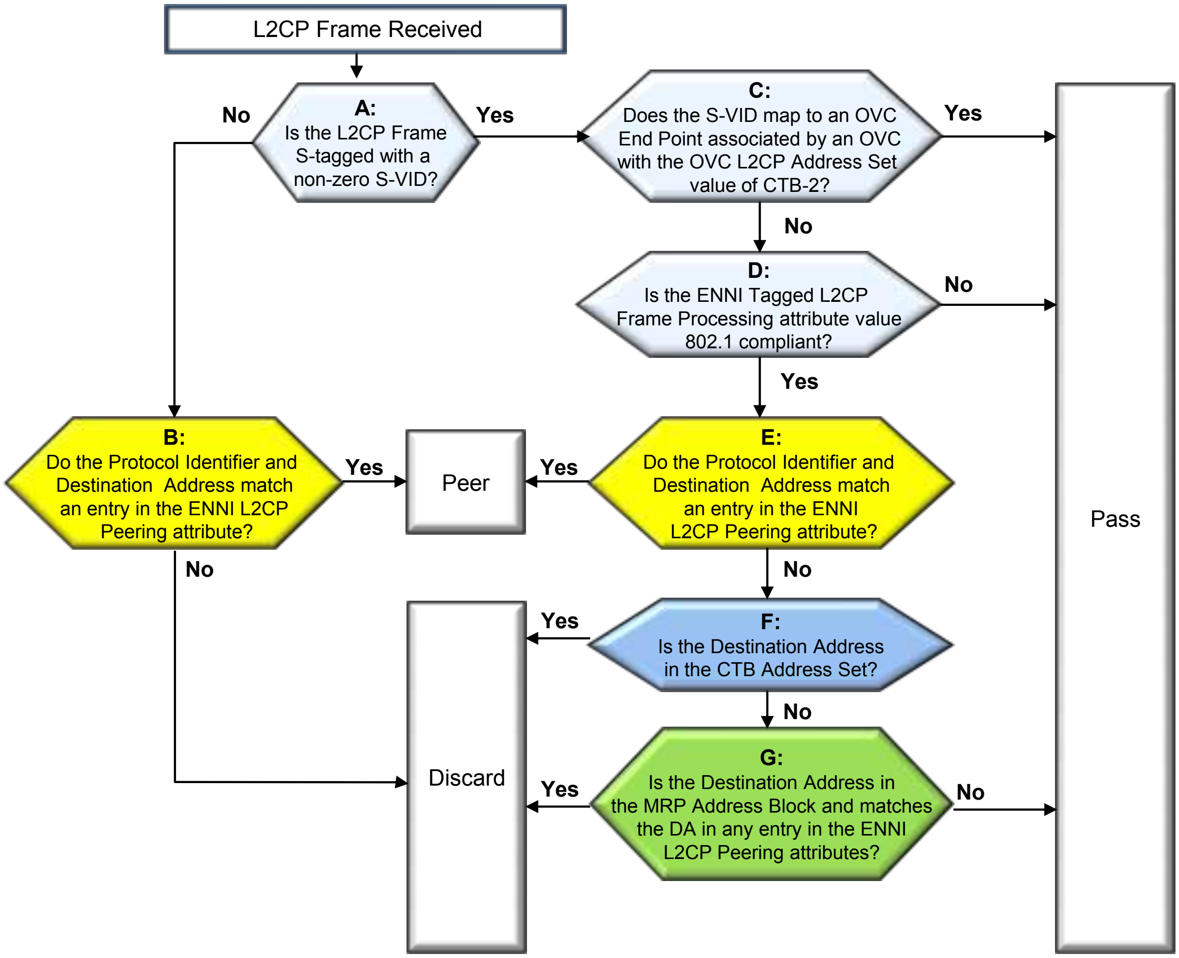

Figure 7 – Flow Chart for ENNI Decision Point

The first decision block in the flow chart (A) separates S-VLAN specific L2CP ENNI Frames (S-tagged with S-VID not equal to zero), from L2CP Frames that are not specific to a S-VLAN (without an S-tag, or with a priority-S-tag). The second decision block (B) determines whether a Port-based L2CP Frame will be Peered by comparing the Destination Address and Protocol Identifier in the frame with the list entries configured in the ENNI L2CP Peering service attribute. Since Port-based L2CP ENNI Frames cannot be mapped to any OVC End Point or VUNI End Point they cannot be Passed. Therefore if they are not Peered they are Discarded.

The third decision block (C) determines whether the L2CP Frame is associated with a S-VID value that maps to an OVC End Point associated by an OVC supporting an EPL service with EPL Option 2 L2CP processing. If so then the frame is Passed. Otherwise, including the case where the L2CP Frame is associated with a S-VID that maps to a VUNI End Point, processing continues with decision block (D).

The fourth decision block (D) determines whether the L2CP processing implementation at the ENNI supports 802.1 compliant processing of tagged L2CP Frames (see section [R18]). If not then the frame is Passed.

The fifth decision block (E) determines whether a L2CP Frame associated with a non-zero S-VID will be Peered by comparing the Destination Address and Protocol Identifier in the L2CP Frame with the list entries configured in the ENNI L2CP Peering service attribute.

If the L2CP Frame is not Peered, the sixth decision block (F) determines whether it will be Discarded by comparing the Destination Address of the L2CP Frame with the specific set of Reserved Addresses checked in the CTB column of Table 5.

As described in section 6.3, the special forwarding rule for MRP Reserved Addresses is that if any protocol using an MRP address is Peered, then no frames with that address will be Passed. The fifth decision block (E) assures that frames with an MRP Address and PID that are listed in the L2CP Peering service attribute will be Peered (and therefore not Passed). The seventh decision block (G) assures that frames with that MRP Address but a different PID will be Discarded (and therefore not Passed).

Otherwise the frame is Passed.

Recall from section 7.1.3 that a L2CP Frame that is Passed is still subject to the same propagation constraints as a Data Frame, and in particular any L2CP Frame with an S-VID value that does not map to any OVC End Point or VUNI End Point will not be propagated to Decision Points at other External Interfaces.

9.2.1 Example L2CP Frame evaluation at a ENNI L2CP Decision Point

For a first example, consider the LLDP frame from the example in 7.1.1. Specifically consider the case where the LLDP frame was Passed by the ingress UNI L2CP Decision Point and propagated to an OVC End Point at an ENNI where it will be evaluated by an egress ENNI L2CP Decision Point. Since all potential egress L2CP Frames at an ENNI are associated with an OVC End Point that maps to a non-zero S-VID, the result of decision block A will be to proceed to decision block C.

If the OVC Address Set service attribute is CTB-2 then decision block C will cause the frame to be Passed. Otherwise, if the ENNI implementation does not support processing of tagged L2CP frames, then decision blocks D will cause the frame to be Passed. Otherwise the processing continues with decision block E.

The address of the LLDP frame from the example in section 9.1.2 is the Nearest Customer Bridge address. Since this address is not in the CTB subset of Table 5, there cannot be an entry in the ENNI L2CP Peering service attribute that matches this frame (per [R11]). Therefore the frame will not be Peered. Since the address is not in the CTB subset of Table 5, nor is it an MRP address, the frame will not be discarded as a result of decision blocks F or G. The final decision will be to Pass the frame.

Since the LLDP frame is Passed at the egress ENNI Decision Point, it will be transmitted on the ENNI and evaluated at the ingress ENNI Decision Point in the other operator network. The result of the ingress ENNI Decision Point evaluation will be the same as the egress ENNI Decision Point evaluation, i.e. the frame will be Passed.

For a second example, consider an LLDP frame that is untagged at the ENNI. At an ingress ENNI Decision Point, decision block B will result in this frame being Peered if there is a matching entry for the LLDP protocol in the ENNI L2CP Peering attribute, and Discarded otherwise.

10 Service Requirements for L2CP

10.1 EVPL, EVP-LAN, and EVP-Tree Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for EVPL, EVP-LAN and EVP-Tree service types are shown in Table 10.

UNI Service Attributes	EVPL, EVP-LAN, EVP-Tree Service type Requirement
L2CP Address Set	**[R23]** **MUST** be CTA
L2CP Peering	No additional constraints from section 8.2

Table 10 – UNI L2CP Service Attributes for Ethernet Virtual Private Services

10.2 EPL, EP-LAN, and EP-Tree Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for EPL, EP-LAN and EP-Tree service types are shown in Table 11.

UNI Service Attributes	EPL, EP-LAN, EP-Tree Service type Requirement
L2CP Address Set	**[R24]** EPL Option 1, EP-LAN, and EP-Tree: **MUST** be CTB **[R25]** EPL Option 2: **MUST** be CTB-2
L2CP Peering	EPL Option 1, EP-LAN, and EP-Tree: No additional constraints from section 7.2 **[D5]** EPL Option 2: The UNI L2CP Peering attribute **SHOULD NOT** have any protocols listed to be Peered.

Table 11 – UNI L2CP Service Attributes for Ethernet Private Services

10.3 Access EVPL, Access EPL and UTA Service Requirements

10.3.1 Access EVPL Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for Access EVPL services are shown in Table 12, Table 13, and Table 14.

UNI Service Attributes	Access EVPL Service type Requirement
L2CP Address Set	**[R26] MUST** be CTA This is a consequence of [R5].
L2CP Peering	No additional constraints from section 8.2

Table 12 – UNI L2CP Service Attribute for Access EVPL

OVC Service Attributes	Access EVPL Service type Requirement
L2CP Address Set	**[R27] MUST** be CTA This is a consequence of [R5] and [R9].

Table 13 – OVC L2CP Service Attributes for Access EVPL

ENNI Service Attributes	Access EVPL Service type Requirement
L2CP Peering	No additional constraints from section 8.2
ENNI Tagged L2CP Frame Processing	No additional constraints from section [R18]

Table 14 – ENNI L2CP Service Attributes for Access EVPL

10.3.2 Access EPL Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for Access EPL services are shown in Table 15, Table 16, and Table 17.

UNI Service Attributes	Access EPL Service type Requirement
L2CP Address Set	**[R28]** **MUST** be CTB or CTB-2 Note that [R9] requires this to be the same value as the OVC L2CP Address Set Attribute in Table 16.
L2CP Peering	No additional constraints from section 8.2

Table 15 – UNI L2CP Service Attributes for Access EPL

OVC Service Attributes	Access EPL Service type Requirement
L2CP Address Set	**[R29]** **MUST** be CTB or CTB-2. **[R30]** **MUST** be CTB-2 when the UNI-to-UNI service is EPL option 2. Note that [R9] requires this to be the same value as the UNI L2CP Address Set Attribute in Table 15.

Table 16 – OVC L2CP Service Attributes for Access EPL

ENNI Service Attributes	Access EPL Service type Requirement
L2CP Peering	No additional constraints from section 8.2
ENNI Tagged L2CP Frame Processing	No additional constraints from section [R18]

Table 17 – ENNI L2CP Service Attributes for Access EPL

Note that [R29] and [R30] allow the UNI and OVC L2CP Address Set for an Access EPL service to be CTB-2 even when the end-to-end service is not EPL with EPL Option 2 L2CP processing, however this can compromise proper operation of many protocols, including LACP, LLDP, Link-OAM, E-LMI, PTP Peer Delay and ESMC.

10.3.3 UNI Tunnel Access (UTA) Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for UTA services are shown in Table 18, Table 19, and Table 20.

UNI Service Attributes	UTA Service type Requirement
L2CP Address Set	**[R31] MUST** be CTB
L2CP Peering	No additional constraints from section 8.2

Table 18 – UNI L2CP Service Attributes for UTA

OVC Service Attributes	UTA Service type Requirement
L2CP Address Set	**[R32] MUST** be CTB

Table 19 – OVC L2CP Service Attributes for UTA

ENNI Service Attributes	UTA Service type Requirement
L2CP Peering	No additional constraints from section 8.2
ENNI Tagged L2CP Frame Processing	No additional constraints from section [R18]

Table 20 – ENNI L2CP Service Attributes for UTA

10.4 VUNI L2CP Service Requirements

The Service Attribute and Parameter requirements pertaining to services including a VUNI are shown in Table 21 and Table 22.

VUNI Service Attributes	VUNI Service type Requirement
L2CP Address Set	**[R33] MUST** be CTB when the VUNI supports an EPL, EP-LAN, or EP-TREE. **[R34] MUST** be CTA when the VUNI is supporting EVPL, EVP-LAN, or EVP-TREE service(s). Note that [R9] requires this to be the same value as the OVC L2CP Address Set Attribute in Table 19.
L2CP Peering	No additional constraints from section 8.2

Table 21 – VUNI L2CP Service Attributes for VUNI Service

OVC Service Attributes	VUNI Service type Requirement
L2CP Address Set	**[R35] MUST** be CTB when the VUNI supports an EPL, EP-LAN, or EP-TREE. **[R36] MUST** be CTA when the VUNI is supporting EVPL, EVP-LAN, or EVP-TREE service(s).

Table 22 – OVC L2CP Service Attributes for VUNI Service

10.5 vNID Service Requirements

10.5.1 vNID Case A Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for vNID Case A services are shown in Table 23, Table 24, and Table 25.

UNI Service Attributes	vNID Case A Service type Requirement
L2CP Address Set	**[R37] MUST** be CTA when not all CE-VLAN IDs map to the same OVC End Point This is a consequence of [R5]. **[R38] MUST** be CTB or CTB-2 when all CE-VLAN IDs map to the same OVC End Point Note that [R9] requires this to be the same value as the OVC L2CP Address Set Attribute in Table 24.
L2CP Peering	No additional constraints from section 8.2

Table 23 – UNI L2CP Service Attribute for vNID Case A

OVC Service Attributes	vNID Case A Service type Requirement
L2CP Address Set	**[R39] MUST** be CTB-2 when the UNI-to-UNI service is EPL option 2. Note that [R9] requires this to be the same value as the UNI L2CP Address Set Attribute in Table 23.

Table 24 – OVC L2CP Service Attributes for vNID Case A

ENNI Service Attributes	vNID Case A Service type Requirement
L2CP Peering	No additional constraints from section 8.2
ENNI Tagged L2CP Frame Processing	No additional constraints from section [R18]

Table 25 – ENNI L2CP Service Attributes for vNID Case A

10.5.2 vNID Case B Service Requirements

The Service Attribute and Parameter requirements pertaining to L2CP for vNID Case B services are shown in Table 26, Table 27, and Table 28.

UNI Service Attributes	vNID Case B Service type Requirement
L2CP Address Set	**[R40]** **MUST** be CTB or CTB-2 Note that [R9] requires this to be the same value as the OVC L2CP Address Set Attribute in Table 13.
L2CP Peering	No additional constraints from section 8.2

Table 26 – UNI L2CP Service Attributes for vNID Case B

OVC Service Attributes	vNID Case B Service type Requirement
L2CP Address Set	**[R41]** **MUST** be CTB or CTB-2. **[R42]** **MUST** be CTB-2 when the UNI-to-UNI service is EPL option 2. Note that [R9] requires this to be the same value as the UNI L2CP Address Set Attribute in Table 26.

Table 27 – OVC L2CP Service Attributes for vNID Case B

ENNI Service Attributes	vNID Case B Service type Requirement
L2CP Peering	No additional constraints from section 8.2
ENNI Tagged L2CP Frame Processing	No additional constraints from section [R18]

Table 28 – ENNI L2CP Service Attributes for vNID Case B

Note that [R41] and [R42] allow the UNI and OVC L2CP Address Set for an Access EPL service to be CTB-2 even when the end-to-end service is not EPL with EPL Option 2 L2CP processing, however this can compromise proper operation of many protocols, including LACP, LLDP, Link-OAM, E-LMI, PTP Peer Delay and ESMC.

11 References

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[19] MEF Forum MEF 10.3, *Ethernet Services Attributes Phase 3*, October 2013.

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[25] MEF Forum MEF 28, External Network Network Interface (ENNI) Support for UNI Tunnel Access and Virtual UNI, October 2010.

[26] MEF Forum MEF 30, Service OAM Fault Management Implementation Agreement, January 2011.

[27] MEF Forum MEF 33, *Ethernet Access Services Definition*, January 2012.

[28] MEF Forum MEF 35, Service OAM Performance Monitoring Implementation Agreement, April 2012.

Appendix A Summary of L2CP Service Attributes

The L2CP Service Attributes and Parameter Values are shown in Table 29, Table 30, Table 31 and Table 32.

UNI Service Attributes	Parameter Values
L2CP Address Set	CTA or CTB or CTB-2
L2CP Peering	Empty list, or list of protocols to be Peered where each entry consists of {Destination Address, Protocol Identifier}or {Destination Address, Protocol Identifier, Link Identifier}

Table 29 – UNI L2CP Service Attributes

OVC Service Attributes	Parameter Values
L2CP Address Set	CTA or CTB or CTB-2

Table 30 – OVC L2CP Service Attributes

ENNI Service Attributes	Parameter Values
L2CP Peering	Empty list, or list of protocols to be Peered where each entry consists of {Destination Address, Protocol Identifier}or {Destination Address, Protocol Identifier, Link Identifier}
ENNI Tagged L2CP Frame Processing	802.1 compliant or 802.1 non-compliant

Table 31 – ENNI L2CP Service Attributes

VUNI Service Attributes	Parameter Values
L2CP Address Set	CTA or CTB
L2CP Peering	Empty list, or list of protocols to be Peered where each entry consists of {Destination Address, Protocol Identifier}or {Destination Address, Protocol Identifier, Link Identifier}

Table 32 – VUNI L2CP Service Attributes

Appendix B L2CP Examples / Use Cases

This annex provides a brief description of common protocols, and what it means to have a Service Provider "Peer" the protocol at a UNI or ENNI.

B.1 Link Aggregation (LACP/LAMP)

Link Aggregation is a mechanism for making multiple point-to-point links between a pair of devices appear to be a single logical link between those devices. Link Aggregation is specified in IEEE Std 802.1AX[12], Link Aggregation Control Protocol (LACP) [13].operates between exactly two peer devices for the purpose of creating, verifying, and monitoring the logical link created by aggregating individual links. Specific L2CP frames, known as Link Aggregation Control Protocol Data Units (LACPDUs), are exchanged between the peer devices on each individual link in the aggregation. The protocol identifier used by LACP is an Ethertype with a value of 0x8809 (the "Slow Protocols" Ethertype) and subtype values 01 and 02.

The operation of LACP affects the entire interface (UNI or ENNI) regardless of the number of services supported across that interface. LACP can be supported at each interface independent of whether it is supported at any other interface.

The 802.1AX standard supports aggregation of physical links, chains of physical links concatenated by Two Port MAC Relays (TPMRs), and virtual connections such as an EPL service in a CEN. A port can support one, two, or all three of these types of aggregation by running an instance of LACP for each type of aggregation. Each LACP instance uses a different destination MAC address in LACPDUs so that the LACPDUs are addressed to the appropriate peer LACP instance. The destination addresses specified by IEEE Std 802.1AXbk-2012 for use by LACP are shown in Table 33. The 00-80-C2-00-

[12] Link Aggregation was originally specified as clause 43 of IEEE Std 802.3 (originally as IEEE Std 802.3ad-2000 and subsequently incorporated into base 802.3 document). In 2008 the responsibility for maintaining the standard was moved from the 802.3 working group to the 802.1 working group, so it was removed from IEEE Std 802.3-2008 and published as IEEE Std 802.1AX-2008. It has since been amended by 802.1AXbk-2012.
[13] The Link Aggregation standard specifies two protocols: Link Aggregation Control Protocol (LACP) and Link Aggregation Marker Protocol (LAMP). For the purposes of this document the label "LACP" includes both LACP and LAMP, and the label "LACPDU" includes both LACPDUs (protocol subtype 01) and LAMPDUs (protocol subtype 02). When a UNI or ENNI L2CP Service Attribute lists LACP as being peered, peering of LAMP is implied.

00-02 “Slow Protocols” is the default address for a single LACP instance, and was the only address specified in the original Link Aggregation standard. LACPDUs are untagged when generated by an LACP instance.

L2CP Reserved Destination MAC Address	Assignment	Used to aggregate:
01-80-C2-00-00-00	Nearest Customer Bridge	virtual connections
01-80-C2-00-00-02	Slow Protocols	physical links
01-80-C2-00-00-03	Nearest Non-TPMR Bridge	chains of physical links

Table 33 – LACP Destination Addresses

B.1.1 Peering LACP at a UNI

MEF 10.3 requires peering of LACP on physical links for a UNI with two links. In this case LACP is listed as being Peered in the UNI L2CP Peering Service Attribute. When LACP is peered at a UNI, the Slow Protocols destination address is used ([R13]). This provides the basic aggregation of two physical links shown in Figure 8.

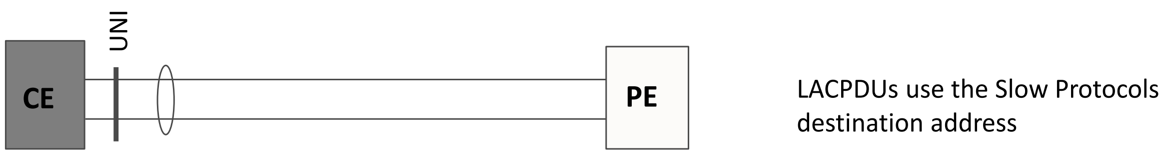

Figure 8 – Basic Link Aggregation at a UNI

LACPDUs generated by a LACP instance at a UNI are untagged. A tagged LACPDU with the Slow Protocols destination address is discarded by the protocol entity.

B.1.2 Peering LACP at a ENNI

MEF 26.1 requires peering of LACP on physical links for an ENNI with two links. In this case LACP is listed as being Peered in the ENNI L2CP Peering Service Attribute. When LACP is peered at an ENNI, the Slow Protocols destination address is used ([R14]). This provides the basic aggregation of two physical links shown in Figure 9.

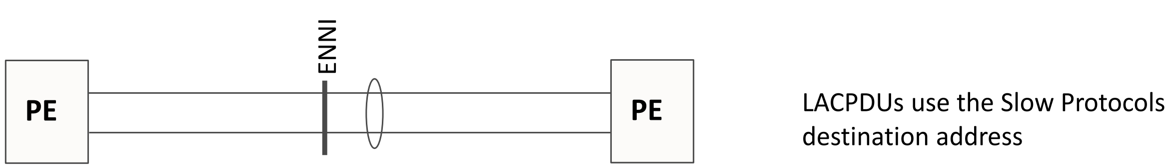

Figure 9 – Basic Link Aggregation at an ENNI

LACPDUs generated by a LACP instance at an ENNI are untagged. Ingress LACPDUs at an ENNI that have an S-VLAN tag will not be delivered to a LACP protocol entity by the processes and requirements specified in section 9. Any such frames that were not generated in error will have resulted from ingress LACPDUs at a UNI. In the absence of errors these frames either have the Nearest Customer Bridge destination address or are on an EPL service with EPL Option 2 L2CP processing. In these cases the frames are Passed by the processes and requirements specified in section 9. In all other cases S-tagged LACPDUs are either Passed or Discarded by the processes and requirements specified in section 9.

B.1.3 LACP and EPL Option 2 L2CP processing

EPL Option 2 L2CP processing recommends that LACPDUs with the Slow Protocols destination address are Passed at all UNIs. This conflicts with the requirement to use Link Aggregation with LACP on a UNI with two links. Therefore if LACPDUs with the Slow Protocols destination address are Passed at the UNI, the UNI can only have a single link and LACP is not listed as being peered in the UNI L2CP Peering Service Attribute. Conversely, if the UNI has two links then LACP is listed as being peered in the UNI L2CP Peering Service Attribute and LACPDUs with the Slow Protocols destination address are not Passed.

B.1.4 Aggregation of EPL services

Figure 10 shows an example of a Subscriber using Link Aggregation to aggregate EVCs. Because Link Aggregation is only intended to operate on point-to-point links between the same systems, these EVCs are point-to-point EVCs between All-to-One Bundled UNIs (i.e. they are EPL services). In this case only the CEs need to be running LACP and the PEs do not participate. Therefore LACP is not listed as being Peered in the UNI L2CP Peering Service Attribute. The LACP instances in the CEs use the Nearest Customer Bridge destination address so that the LACPDUs will pass through the CEN. If the EVCs are EPL services with EPL Option 2 L2CP processing that Pass LACPDUs with the Slow Protocols destination address, then the CE can use the Slow Protocols destination address instead.

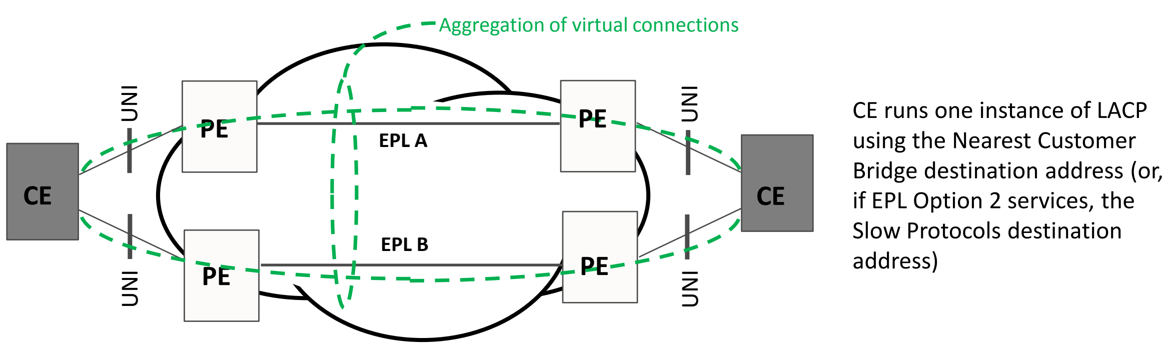

Figure 10 – Link Aggregation of EPL Services

It is possible to aggregate EVCs where one or more of the UNIs are protected by Link Aggregation on the physical links as shown in Figure 11. In this case the CE runs two instances of LACP, one using the Slow Protocols destination address and one using the Nearest Customer Bridge destination address. LACP is listed as being Peered in the UNI L2CP Peering Service Attribute, and the PE runs one instance of LACP using the Slow Protocols address. From the Service Provider point of view this is no different than the basic Link Aggregation at a UNI shown in Figure 8.

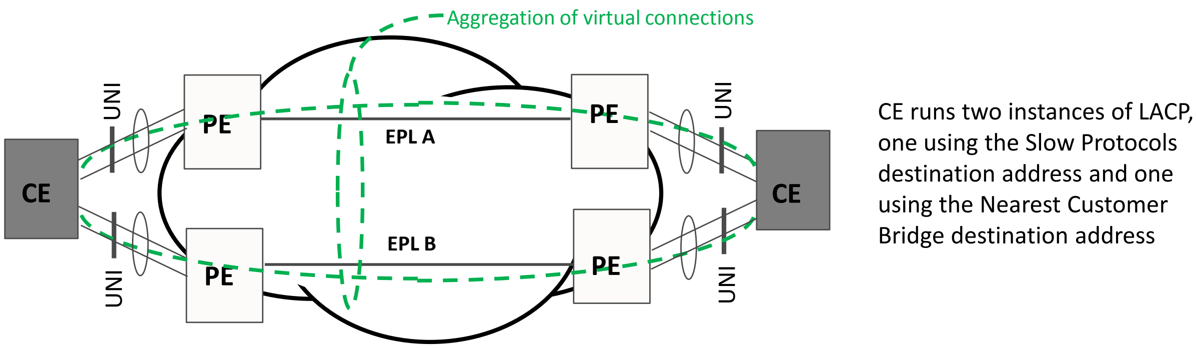

Figure 11 – Link Aggregation of EPL services with protected UNIs

B.1.5 Configuring Link Aggregation for Active/Standby operation

MEF 10.3 and MEF 26.1 require that LACP at a UNI or ENNI operates in active/standby mode. 802.1AX will designate links in an aggregation as active or standby when device limitations prevent all links from being active simultaneously, however there is no standard management object that allows an operator to explicitly configure active/standby operation. Some devices have private management objects that either specify active/standby operation directly, or allow setting the maximum number of active links in an aggregation to one. In either of these cases the primary link can be designated by the setting of the port priority value. It is sufficient to configure active/standby operation in just one of the devices in the aggregation, so at a UNI it is typically configured in the PE.

An alternative way to achieve active/standby operation is to use a distribution algorithm that transmits all frames on one link in the aggregation. Whether this distribution algorithm is supported, and how it is configured, is device specific.