MEF Standard

MEF 47.1

Elastic Ethernet Services & Cloud Connectivity

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1 List of Contributing Members

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2 Abstract

This MEF Standard describes and defines Elastic Ethernet Services. These are Ethernet Services, described using the Service Attributes defined in MEF 10.4 [5] or in MEF 26.2 [8], that include the capability for modifying the values of selected Service Attributes within a short Maintenance Interval. The Service Attributes that can be modified in this way – termed Elastic Service Attributes – are identified. Additional Service Attributes for Elastic Ethernet Services are defined, including some that place constraints on the values to which Elastic Service Attributes can be modified.

Additionally, specific Elastic Ethernet Services are defined, based on the Ethernet Services defined in MEF 6.3 [4] and MEF 51.1 [11], to support connectivity for Cloud Services. This connectivity for Cloud Services falls into two broad categories: 1) Cloud Interconnect, and 2) Cloud Access. Connectivity for Cloud Services is addressed for a single Cloud Service Provider (Cloud SP), using one or more Ethernet Services and one or more Cloud Services provided by one or more Cloud Operators. Additional requirements for these specific cloud connectivity services are specified.

3 Terminology and Abbreviations

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 10.4 [5], MEF 26.2 [8], MEF 6.3 [4], MEF 45.1 [9], MEF 51.1 [11], MEF 23.2 [6], MEF 23.2.1 [7], and MEF 55 [12] are included in this document by reference and, hence, not repeated in table below.

Term	Definition	Reference
Accepted Service Modification Request	A Valid Service Modification Request whose requested changes the Ethernet SP or Operator has committed to fulfill.	This document
Cloud Access	The use of a connectivity service to connect one or more sites of one or more Cloud Subscribers, to one or more sites of one or more Cloud Operators.	This document
Cloud Interconnect	The use of a connectivity service to connect two or more Cloud Operator locations.	This document
Cloud Operator	An organization or entity that provides Cloud Services to Cloud Service Providers or other Cloud Operators.	This document
Cloud Service Provider	A person, organization or entity that provides Cloud Services to Cloud Subscribers.	This document
Cloud Service	A service comprising one or more components such as compute, storage, or applications, and connectivity among them, that may be accessed by the user of the service from one or more locations.	This document
Cloud Subscriber	The end-user of a Cloud Service.	This document
Cloud SP	Cloud Service Provider.	This document
Ethernet SP or Operator	An Ethernet SP or an Ethernet Operator that provides Elastic Ethernet Services.	This document
Elastic	An adjective used to indicate the capability to modify an active service by changing the value of one or more Service Attributes within a short Maintenance Interval.	This document
Elastic Ethernet Service	An Ethernet Service defined using the Service Attributes in MEF 10.4 [5] or MEF 26.2 [8], as well as the Service Attributes defined in this standard, and which has at least one Elastic Ethernet Service Attribute.	This document
Elastic Ethernet Service Attribute	A Service Attribute that is Elastic.	This document
Elastic Subscriber Ethernet Cloud Connectivity Service	An Elastic Subscriber Ethernet Service that is based on MEF 6.3 [4] services and complies with the requirements in Section 11.1.	This document
Elastic Subscriber Ethernet Service	An Elastic Ethernet Service that is based on MEF 10.4 [5] Service Attributes.	This document
Elastic Operator Ethernet Cloud Connectivity Service	An Elastic Operator Ethernet Service that is based on MEF 51.1 [11] services and complies with the requirements in Section 11.2.	This document
Elastic Operator Ethernet Service	An Elastic Ethernet Service that is based on MEF 26.2 [8] Service Attributes.	This document

Term	Definition	Reference
Envelope Aggregate CIR	The sum of CIR values over all the Bandwidth Profile Flows in the Envelope.	This document
Invalid Service Modification Request	A Service Modification Request that was declared *Invalid*.	This document
Modification Maintenance Interval	The Maintenance Interval during which changes requested in a Service Modification Request are attempted to be made.	This document
Notification	Information that is passed from the Ethernet SP or Operator to the Requestor.	This document
Request	Information that is passed from the Requestor to the Ethernet SP or Operator.	This document
Request Time	The UTC time specified to the second that the Service Modification Request is received by the Ethernet SP or Operator.	This document
Requestor	The user of the Elastic Ethernet Service (that is, the party acting as the Ethernet Subscriber for an Elastic Subscriber Ethernet Service or as the Ethernet SP/SO for an Elastic Operator Ethernet Service).	This document
Service Modification Request	Request sent by a Requestor to the Ethernet SP or Operator to set one or more of the Elastic Ethernet Service Attributes values for a given Elastic Ethernet Service.	This document
Valid Service Modification Request	A Service Modification Request that was declared *Valid*.	This document

Table 1 – Terminology and Abbreviations

4 Introduction

This standard defines Elastic Ethernet Services, focusing particularly on their use for cloud connectivity, i.e. connectivity to and between Cloud Services. Elastic is an adjective used to indicate the capability to modify an active service by changing the value of one or more Service Attributes within a short Maintenance Interval.

Cloud Services allow the scaling up and down of resources, such as storage or computing, within a short interval. This rapid scaling leads to a desire for similar rapid changes to connectivity properties. Users of Cloud Services can use connectivity to access the services. Connectivity can also be used to implement Cloud Services, for example, to access Cloud Service functionality at appropriate locations. This connectivity is expected to make use of rapid modifications during its use so as to, for example, align with rapid changes in the behaviors of Cloud Services.

Ethernet Services can be used for connectivity for Cloud Services. Such Ethernet Services, with additional behaviors specified in this standard, can be valuable to the users and implementers of Cloud Services.

In particular Elastic Ethernet Services allow the desired rapid modification of selected Service Attribute values as described in this standard.

The Ethernet Subscriber, for Subscriber Ethernet Services, or SP/SO, for Operator Ethernet Services, can request modification of these Service Attribute values to meet the changing demands of the Cloud Services supported by an Ethernet Service. Since some traffic impact might be unavoidable as network functions are reconfigured, a Service Attribute value is modified in a Maintenance Interval (MEF 10.4 [5], MEF 26.2 [8]) during which service performance is not considered when evaluating whether the Service Level Specification (SLS) objectives have been met. Thus, the potential traffic impact caused by network reconfiguration does not affect the SLS. The new Service Attribute values remain in effect for a specified duration or until request(s) for another modification is received. MEF 55 [12] defines Service Control as the ability for the service to be dynamically changed within specific bounds described in policies that are established at the time of ordering. A service can be dynamically changed if the Service Attribute values can be modified rapidly within a short Maintenance Interval.

This standard addresses the need for Elastic Ethernet Services in the context of cloud connectivity by defining Elastic Ethernet Services in general, and then by defining specific Elastic Ethernet Cloud Connectivity Services. Section 7 gives more detail on the cloud connectivity use cases and how Elastic Ethernet Services can be used in the context of Cloud Services. Sections 8, 9 and 10 define Elastic Ethernet Services generally, by specifying additional Service Attributes and defining the externally visible behavior relating to requesting and enacting Elastic changes to Service Attribute values. Section 11 defines the specific Elastic Ethernet Cloud Connectivity Services.

While the focus of this standard is on the use of Elastic Ethernet Cloud Connectivity Services, the use of Elastic Ethernet Services for other purposes is not precluded.

This standard supersedes MEF 47 [10].

5 Compliance Levels

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 BCP 14 (RFC 2119 [2], RFC 8174 [3]) when, and only when, they appear in all capitals, as shown here. 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.

A paragraph preceded by **[CR*a*]<** specifies a conditional mandatory requirement that **MUST** be followed if the condition(s) following the "<" have been met. For example, "**[CR1]<[D38]**" indicates that Conditional Mandatory Requirement 1 must be followed if Desirable Requirement 38 has been met. A paragraph preceded by **[CD*b*]<** specifies a Conditional Desirable Requirement that **SHOULD** be followed if the condition(s) following the "<" have been met. A paragraph preceded by **[CO*c*]<** specifies a Conditional Optional Requirement that **MAY** be followed if the condition(s) following the "<" have been met.

6 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 2.

Decimal		**Binary**	
Symbol	Value	Symbol	Value
k	**10^3**	**Ki**	**2^{10}**
M	**10^6**	**Mi**	**2^{20}**
G	**10^9**	**Gi**	**2^{30}**
T	**10^{12}**	**Ti**	**2^{40}**
P	**10^{15}**	**Pi**	**2^{50}**
E	**10^{18}**	**Ei**	**2^{60}**
Z	**10^{21}**	**Zi**	**2^{70}**
Y	**10^{24}**	**Yi**	**2^{80}**

Table 2 – Numerical Prefix Conventions

7 Cloud Connectivity Using Elastic Ethernet Services

A Cloud Service is defined as a service comprising one or more components such as compute, storage, or applications, and connectivity among them, that may be accessed by the user of the service from one or more locations. The end-user of a Cloud Service is called a Cloud Subscriber. A person, organization or entity that provides Cloud Services to Cloud Subscribers is called a Cloud Service Provider. An organization or entity that provides Cloud Services to Cloud Service Providers or other Cloud Operators is called a Cloud Operator.

A Cloud Service Provider may implement a Cloud Service by subcontracting with other organizations, either for Cloud Services provided by a Cloud Operator, or for connectivity services. If Ethernet Services are used to provide connectivity, then the connectivity is provided by an Ethernet Service Provider (Ethernet SP) (if it provides a Subscriber Ethernet Service) or an Ethernet Operator (if it provides an Operator Ethernet Service).

While the Cloud Service Provider (Cloud SP) can be treated as a distinct party from the Cloud Subscriber or any Cloud Operators, in practice it describes a role that can be played by any of these, or by a third party. Figure 1 illustrates three possibilities.

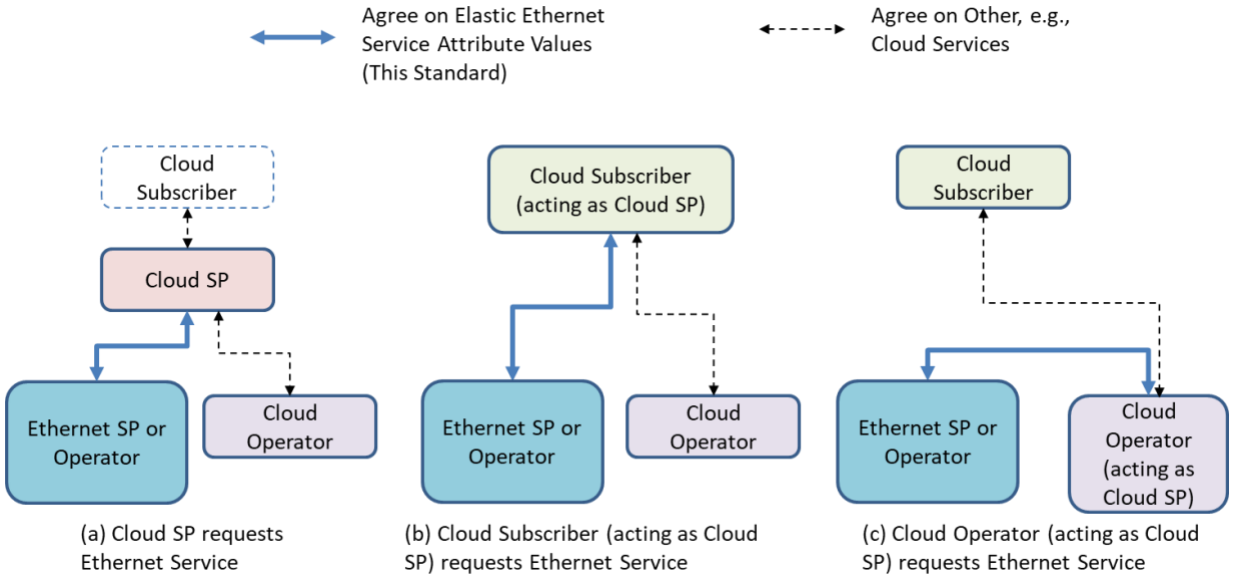


Figure 1 – Parties in Cloud & Elastic Ethernet Services

Figure 1 (a) shows a case where the Cloud SP is a separate entity to any of the other parties involved in the Cloud Service. The term Ethernet SP or Operator is defined as an Ethernet SP or an Ethernet Operator that provides Elastic Ethernet Services. The Cloud SP creates the Cloud Service for the Cloud Subscriber by agreeing on a Cloud Service with a Cloud Operator, and agreeing on an Elastic Ethernet Service with an Ethernet SP or Operator to connect the Cloud Subscriber to the Cloud Operator. Figure 1 (b) shows a case where the Cloud Subscriber acts as the Cloud SP, i.e. the Cloud Subscriber separately agrees on a Cloud Service with a Cloud Operator, and an Elastic Ethernet Service with an Ethernet SP or Operator to provide

connectivity to that Cloud Service. Figure 1 (c) shows a case where a Cloud Operator acts as the Cloud SP and agrees to an Elastic Ethernet Service with an Ethernet SP or Operator to provide connectivity between the Cloud Operator and the Cloud Subscriber. This standard is focused on defining Elastic Ethernet Services that can be used in any of these cases. In the interest of simplicity, Figure 1 only shows a single instance of an Ethernet SP or Operator, a single instance of a Cloud Subscriber, and a single instance of a Cloud Operator. In all cases there can multiple instances of Ethernet SPs or Operators, and/or Cloud Subscribers, and/or Cloud Operators.

For an Elastic Ethernet Service agreed on between a Cloud SP and an Ethernet SP, the Ethernet SP provides services based on MEF 10.4 [5] with UNIs as the points of demarcation. The Cloud SP acts as the Ethernet Subscriber.

For an Elastic Ethernet Service agreed on between a Cloud SP and an Ethernet Operator, an Ethernet Operator provides services based on MEF 26.2 [8] associating UNIs and/or ENNIs as the points of demarcation. The Cloud Operator typically has at least one ENNI demarcation to the Ethernet Operator. The Cloud Subscriber typically has one or more UNI demarcations to the Ethernet Operator. The Cloud SP acts as the Ethernet SP/SO (MEF 26.2 [8]). The Ethernet Operator can act as an Ethernet Super Operator and, in turn, can agree on Operator Ethernet Services from other Ethernet Operators.

Section 7.1 describes, in general, use cases of Elastic Ethernet Services being used for cloud connectivity. Section 7.2 describes the application of Elastic Ethernet Services to these use cases in more detail.

7.1 Cloud Connectivity Use Cases for Elastic Ethernet Services

There are two use cases covered by this MEF Standard as shown in Figure 2:

- Cloud Access addresses Elastic Ethernet Service between Cloud Subscriber(s) and Cloud Operator(s) as shown in Figure 2 (a).

- Cloud Interconnect addresses the need for Elastic Ethernet Service between Cloud Operators as shown in Figure 2 (b).

As described in MEF 10.4 [5] and MEF 26.2 [8], an Ethernet Service connects External Interfaces (i.e., UNIs and ENNIs). One such External Interface is where the Ethernet SP or Operator connects to the Cloud Operator; another is where the Ethernet SP or Operator connects to a Cloud Subscriber.

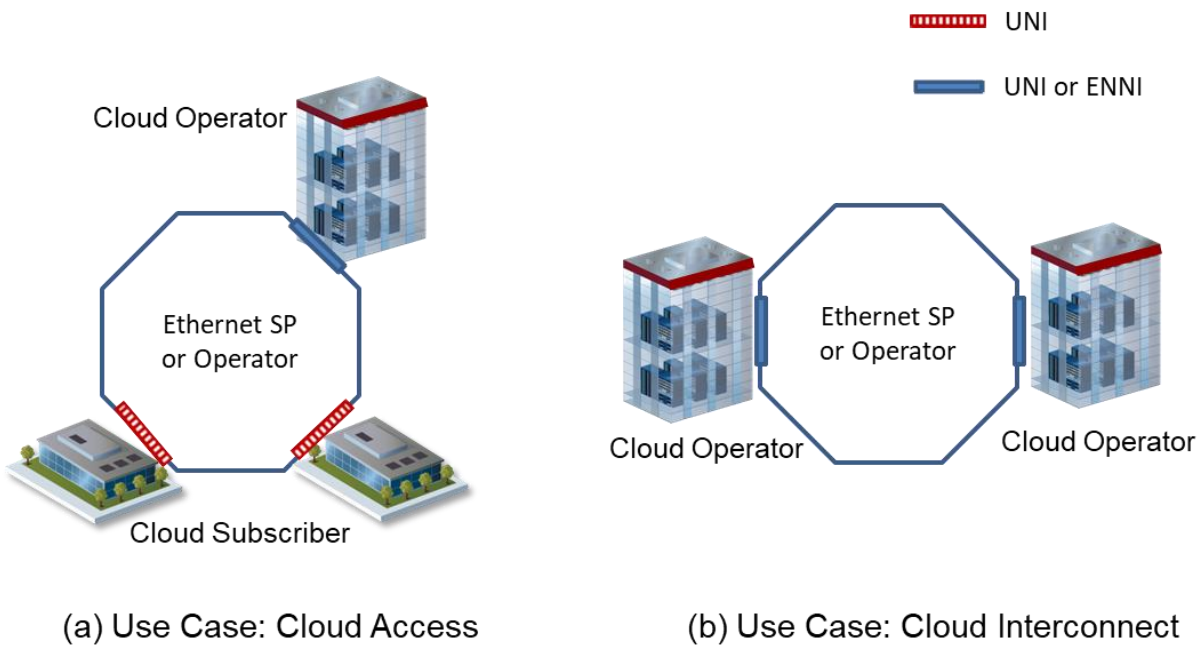


Figure 2 – Cloud Connectivity Use Cases

In both of these use cases, the services have Elastic behavior for some of the Ethernet Service Attributes. After an Ethernet service is established, each Elastic Ethernet Service Attribute, defined as a Service Attribute that is Elastic, can be modified rapidly from time to time. As an example, for Service Control (MEF 55, [12]), the Cloud SP can request modification of Elastic Ethernet Service Attributes via a Service Control API across MEF 55 Management Interface Reference Points. The Management Interface Reference Points used to request modification of Elastic Ethernet Service Attribute values are shown in Figure 2 in MEF 55 [12] with high level interactions as outlined in Table 5 in MEF 55 [12]. However, this standard does not mandate the use of a particular Service Control API.

7.1.1 Cloud Access Use Case

Cloud Access is defined as the use of connectivity service to connect one or more sites of one or more Cloud Subscribers, to one or more sites of one or more Cloud Operators. The ability to quickly change the values of the Service Attributes for these services, to address various aspects of the application traffic requirements, is useful for this use case. For example, for a database transfer, the mapping of frames to Class of Service Names by the Ethernet SP or Operator can be quickly changed to meet the needed performance.

Elastic Ethernet Cloud Connectivity Services defined in Section 11 of this standard are well suited for Cloud Access.

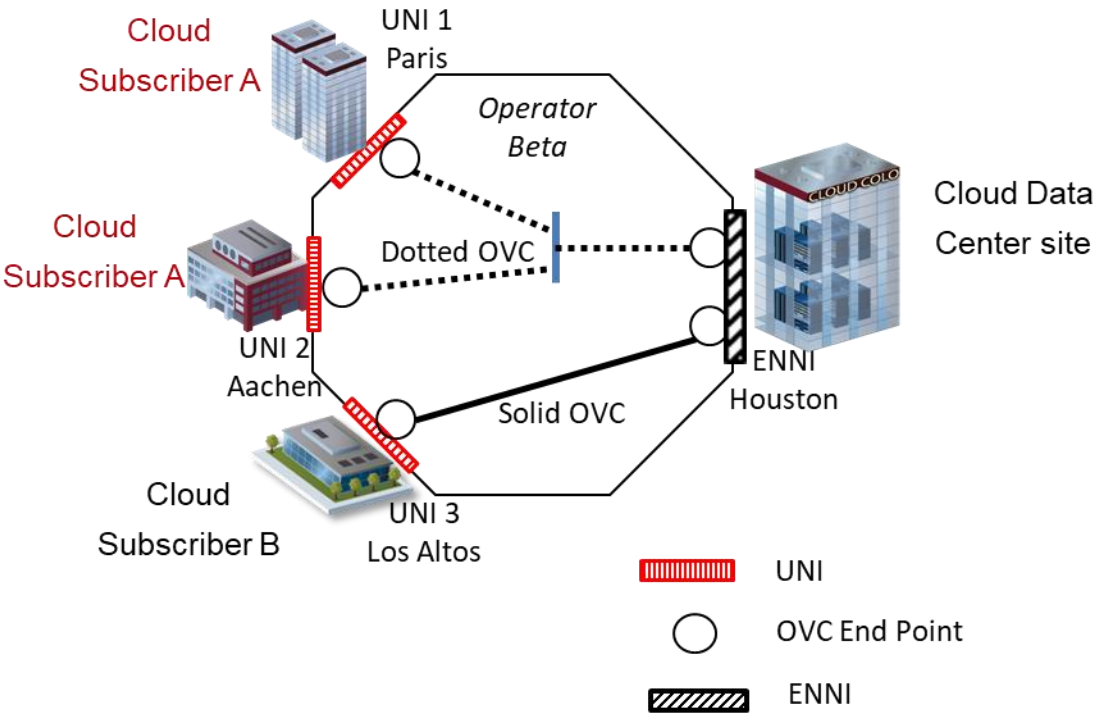


Figure 3 – Cloud Access Example using Elastic Operator Ethernet Services

Figure 3 shows, as an example, Ethernet Operator Beta providing two Elastic Operator Ethernet Services each associating UNI(s) and one ENNI. In this example, for each Elastic Operator Ethernet Service shown in Operator Beta's network, the Cloud Operator is acting as the Cloud SP, and therefore is the organization that agrees on the Elastic Ethernet Service with Ethernet Operator Beta, as shown in (c) of Figure 1. The Cloud Operator and Operator Beta are shown as interconnecting at an ENNI. Cloud Subscriber A's sites UNI 1 (Paris) and UNI 2 (Aachen) are associated with ENNI (Houston) at the Cloud Data Center site using the Multipoint-to-Multipoint OVC type (Dotted OVC). The Cloud Subscriber B's site UNI 3 (Los Altos) is associated with the same ENNI (Houston) using the Point-to-Point OVC type (Solid OVC).

Note that in the example shown in Figure 3, there is no Subscriber Ethernet Service (i.e. UNI to UNI over an EVC) because the scope of Ethernet Service required is only up to the ENNI with the Cloud Operator. How the Cloud Operator associates this ENNI to the Cloud Services, e.g., virtual machines, in their domain is outside the scope of this standard.

See Appendix A for a detailed example of the Elastic Ethernet Services based on MEF 6.3 [5] Subscriber Ethernet Services (EVP-Tree) for the Cloud Access use case.

7.1.2 Cloud Interconnect Use Case

Cloud Interconnect is defined as the use of connectivity service to connect two or more Cloud Operator locations. Cloud Interconnect using Elastic Ethernet Service is well suited for handling occasional surges in traffic due to such things as database transfers. One Class of Service Name, e.g., "normal", can include application interactions between data centers and continuous synchronization of distributed/redundant databases. Another Class of Service Name, e.g.,

"surge", can include moving virtual machines from one data center to another or copying large datasets for backup. These occasional surges create a temporary demand for increased bandwidth as well as mapping frames to a different Class of Service Name to obtain the connectivity performance required by the application interaction. Such a service interconnecting the data centers can enable faster and more reliable (e.g., low delay and low loss) completion of the transfer.

Elastic Ethernet Cloud Connectivity Services defined in Section 11 of this standard are well suited for Cloud Interconnect.

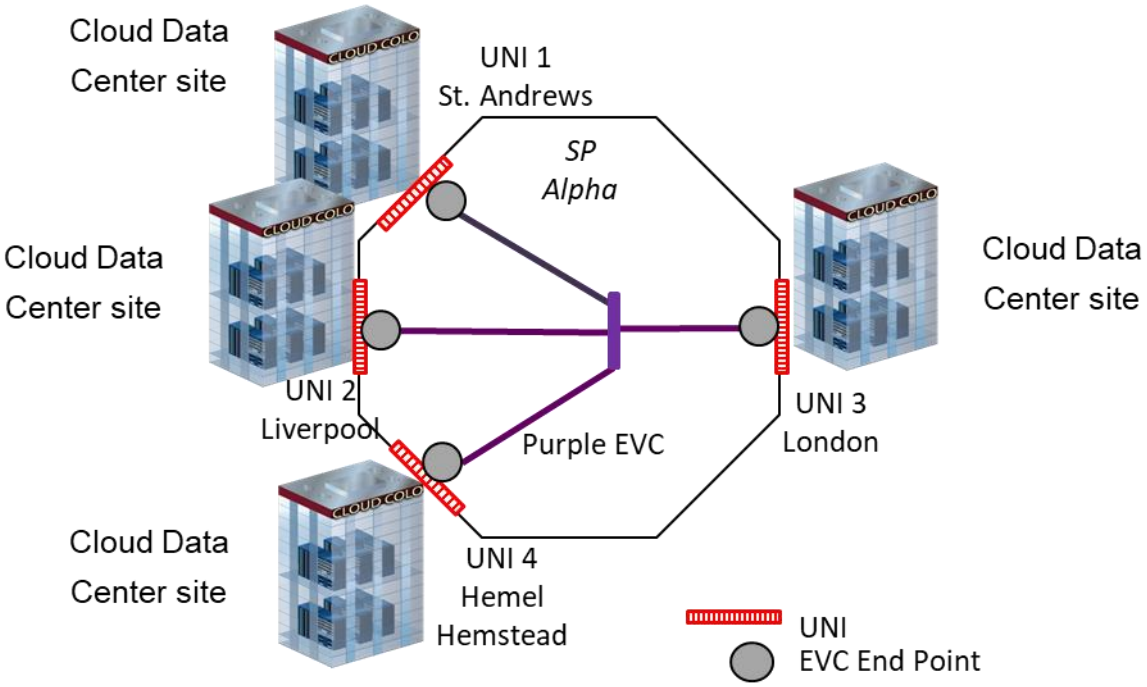


Figure 4 – Cloud Interconnect Example using Elastic Subscriber Ethernet Services

Figure 4 shows, as an example, an Elastic Subscriber Ethernet Service using an E-LAN Service Type with the "Purple EVC" associating EVC EPs at UNIs 1 through 4 where SP Alpha has demarcation points with the Cloud Operator. In this example, the Cloud Operator is acting as the Ethernet Subscriber negotiating Elastic Subscriber Ethernet Service as shown in (c) of Figure 1.

See Appendix B for an example of the Elastic Ethernet Services based on MEF 6.3 [5] Subscriber Ethernet Services (EPL) for the Cloud Interconnect use case.

7.2 Using Elastic Ethernet Services in Cloud Services

This section describes the use of Elastic Ethernet Cloud Connectivity Services. Elastic Ethernet Cloud Connectivity Services are formally defined in Section 11. The relevant cloud connectivity uses cases are as discussed in Section 7.1. Specific services and requirements for these services are defined in Section 11.

7.2.1 Elastic Subscriber Ethernet Services in Cloud Services

Elastic Ethernet Services based on MEF 6.3 [4] Subscriber Ethernet Services can be used in either Cloud Access or Cloud Interconnect use cases. Figure 5 shows an example where a Cloud Operator is acting as the Cloud SP per Figure 1 (c), and agrees on an Elastic Subscriber Ethernet Service with an Ethernet SP. The Cloud Operator is therefore acting as the Ethernet Subscriber. Figure 5 shows examples for both Cloud Access, using the Multipoint-to-Multipoint Dotted EVC, and Cloud Interconnect, using the Point-to-Point Solid EVC.

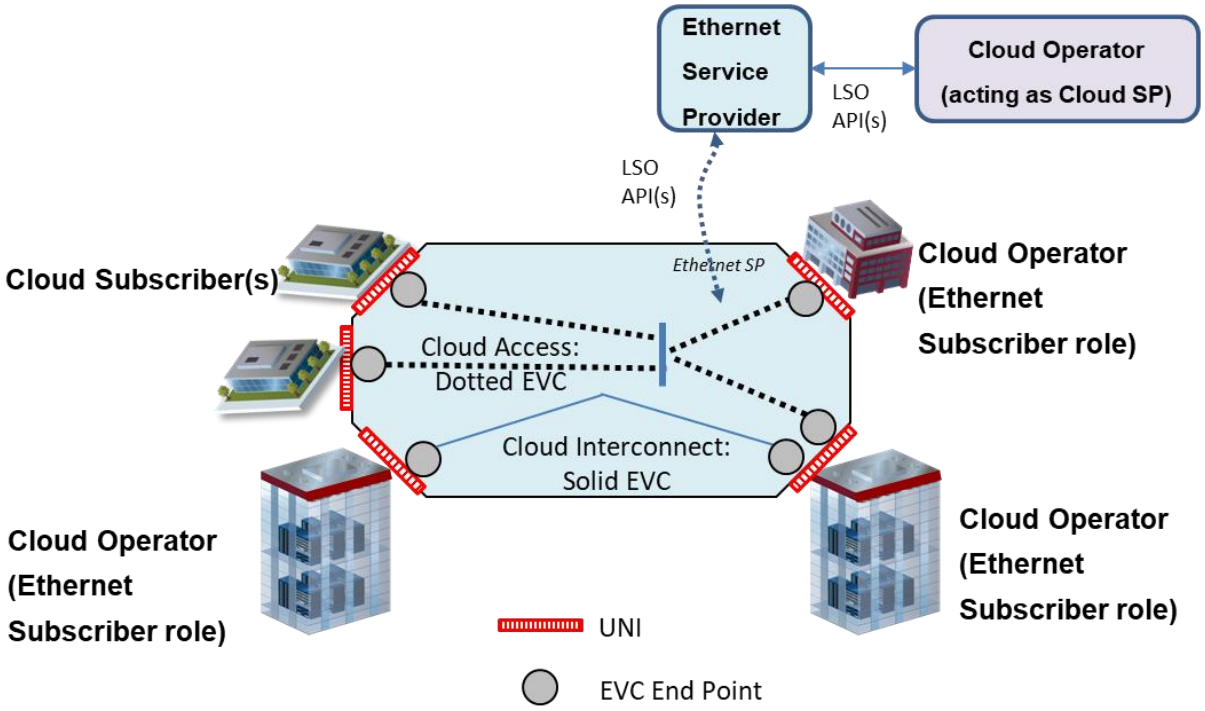


Figure 5 – Example of Elastic Subscriber Ethernet Services

Elastic Ethernet Cloud Connectivity Services provide Elastic behavior for certain Service Attributes as specified in this standard (e.g., the ability to rapidly change a *CIR* value or a Class of Service Name mapping) to allow the Cloud SP to adjust the service to meet varying traffic requirements between the sites. As an example, Figure 5 shows the values of the Elastic Ethernet Service Attributes of the services being controlled via LSO APIs for Service Control (Cantata or Allegro reference points, MEF 55 [12]) between the Cloud SP and the Ethernet SP.

7.2.2 Elastic Operator Ethernet Services in Cloud Services

Elastic Ethernet Services based on MEF 51.1 [11] Operator Ethernet Services can be used in either Cloud Access or Cloud Interconnect use cases. Figure 6 shows an example where a Cloud SP agrees on two Elastic Operator Ethernet Services with an Ethernet Operator. One service is a Multipoint-to-Multipoint OVC used for Cloud Access, and another is a point-to-Point OVC used for Cloud Interconnect. In this example, Operator B is an Ethernet Operator while the Cloud SP can be seen as acting as an Ethernet SP/SO (MEF 26.2 [8]) negotiating Elastic Operator Ethernet Service with Operator B. Additionally, there is no party acting as an Ethernet Subscriber because there is no EVC associating only UNIs.

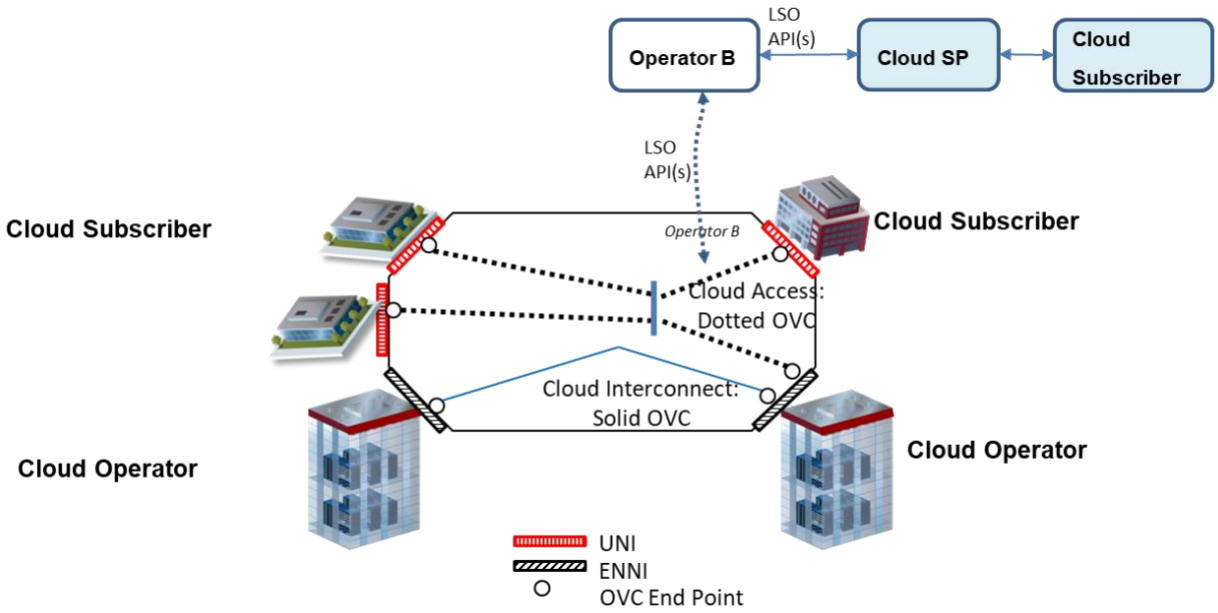


Figure 6 – Example of Operator Ethernet Services with ENNI at Cloud Operator

Figure 7 shows services across two Ethernet Operators with examples for both Cloud Access and Cloud Interconnect. Cloud Access uses the Multipoint-to-Multipoint Dotted OVC in the Operator B network and the Purple Dotted Point-to-Point OVCs in the Operator A network. Cloud Interconnect uses the Point-to-Point Blue Solid OVC in the Operator B and the Point-to-Point Red Solid OVC in the Operator A network. Additionally, the Cloud SP per Figure 1 (c) is responsible for coordinating the Service Attribute values with the Ethernet Operators to use MEF 51.1 [11] E-Access and/or E-Transit service(s) to meet the required service behaviors. A transit network providing ENNI-to-ENNI E-Transit services could be used to further extend the reach. Additionally, there is no party acting as an Ethernet Subscriber because there is no EVC associating only UNIs.

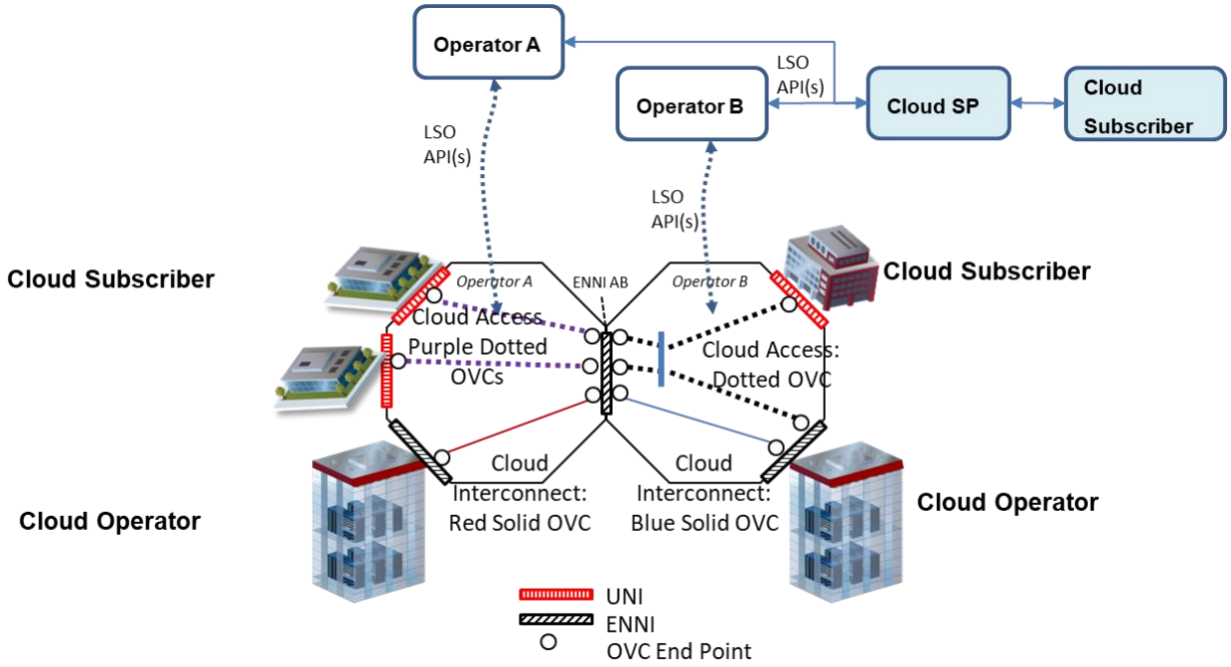


Figure 7 – Example of Elastic Operator Ethernet Services from Two Operators

Elastic Ethernet Cloud Connectivity Services provide Elastic behavior for certain Service Attributes as specified in this standard (e.g., the ability to rapidly change a *CIR* value or a Class of Service mapping) to allow the Cloud SP to adjust the service to meet varying traffic requirements between the sites. As an example, Figure 6 and Figure 7 show the Elastic Ethernet Service Attributes of the service being controlled via LSO APIs for Service Control (Sonata or Interlude reference points, MEF 55 [12]) between the Cloud SP and the Ethernet Operators. The Cloud SP can request modifications to the Operator Service(s) at any time. For example, the Cloud SP can request changes to the Operator Service(s) in advance to prepare for the Cloud Services modification.

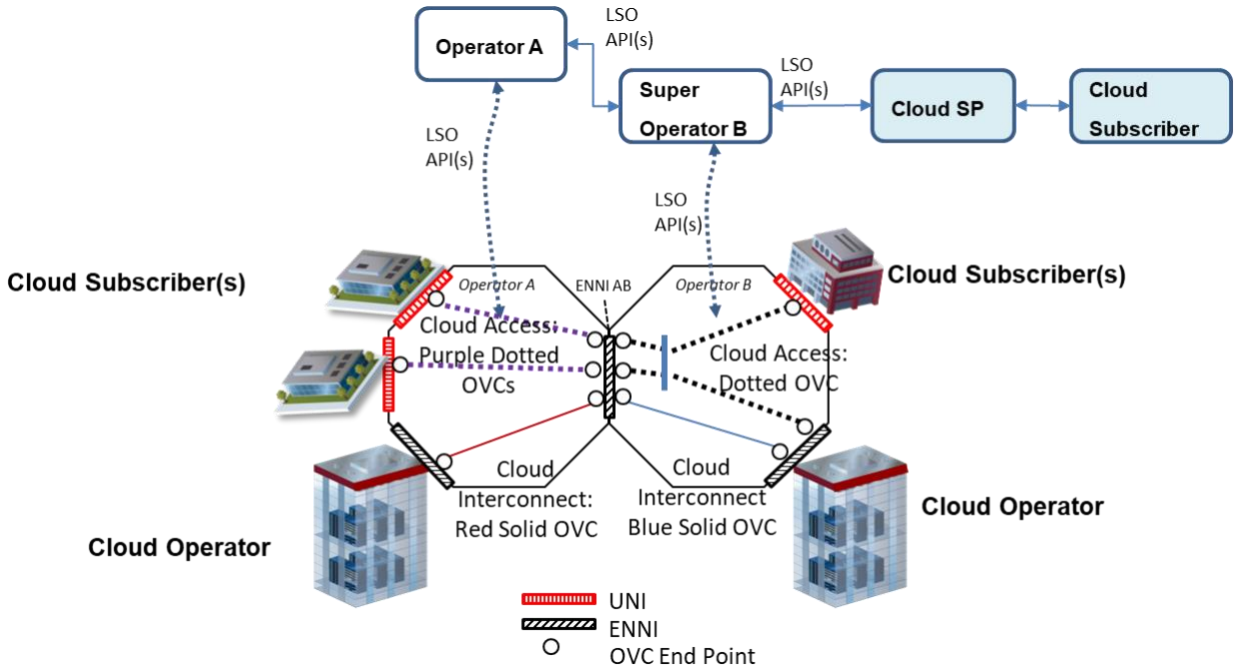


Figure 8 – Example of Elastic Operator Ethernet Services from Super Operator

Figure 8 illustrates the same scenario as depicted in Figure 6, but shows additionally that Operator B is acting as an Ethernet Super Operator and has sub-contracted with another Ethernet Operator, Operator A, to implement the Elastic Ethernet Services provided to the Cloud SP. Operator B might use LSO APIs for Service Control (Sonata or Interlude reference points, MEF 55 [12]) to control the corresponding Elastic Ethernet Service Attributes of the Operator Ethernet Service provided by Operator A. Operator B can request modifications to the Operator Ethernet Service(s) provided by Operator A at any time. For example, if a modification to an Operator Ethernet Service provided by Operator B to the Cloud SP is scheduled to increase the *CIR* at a given time, Operator B can request Ethernet Operator A to modify their Operator Ethernet Service in advance, to prepare for the scheduled modification to Operator B's service. Similarly, if Operator B receives a request from the Cloud SP to reduce the *CIR*, they can make the modifications in their domain while requesting changes in the Operator Ethernet Service provided by Operator A to reduce *CIR* for that service at a later time.

8 Elastic Ethernet Services

An Elastic Ethernet Service is an Ethernet Service defined using the Service Attributes in MEF 10.4 [5] or MEF 26.2 [8], as well as the Service Attributes defined in this standard, and which has at least one Elastic Behavior Service Attribute defined in Section 9 having a value other than *None*.

This standard defines a general class of Elastic Ethernet Services, as well as two specific Elastic Ethernet Services, for cloud connectivity. This section gives an overview of Elastic Ethernet Services and how Service Attribute values can be modified.

This standard specifies requirements for Elastic Ethernet Services using additional Service Attributes. Section 9 defines additional Service Attributes used for Elastic Ethernet Services, and Section 10 describes the behavior in more detail. The External Interface between the Ethernet SP or Operator and a Cloud Operator can be either a UNI or an ENNI. The choice might be based on the type of service identifier required, i.e., C-Tag VLAN ID at a UNI versus S-Tag VLAN ID at an ENNI.

An Elastic Ethernet Service that is based on MEF 10.4 [5] Service Attributes is called an Elastic Subscriber Ethernet Service. Such a service is agreed on between an Ethernet SP and a party acting as an Ethernet Subscriber. An Elastic Ethernet Service that is based on MEF 26.2 [8] Service Attributes is called an Elastic Operator Ethernet Service. Such a service is agreed on between an Ethernet Operator and a party acting as an Ethernet SP/SO. For ease of exposition, in this standard the user of the Elastic Ethernet Service (that is, the party acting as the Ethernet Subscriber for an Elastic Subscriber Ethernet Service or as the Ethernet SP/SO for an Elastic Operator Ethernet Service) is referred to as the Requestor.

[R1] An Elastic Ethernet Service **MUST** have values agreed on for the additional Service Attributes defined in this standard.

[R1] means that the set of Service Attribute values that need to be agreed on for an Elastic Ethernet Service comprises values for the Service Attributes defined in MEF 10.4 [5] or MEF 26.2 [8], combined with values for the Service Attributes defined in this standard.

8.1 Service Modification Requests

A Service Modification Request is sent by a Requestor to the Ethernet SP or Operator to set one or more of the Elastic Ethernet Service Attribute values for a given Elastic Ethernet Service. A value that is requested might or might not reflect a change from the value in force at the Request Time (Section 8.1.1). However, for simplicity, the remainder of this standard usually describes a Service Modification Request as “modifying” or “changing” one or more Service Attribute values.

Each Service Modification Request is validated to ensure it is well formed and conforms to the constraints associated with the service. If a Service Modification Request is accepted, the necessary configuration changes are scheduled. The Requestor is notified when the changes are

scheduled to start and when they have been completed. If the change cannot be completed for any reason the Requestor is so notified.

A Service Modification Request is made to set the value of one or more of the Service Attributes listed in the Elastic Behavior Service Attributes defined in Sections 9.1.1.1, 9.1.2.1, 9.2.1.1 and 9.2.3.1 and subject to the agreed values of the Service Attributes defined in Section 9.3. A Service Modification Request includes information that identifies the Service instance being modified and may also include additional information, e.g., a unique identifier for the Service Modification Request. Such additional information is beyond the scope of this standard.

Changes done by means other than Service Modification Requests are outside the scope of this standard.

A Service Modification Request can be made using any appropriate communication vehicle acceptable to the Requestor and the Ethernet SP or Operator. One example is the use of a web portal that the Requestor uses to fill in an electronic form. Another example is a Service Modification Request that could be executed via an LSO API. The details of how a Service Modification Request is communicated are beyond the scope of this standard.

An Elastic Behavior Service Attribute value modification can be scheduled to occur at a set time in the future or it can be requested to occur as soon as possible. As can be seen from Section 8.2, there can be one or more changes to the value of an Elastic Service Attribute resulting from a single Service Modification Request.

Each Service Modification Request always contains a *Connection ID* parameter (Section 8.1.2), a *Request Type* parameter (Section 8.1.3), and a *Start Time* parameter (Section 8.1.4). Depending on the value of the *Request Type* parameter, a Service Modification Request can have a *Revert Time* parameter (Section 8.1.5) and/or a *Period* parameter (Section 8.1.6). In addition, each Service Modification Request is associated with a Request Time (Section 8.1.1) specified to the second, which is the UTC time that the Service Modification Request is received by the Ethernet SP or Operator. These five parameters and the Request Time are described in the following subsections. Note that these parameters are in addition to other information included in the Request, such as identifying which Service Attributes are being modified, the values for those Service Attributes, and the identification of the entities (UNIs, EVC EPs, ENNIs, OVC End Points, etc.) to which the Service Modification Request applies. A requested value for a Service Attribute in a Service Modification Request needs to completely specify the Service Attribute value. For example, for the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute, (Section 10.9 in MEF 10.4 [5]), the values for all of the parameters, $\langle CIR, CIR_{max}, CBS, EIR, EIR_{max}, EBS, CF, CM, ER, F\rangle$ need to be specified for all of the Class of Service Names listed in the value of the Service Attribute, even if the intent is to change only one of these parameters.

A Service Modification Request is declared *Valid* or *Invalid* by the Ethernet SP or Operator. A Service Modification Request that was declared *Valid* is called a Valid Service Modification Request. A Service Modification Request that was declared *Invalid* is called an Invalid Service Modification Request. Reasons for declaring a Service Modification Request *Invalid* are many and include:

- The Service Modification Request refers to a non-existent service,
- A requested value for an Elastic Ethernet Service Attribute that is not allowed, and
- The Service Modification Request conflicts with another Service Modification Request that is in progress (Section 10.2).

The intent of declaring Service Modification Requests as *Valid* or *Invalid* is that the determination can be made quickly (see [D1]) without the need for the Ethernet SP or Operator to check availability of network resources in the Ethernet SP or Operator's network or the network of a partner organization. This section and the subsequent sections contain some sufficient conditions for a Service Modification Request to be declared *Invalid*.

[R2] A Service Modification Request for an Elastic Subscriber Ethernet Service **MUST** be declared *Invalid* if a requested value for an Elastic Ethernet Service Attribute is not a value that is allowed for the Service Attribute in MEF 10.4 [5].

[R3] A Service Modification Request for an Elastic Operator Ethernet Service **MUST** be declared *Invalid* if a requested value for an Elastic Ethernet Service Attribute is not a value that is allowed for the Service Attribute in MEF 26.2 [8].

See Sections 9 and 10 for additional sufficient conditions for a Service Modification Request to be declared *Invalid*.

A Valid Service Modification Request can be *Accepted* or *Rejected* by the Ethernet SP or Operator. An Accepted Service Modification is defined as a Valid Service Modification Request whose requested changes the Ethernet SP or Operator has committed to fulfill. It is expected that in order to determine if a Valid Service Modification Request is *Accepted*, the Ethernet SP or Operator will need to check availability of network resources. The proportion of Valid Service Modification Requests that are *Accepted* can be a subject of the Elastic Ethernet Service Control SLS Service Attribute (Section 9.3.1).

Consider a Service Modification Request that has been *Accepted* and still is in progress. It is possible that a change to a Service Attribute value via a mechanism other than a Service Modification Request is such that the in progress Service Modification Request would be declared *Invalid* if it were to be re-requested. For example, the in progress Service Modification Request requests a value for a *CIR* parameter that is later removed from the set of allowed values, e.g., see Section 9.1.2.2.2. Methods for preventing and/or resolving such a situation are beyond the scope of this standard.

8.1.1 Request Time

The Request Time for a Service Modification Request is defined as the UTC time specified to the second that the Service Modification Request is received by the Ethernet SP or Operator. The Request Time is not sent as part of the Service Modification Request itself but is an additional value that is associated with the Service Modification Request.

8.1.2 Connection ID Parameter

The *Connection ID* parameter has a value that is either an EVC ID Service Attribute value (Section 8.1 in MEF 10.4 [5]) or an OVC Identifier Service Attribute value (Section 12.1 in MEF 26.2 [8]). Consequently, the value of the *Connection ID* parameter identifies either a single EVC or a single OVC.

[R4] A Service Modification Request that does not have exactly one *Connection ID* parameter **MUST** be declared *Invalid*.

[R5] A Service Modification Request whose Connection ID parameter refers to a non-existent EVC ID or OVC Identifier **MUST** be declared *Invalid*.

8.1.3 Request Type Parameter

The *Request Type* parameter has a value of one of *One-Time Change*, *Periodic Change*, *Reverting Change*, or *Reverting Periodic Change*. An Ethernet SP or Operator might not support all values.

[R6] A Service Modification Request that does not have exactly one *Request Type* parameter **MUST** be declared *Invalid*.

The Requestor's intention for each value:

- *One-Time Change*: Each requested Elastic Ethernet Service Attribute value is retained until a subsequent Service Modification Request or other mechanism successfully changes it.
- *Periodic Change*: Each requested Elastic Ethernet Service Attribute value is periodically set to the requested value.
- *Reverting Change*: Each requested Elastic Ethernet Service Attribute value changes to a first value at the *Start Time* parameter value and then to a second value at the *Revert Time* parameter value.
- *Reverting Periodic Change*: Each requested Elastic Ethernet Service Attribute value periodically changes between two values.

[R7] A Service Modification Request for an Elastic Ethernet Service **MUST** be declared *Invalid* if the value of the *Request Type* parameter equals *One-Time Change* or *Periodic Change* and the Service Modification Request does not have exactly one value for each Elastic Ethernet Service Attribute to which the Service Modification Request applies.

[R8] A Service Modification Request for an Elastic Ethernet Service **MUST** be declared *Invalid* if the value of the *Request Type* parameter equals *Reverting Change* or *Reverting Periodic Change* and the Service Modification Request does not contain exactly two values for each Elastic Ethernet Service Attribute to which the Service Modification Request applies.

8.1.4 Start Time Parameter

The value of the *Start Time* parameter is either a UTC value specified to the second or *ASAP*. This time is when instantiation of the change(s) in the Service Modification Request are to be started.

[R9] A Service Modification Request for an Elastic Ethernet Service that does not have exactly one *Start Time* parameter **MUST** be declared *Invalid*.

[R10] A Service Modification Request for an Elastic Ethernet Service **MUST** be declared *Invalid* if the value of the *Start Time* parameter equals *ASAP* and the *Request Type* parameter does not equal *One-Time Change*.

[R11] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *One-Time Change*, and for which the value of the *Start Time* parameter is not *ASAP*, the time that the change is initiated **MUST** be at or after the value of the *Start Time* parameter.

[R12] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Periodic Change*, the time that the change in the n^{th} cycle is initiated **MUST** be at or after the value of the *Start Time* parameter plus *n* times the value of the *Period* parameter for $n = 0, 1, 2, \ldots..$

[R13] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Reverting Change*, the time that the first change is initiated **MUST** be at or after the value of the *Start Time* parameter.

[R14] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Reverting Periodic Change*, the time that the initial change in the n^{th} cycle is initiated **MUST** be at or after the value of the *Start Time* parameter plus *n* times the value of the *Period* parameter for $n = 0, 1, 2, \ldots..$

Per [R133], [R134], and [R135], the value of the Minimum Lead Time Service Attribute (Section 9.3.2) and the value of the Maximum Lead Time Service Attribute (Section 9.3.3) place limits on the value of the *Start Time* parameter for a Service Modification Request to be declared *Valid*.

8.1.5 Revert Time Parameter

The *Revert Time* parameter has a UTC value specified to the second. This time is when instantiation of the change(s) to the second value(s) in the Service Modification Request are to be started.

[R15] A Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Reverting Change* or *Request Type* parameter = *Reverting Periodic Change* that does not have exactly one *Revert Time* parameter **MUST** be declared *Invalid*.

[R16] A Service Modification Request for an Elastic Ethernet Service with *Request Type* parameter = *One-Time Change* or *Periodic Change* that has a *Revert Time* parameter **MUST** be declared *Invalid*.

[R17] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Reverting Change*, the time that the second value change is initiated **MUST** be at or after the value of the *Revert Time* parameter.

[R18] For an Accepted Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Reverting Periodic Change*, the time that the second value change in the n^{th} cycle is initiated **MUST** be at or after the value of the *Revert Time* parameter plus *n* times the value of the *Period* parameter for $n = 0, 1, 2, \ldots..$

8.1.6 Period Parameter

The value of the *Period* parameter is a time duration in an integer number of seconds. This parameter controls the elapsed time between the beginning of one periodic change and the beginning of the next periodic change. The *Period* parameter is needed when the *Request Type* parameter = *Periodic Change* (Figure 10) or *Reverting Periodic Change* (Figure 13).

[R19] A Service Modification Request for an Elastic Ethernet Service with the *Request Type* parameter = *Periodic Change* or *Reverting Periodic Change* that does not have exactly one *Period* parameter **MUST** be declared *Invalid*.

[R20] A Service Modification Request for an Elastic Ethernet Service with *Request Type* parameter = *One-Time Change* or *Reverting Change* that has a *Period* parameter **MUST** be declared *Invalid*.

8.2 Types of Service Modification

The following figures illustrate examples of the four types of Service Modification Requests and the effect of the values of the parameters contained in the Service Modification Request. All of the figures are for examples where all requested changes are successfully made by the Ethernet SP or Operator and the value of the *Start Time* parameter (Section 8.1.4) is not *ASAP*.

Figure 9 shows the effect of a Service Modification Request with the value of the *Request Type* parameter = *One-Time Change* (Section 8.1.3). In Figure 9, “Elastic Ethernet Service Attribute Initial Value” is the value of the Service Attribute immediately before the value of the *Start Time* parameter and “Elastic Ethernet Service Attribute Requested Value” is the value in the Service Modification Request. The value of the *Start Time* parameter controls when the process of making the change begins (Section 8.1.4). The "Modification Maintenance Interval" is defined as the Maintenance Interval (defined in Section 8.8.1.3 in MEF 10.4 [5] or in Section 12.13.1.2 in MEF 26.2 [8]) during which changes requested in a Service Modification Request are attempted to be made. It begins at either the value of the *Start Time* parameter when that value is not *ASAP* or at the time the changes in the Service Modification Request are initiated when the value of the *Start Time* parameter is *ASAP*. It ends with either the completion of the requested changes or the failure to make the changes. During the Modification Maintenance Interval, the value of the Elastic Ethernet Service Attribute being changed is indeterminate.

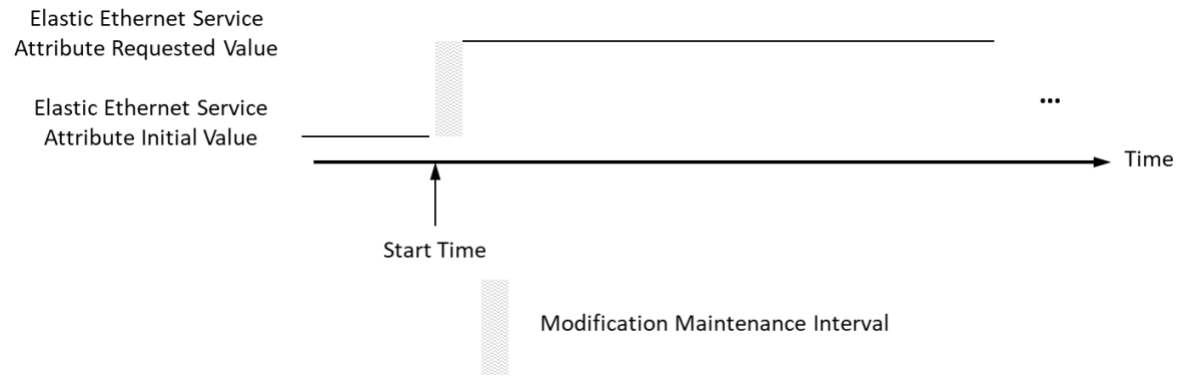


Figure 9 – Illustration of a Successful One-Time Change Service Modification Request

Figure 10 shows the effects of a Service Modification Request with *Request Type* parameter = *Periodic Change* (Section 8.1.3). In Figure 10, "Elastic Ethernet Service Attribute Initial Value" is the value of the Service Attribute immediately before the value of the *Start Time* parameter and "Elastic Ethernet Service Attribute Requested Value" is the value in the Service Modification Request. The value of the *Start Time* parameter controls when the process of making the changes begins. Additional changes (if necessary) are begun at $t_{start} + n \times p, n = 1,2, \ldots$ where t_{start} is the value of the *Start Time* parameter and p is the value of the *Period* parameter. During each period, other Service Modification Requests can change the value of the Elastic Ethernet Service Attribute. These values are displayed as dashed lines in Figure 10.

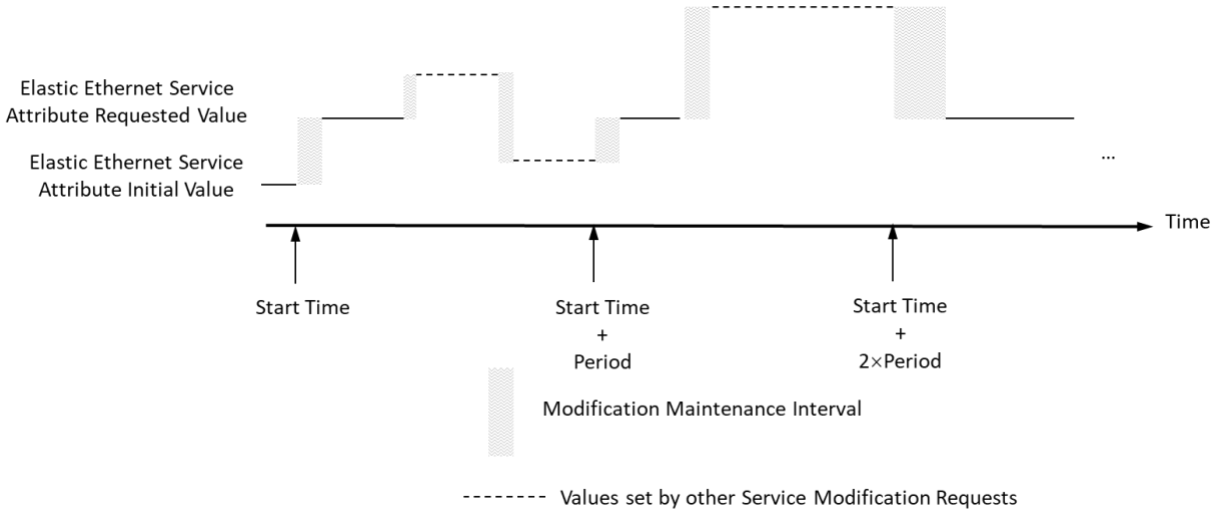


Figure 10 – Illustration of a Successful Periodic Change Service Modification Request

Figure 11 shows the effects of a Service Modification Request with *Request Type* parameter = *Reverting Change* (Section 8.1.3). This type of Service Modification Request specifies two values for each Elastic Ethernet Service Attribute. The first value is labeled "Elastic Ethernet Service Attribute Requested Value 1" in Figure 11. The second value is labeled "Elastic Ethernet Service Attribute Requested Value 2" in Figure 11. The value of the Service Attribute immediately before the value of the *Start Time* parameter is labeled "Elastic Ethernet Service Attribute Initial Value" in Figure 11. The value of the *Start Time* parameter controls when the process of establishing the first value begins. The value of the *Revert Time* parameter (8.1.5)

controls when establishing the second value begins. It is possible that another Service Modification Request or some other mechanism can effect a change in the value of the Elastic Ethernet Service Attribute to something other than Elastic Ethernet Service Attribute Value 1 in the time interval starting with the value of the *Start Time* parameter and ending with the value of the *Revert Time* parameter. This example assumes that such a change does not happen.

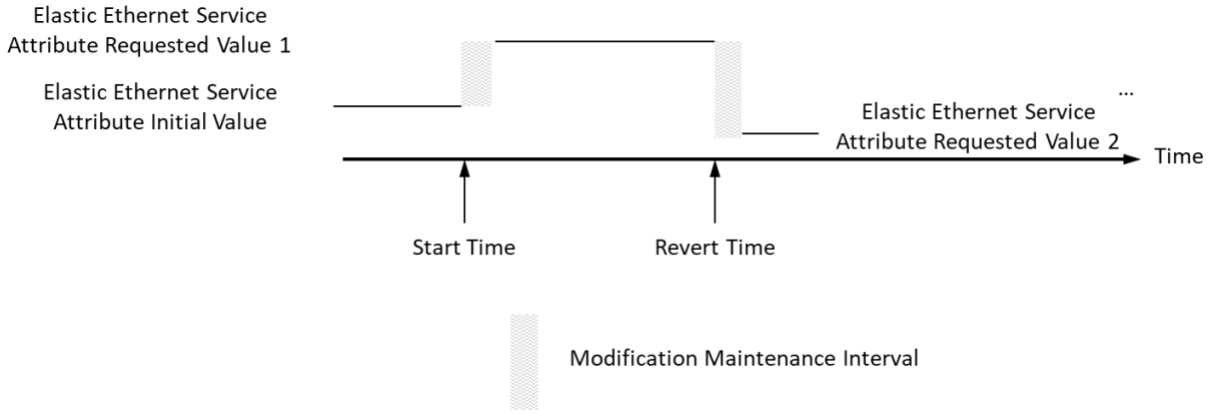


Figure 11 – Illustration of a Successful Reverting Change Service Modification Request

The motivation for the Reverting Change Service Modification Request type is to allow the Requestor to change the value of an Elastic Ethernet Service Attribute for a specified amount of time and then "revert" back to the previous value without having to make two One-Time Change Service Modification Requests. However, it might be difficult for the Requestor to know the (future) value of the Elastic Ethernet Service Attribute immediately before the value of the *Start Time*. For example, the value at the time of making the Reverting Change Service Modification Request might be changed by an in progress Service Modification Request. By having the second value in the Reverting Change Service Modification Request, the uncertainty regarding the value after the Service Modification Request is completed is eliminated.

It is possible that another Service Modification Request or some other mechanism can effect a change in the value of the Elastic Ethernet Service Attribute to something other than Elastic Ethernet Service Attribute Value 1 in the time interval starting with the value of the *Start Time* parameter and ending with the value of the *Revert Time* parameter. Figure 12 shows a second Service Modification Request with *Request Type* parameter = *Reverting Change* (Section 8.1.3) starting and completing within this time interval. In Figure 12 "Elastic Ethernet Service Attribute Requested Value 1", "Elastic Ethernet Service Attribute Requested Value 2", "Start Time 1", and "Revert Time 1" are values from the first Service Modification Request. "Elastic Ethernet Service Attribute Requested Value 3", "Elastic Ethernet Service Attribute Requested Value 4", "Start Time 2", and "Revert Time 2" are values from the second Service Modification Request.

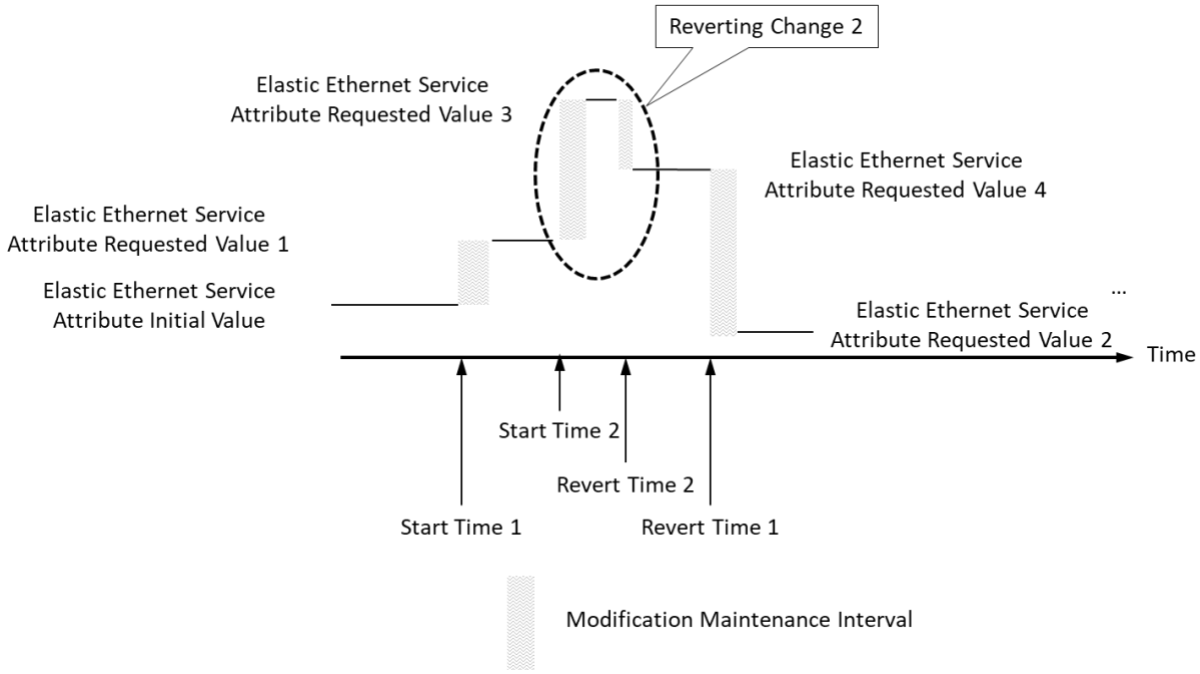


Figure 12 – Illustration of Nested Reverting Change Service Modification Requests

Figure 13 shows the effects of a Service Modification Request with *Request Type* parameter = *Reverting Periodic Change* (Section 8.1.3). This type of Service Modification Request specifies two values for each Elastic Ethernet Service Attribute. The first value is labeled "Elastic Ethernet Service Attribute Requested Value 1" in Figure 13. The second value is labeled "Elastic Ethernet Service Attribute Requested Value 2" in Figure 13. The value of the Service Attribute immediately before the value of the *Start Time* parameter is labeled "Elastic Ethernet Service Attribute Initial Value" in Figure 13. The value of the *Start Time* parameter controls when the process of establishing the first value first begins. The value of the *Revert Time* parameter (Section 8.1.5) controls when establishing the second value first begins. The value of the *Period* parameter controls the timing of the subsequent Elastic Service Attribute value changes with the initiations of the first value starting at $t_{start} + n \times p, n = 1,2, \ldots$ and the initiations of the second value starting at $t_{revert} + n \times p, n = 0,1,2, \ldots$ where t_{start} is the value of the *Start Time* parameter, t_{revert} is the value of the *Revert Time* parameter, and p is the value of the *Period* parameter. This example assumes that no other Service Modification Request or other mechanism changes the value of the Elastic Ethernet Service Attribute.

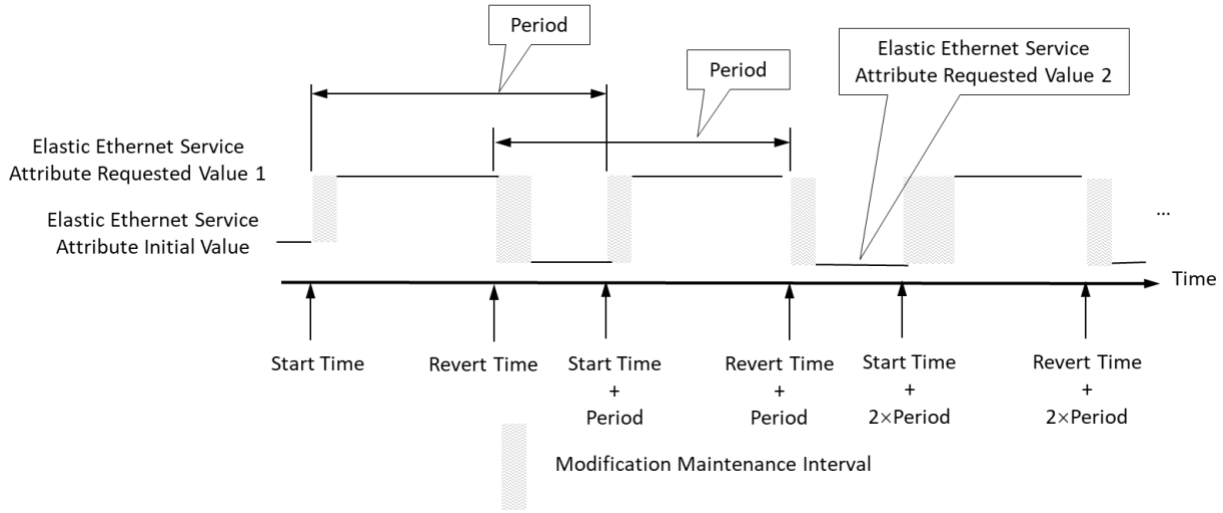


Figure 13 – Illustration of a Successful Reverting Periodic Change Service Modification Request

8.3 Service Control Requests and Notifications

The values of the Elastic Ethernet Service Attributes listed in Table 3, Table 4, Table 5 and Table 6 are subject to change via information exchanged between the Requestor and the Ethernet SP or Operator. Information is passed from the Requestor to the Ethernet SP or Operator in what is called a Request. Information is passed from the Ethernet SP or Operator to the Requestor in what is called a Notification.

The method by which Requests and Notifications are sent and received is beyond the scope of this standard.

Sections 8.3.1 through 8.3.7 describe the Requests and Notifications. Appendix C contains Request and Notification sequencing examples.

8.3.1 Service Modification Request

A Service Modification Request contains details of one or more changes in the value of one or more Service Attributes that are requested, along with the parameters described in Section 8.1.

8.3.2 Request Response Notification

A Request Response Notification is sent for each Service Modification Request received by the Ethernet SP or Operator. It indicates that the Service Modification Request is either:

- *Valid*: The Service Modification Request is declared *Valid*. Processing of the Service Modification Request by the Ethernet SP or Operator will continue, or,
- *Invalid*: The Service Modification Request is declared *Invalid*. The Ethernet SP or Operator will take no further action regarding the Service Modification Request.

The details of all of the content and structure of this Notification are beyond the scope of this standard but note that when the Request Response Notification indicates *Invalid*, it would be helpful to the Requestor for the Request Response Notification to contain information as to the cause for the *Invalid* declaration.

8.3.3 Request Disposition Notification

A Request Disposition Notification is sent for each Service Modification Request received by the Ethernet SP or Operator that is declared *Valid*. It indicates either:

- *Accept*: The Service Modification Request is *Accepted*. The Ethernet SP or Operator commits to fulfill the changes requested in the Service Modification Request, or
- *Reject*: The Service Modification Request is *Rejected*. The Ethernet SP or Operator will take no further action regarding the Service Modification Request.

The details of all of the content and structure of this Notification are beyond the scope of this standard but note that when the Request Disposition Notification indicates *Reject*, it would be helpful to the Requestor for the Request Disposition Notification to contain information as to the cause for *Reject* decision.

8.3.4 Begin Change Notification

A Begin Change Notification is sent for each Service Modification Request when changes requested in the Service Modification Request are initiated by the Ethernet SP or Operator. This Notification indicates that the Elastic Ethernet Service Attribute value change or changes are in progress and that a Modification Maintenance Interval is in effect for the EVC or OVC.

Note that a single Service Modification Request can lead to multiple sets of Elastic Ethernet Service Attribute value changes. For example, a Service Modification Request for periodic changes can lead to a large number of such changes. Consequently, a single Service Modification Request can result in multiple Begin Change Notifications.

The details of all of the content and structure of this Notification are beyond the scope of this standard.

8.3.5 End Change Notification

An End Change Notification is sent after each Begin Change Notification and indicates either:

- *Success*: All of the Service Modification Request changes requested for this Modification Maintenance Interval have been made, or
- *Fail*: None of the Service Modification Request changes have been made.

Note that [R140] and [R141] preclude the possibility of some but not all changes requested for a particular Modification Maintenance Interval having been made during the Modification Maintenance Interval.

If a Service Modification Request requests a value for an Elastic Service Attribute whose value is equal to the requested value at the Start Time parameter value, then this change is considered to be successfully made. Such a situation is not grounds for an End Change Notification indicating *Fail*.

The End Change Notification indicates that the Modification Maintenance Interval indicated by the corresponding Begin Change Notification is no longer in effect.

Note that a single Service Modification Request can lead to multiple sets of Elastic Ethernet Service Attribute value changes. For example, a Service Modification Request for periodic changes can lead to a large number of such changes. Consequently, a single Service Modification Request can result in multiple End Change Notifications.

The details of all of the content and structure of this Notification are beyond the scope of this standard but note that when the End Change Notification indicates *Fail*, it would be helpful to the Requestor for the End Change Notification to contain information as to the cause for *Fail* decision.

8.3.6 Cancel Request

A Cancel Request asks the Ethernet SP or Operator to stop addressing a Service Modification Request.

The details of all of the content and structure of this Request are beyond the scope of this standard.

8.3.7 Cancel Response Notification

A Cancel Response Notification is sent for each Cancel Request received. It indicates either:

- *Success*: The Service Modification Request is cancelled and no future changes in Elastic Ethernet Service Attribute values per the Service Modification Request will be made, or,

- *Fail*: The Service Modification Request continues in force.

The details of all of the content and structure of this Notification are beyond the scope of this standard but note that when the Cancel Response Notification indicates *Fail*, it would be helpful to the Requestor for the Cancel Response Notification to contain information as to the cause for *Fail* decision.

8.4 Handling Service Modification Requests

Figure 14 shows an example of the key steps and timeline involved in the handling of a One-Time Change Service Modification Request when the value of the *Start Time* parameter is not *ASAP*:

0. The Ethernet SP or Operator receives a new Service Modification Request.

1. The new Service Modification Request is checked to determine whether it is *Valid*. A Request Response Notification of either *Invalid* or *Valid* is sent.

2. For a Valid Service Modification Request, the Ethernet SP or Operator determines whether to accept or reject the request, for example, based on business, system or network constraints. A Request Disposition Notification of either *Reject* or *Accept* is sent.

3. For an Accepted Service Modification Request, the Ethernet SP or Operator waits until the value of the *Start Time* parameter (Section 8.1.4).

4. For an Accepted Service Modification Request, a Begin Change Notification is sent at the value of the *Start Time* parameter. This begins a Modification Maintenance Interval during which the requested changes are made. The change might be completed successfully or might fail. An End Change Notification of *Success* or *Fail* is sent, which ends the Modification Maintenance Interval.

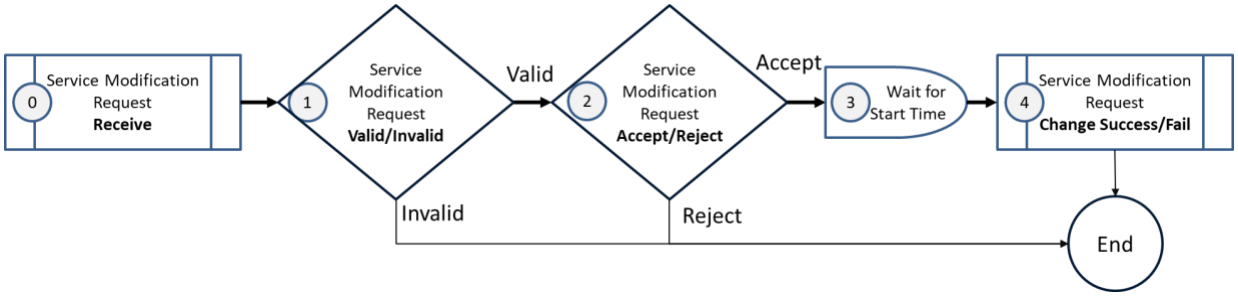


Figure 14 – Example Handling for a One-Time Change Service Modification Request

The state machine in Section 10.1 details the handling of Service Modification Requests for each of the possible values of the *Request Type* parameter values.

9 Elastic Ethernet Services – Additional Service Attributes

This section specifies new Service Attributes that apply to Elastic Ethernet Services.

Section 9.1 presents additional Service Attributes for Elastic Subscriber Ethernet Services. Section 9.2 presents additional Service Attributes for Elastic Operator Ethernet Services. Section 9.3 presents additional Service Attributes that are common to OVCs and EVCs, and are hence used for both Elastic Subscriber Ethernet Services and Elastic Operator Ethernet Services.

9.1 Additional Service Attributes for Elastic Subscriber Ethernet Services

This section describes additional Service Attributes used for Elastic Subscriber Ethernet Services. Section 9.1.1 describes additional Subscriber UNI Service Attributes and Section 9.1.2 describes additional EVC EP Service Attributes. Additional EVC Service Attributes are described in Section 9.3.

9.1.1 Additional Subscriber UNI Service Attributes

This section describes new Subscriber UNI Service Attributes for Elastic Subscriber Ethernet Services.

9.1.1.1 Subscriber UNI Elastic Behavior Service Attribute

The value of the Subscriber UNI Elastic Behavior Service Attribute is either *None* or a non-empty list of Subscriber UNI Service Attribute names taken from the first column of Table 3. When a Service Attribute name is in the list, the value for the Service Attribute can be changed with a Service Modification Request. When the value is *None*, there are no Subscriber UNI Service Attributes that can be changed by a Service Modification Request.

The second column in Table 3 briefly summarizes the aspects of the Subscriber UNI Service Attribute value that can be changed by a Service Modification Request. Requirements constraining the Elastic behaviors follow Table 3.

Subscriber UNI Service Attribute	Elastic Behavior
Subscriber UNI Port Conversation ID to Aggregation Link Map	The value of the Subscriber UNI Port Conversation ID to Aggregation Link Map. See [R23] and [R24] for constraints.

Table 3 – List Entries for the Subscriber UNI Elastic Behavior Service Attribute

[R21] A Service Modification Request for an Elastic Subscriber Ethernet Service that requests a value for a Subscriber UNI Service Attribute that is not listed in the value of the Subscriber UNI Elastic Behavior Service Attribute **MUST** be declared *Invalid*.

Given the definition for Subscriber UNI Elastic Behavior Service Attribute and [R21], all Subscriber UNI Service Attributes other than the Subscriber UNI Port Conversation ID to Aggregation Link Map cannot be Elastic. When the value of the Subscriber UNI Elastic Behavior Service Attribute is *None*, then no Subscriber UNI Service Attributes are Elastic.

[R22] If a Service Modification Request for an Elastic Subscriber Ethernet Service includes a change to the value of a Subscriber UNI Service Attribute, and the *Connection ID* parameter in the Service Modification Request identifies an EVC that does not have an EVC EP at that UNI, then the Service Modification Request **MUST** be declared *Invalid*.

Consider the case when the EVC EP Map is included in the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1), and the value of the Subscriber UNI Link Aggregation Service Attribute is *Other* or *All Active* (see [R77] in MEF 10.4 [5]). It might be desirable to include the Subscriber UNI Port Conversation ID to Aggregation Link Map in the value of the Subscriber UNI Elastic Behavior Service Attribute in order to ensure the C-Tag VLAN ID values listed in the EVC EP Map and the C-Tag VLAN ID values listed in the Subscriber UNI Port Conversation ID to Aggregation Link Map remain consistent.

[R23] If the value of the Subscriber UNI Link Aggregation Service Attribute (Section 9.5 in MEF 10.4 [5]) is not *All Active* or *Other*, the value of the Subscriber UNI Elastic Behavior Service Attribute **MUST NOT** include Subscriber UNI Port Conversation ID to Aggregation Link Map.

[R24] If a Service Modification Request for an Elastic Subscriber Ethernet Service requests a value for the Subscriber UNI Port Conversation ID to Aggregation Link Map Service Attribute for a given UNI such that the resulting value would change the Link Selection Priority List for a Port Conversation ID value whose C-Tag VLAN ID value is contained in the value of EVC EP Map for an EVC EP at the UNI that is not in the EVC identified by the *Connection ID* parameter, then the Service Modification Request **MUST** be declared Invalid.

[R24] means that a Service Modification Request can only change the Link Selection Priority List for C-Tag VLAN ID values that map to EVC EPs in the EVC identified by the *Connection ID* parameter or that do not map to any EVC EP. As described in Section 8.1, a Service Modification Request for an Elastic Subscriber Ethernet Service always applies to a particular EVC, and can only modify Service Attributes for that EVC or EVC EPs in that EVC. Similarly, if the Service Modification Request includes changes to the Subscriber UNI Port Conversation ID to Aggregation Link Map, it can only change the parts of the map that affect that EVC (or that don't affect any EVC).

Note that a Service Modification Request might only change the value of the Subscriber UNI Port Conversation ID to Aggregation Link Map Service Attribute, and not the value of any EVC or EVC EP Service Attributes; however, the Service Modification Request still applies to a particular EVC.

In the case where a UNI has multiple EVC EPs, a Service Modification Request for changing the value of the Subscriber UNI Port Conversation ID to Aggregation Link Map Service Attribute might put all of the EVCs with EVC EPs at this UNI into a Modification Maintenance Interval.

A single Service Modification Request can change the value of the Subscriber UNI Port Conversation ID to Aggregation Link Map at multiple UNIs. A Service Modification Request can also change both the value of the Subscriber UNI Port Conversation ID to Aggregation Link Map at a UNI and the EVC EP Map for an EVC EP Map at the same UNI.

9.1.1.2 Subscriber UNI Envelope Limits Service Attribute

The value for this Service Attribute is a *list* of 2-tuples of the form <x,y> where,

- x is an Envelope ID value,
- y is an integer > 0 in bits per second (b/s).

y specifies an upper bound on the Envelope Aggregate CIR for the Envelope identified by x. Envelope Aggregate CIR is defined as the sum of CIR values over all the Bandwidth Profile Flows in the Envelope. This can be expressed as $\sum_{i=1}^{n} CIR^i$, where CIR^i is the *CIR* value for the Bandwidth Profile Flow of rank *i* within the Envelope and *n* is the number of Bandwidth Profile Flows in the Envelope.

[R25] The Subscriber UNI Envelope Limits Service Attribute **MUS**T include exactly one entry for each Envelope ID in the value of the UNI Envelopes Service Attribute (Section 9.12 in MEF 10.4) that contains at least one Bandwidth Profile Flow of Service Frames mapped to an EVC EP for which the EVC EP Class of Service Name Ingress Bandwidth Profile or the EVC EP Class of Service Name Egress Bandwidth Profile is in the value of the EVC EP Elastic Behavior Service Attribute.

[R25] means that if an Envelope contains a Bandwidth Profile Flow whose parameters can be modified using a Service Modification Request, then the Envelope must be included in the value of the Envelope Limits Service Attribute.

[R26] For each Envelope in the value of the Subscriber UNI Envelope Limits Service Attribute, the Envelope Aggregate CIR **MUST** be less than or equal to the value of y for that Envelope in the value of the Subscriber UNI Envelope Limits Service Attribute at all times.

[R27] For each Envelope in the value of the Subscriber UNI Envelope Limits Service Attribute, if a Service Modification Request would result in the Envelope Aggregate CIR being greater than the value of y, at any time, for that Envelope in the value of the Subscriber UNI Envelope Limits Service Attribute, then the Service Modification Request **MUST** be declared *Invalid*.

[R26] means that the value of Envelope Aggregate CIR can only be less than or equal to the value of y no matter what technique is used to establish the value. [R27] enforces compliance with [R26] when a Service Modification Request is used to establish the value. Note that the impact of value changes resulting from Accepted Service Modification Requests whose requested changes have not yet been instantiated might need to be considered in order to comply with [R27].

9.1.2 Additional EVC EP Service Attributes

This section describes new EVC EP Service Attributes for Elastic Subscriber Ethernet Services.

9.1.2.1 EVC EP Elastic Behavior Service Attribute

The value of the EVC EP Elastic Behavior Service Attribute is either *None* or a non-empty list of EVC EP Service Attribute names taken from the first column of Table 4. When a Service Attribute name is in the list, the value for the Service Attribute can be changed with a Service Modification Request. When the value is *None*, there are no EVC EP Service Attributes that can be changed by a Service Modification Request.

The second column in Table 4 briefly summarizes the aspects of the EVC EP Service Attribute value that can be changed by a Service Modification Request. Note that even though only some aspects can be changed via a Service Modification Request, the entire Service Attribute value needs to be included in the Service Modification Request. The requirements constraining the Elastic behaviors follow Table 4.

See Sections 9.1.2.2 and 9.1.2.3 for additional constraints.

EVC EP Service Attributes	Elastic Behavior
EVC EP Map	Only entries in the list of C-Tag VLAN ID values when the EVC EP Map has a value of *List*. See [R30] and [R31] for constraints.
EVC EP Ingress Class of Service Map	Only entries of *M* in <*F*, *M*, *P*>. See [R32] for constraint.
EVC EP Class of Service Name Ingress Bandwidth Profile	One or more of <*CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, *EBS*> for each Ingress Class of Service Name Bandwidth Profile Flow. See [R33] and [R35] for constraints.
EVC EP Class of Service Name Egress Bandwidth Profile	One or more of <*CIR*, CIR_{max}> for each Egress Class of Service Name Bandwidth Profile Flow. See [R34] and [R36] for constraints

Table 4 – List Entries for the EVC EP Elastic Behavior Service Attribute

[R28] A Service Modification Request for an Elastic Subscriber Ethernet Service that includes a change to the value of an EVC EP Service Attribute that is not listed in the value of the EVC EP Elastic Behavior Service Attribute **MUST** be declared *Invalid*.

Given the definition for the EVC EP Elastic Behavior Service Attribute and [R28], all EVC EP Service Attributes other than those listed in Table 4 cannot be Elastic. When the value of the EVC EP Elastic Behavior Service Attribute is *None*, then no EVC EP Service Attributes are Elastic.

[R29] A Service Modification Request for an Elastic Subscriber Ethernet Service that requests changes in the value of one or more EVC EP Service Attributes for an EVC EP that is not associated by the EVC identified by the value of the *Connection ID* parameter **MUST** be declared *Invalid*.

[R30] When the EVC EP Map Service Attribute value is *UT/PT* or *All*, then the EVC EP Map Service Attribute **MUST NOT** be in the value of the EVC EP Elastic Behavior Service Attribute.

[R31] A Service Modification Request for an Elastic Subscriber Ethernet Service that includes a change to the value of the EVC EP Map Service Attribute **MUST** be declared *Invalid* if the requested new value is not *List*.

[R32] A Service Modification Request that includes a change to the value of $\langle F, M, P \rangle$ for the EVC EP Ingress Class of Service Map Service Attribute **MUST** be declared *Invalid* if the requested new values of *F* or *P* are different from the values at the Request Time.

[R33] A Service Modification Request for an Elastic Subscriber Ethernet Service that includes a change to the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute (a list of entries of the form <x, y>) **MUST** be declared *Invalid* if the requested new value contains entries for a different set of CoS Names (i.e. with different values for x) from the value at the Request Time, or contains different values for *CF*, *CM*, *ER* or *F* in the Bandwidth Profile Flow parameters (y) for any entry compared to the value at the Request Time.

[R34] A Service Modification Request for an Elastic Subscriber Ethernet Service that includes a change to the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute (a list of entries of the form <x, y>) **MUST** be declared *Invalid* if the requested new value contains entries for a different set of CoS Names (i.e. with different values for x) from the value at the Request Time, or contains different values for *ER* in the Bandwidth Profile Flow parameters (y) for any entry compared to the value at the Request Time.

[R35] When the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute is *None*, then the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST NOT** be in the value of the EVC EP Elastic Behavior Service Attribute.

[R36] When the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute is *None*, then the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute **MUST NOT** be in the value of the EVC EP Elastic Behavior Service Attribute.

Note that [R33] and [R35] mean that the set of Bandwidth Profile Flows (CoS Names) used at an EVC EP cannot be changed elastically; all Bandwidth Profile Flows (CoS Names) that might be needed must be listed in the agreed value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute via some non-elastic process (for example when the service is originally ordered). However, which Service Frames, if any, map to a given Class of Service Name can be changed elastically by modifying the value of the EVC EP Ingress Class of Service Map Service Attribute. Additionally, if some Bandwidth Profile Flows are initially unused, the parameters can be set such that all frames are declared Red and discarded (e.g. by setting *CBS* and *EBS* to 0), and later these Bandwidth Profile Flows can be activated by using a Service Modification Request to change the parameter values. [R34] and [R36] have a similar implication for the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute.

9.1.2.2 EVC EP CoS Name Ingress BWP Limits Service Attribute

The EVC EP CoS Name Ingress BWP Limits Service Attribute specifies the allowable values that *CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, and *EBS* can take on for each Ingress Class of Service Name Bandwidth Profile Flow. The value for this Service Attribute is *None* or a *list* of 9-tuples, one for each CoS Name. The elements of the 9-tuple are:

1. CoS Name
2. Allowed CIR Values
3. Allowed EIR Values
4. Allowed CIR_{max} Values
5. Allowed EIR_{max} Values
6. Allowed CBS Values
7. Allowed EBS Values
8. Total IR Upper Bound
9. Total IR Lower Bound

Each element in the 9-tuple is described in the following sections.

[R37] When the value of the EVC EP Elastic Behavior Service Attribute does not contain the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute, then the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute **MUST** be *None*.

[R35] and [R37] means that when the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute is *None*, then the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute is *None*.

[R38] When the value of the EVC EP Elastic Behavior Service Attribute contains the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute, then the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute **MUST NOT** be *None*.

9.1.2.2.1 CoS Name Element

The value of the CoS Name Element is a Class of Service Name that is contained in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute (Section 10.9 in MEF 10.4 [5]). Given [R147] in MEF 10.4 [5], the value of the CoS Name Element cannot be *Discard*.

[R39] When the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute is not *None*, then for each pair <*x*, *y*> in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute (Section 10.9 in MEF 10.4 [5]), the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute **MUST** contain exactly one list entry with CoS Name Element equal to x.

9.1.2.2.2 Allowed CIR Values Element

The Allowed CIR Values Element specifies the possible values for *CIR* that can be in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

An example of the value for Allowed CIR Values Element is {0, 10 x10^6, 20 x10^6, 30 x10^6, 40 x10^6, 50 x10^6, 60 x10^6, 70 x10^6, 80 x10^6, 90 x10^6, 100 x10^6, 200 x10^6, 300 x10^6, 400 x10^6, 500 x10^6, 600 x10^6, 700 x10^6, 800 x10^6, 900 x10^6, 1000 x10^6}. This example contains 10 Mb/s granularity for values of *CIR* under 100 Mb/s and 100 Mb/s granularity for values of *CIR* between 100 Mb/s and 1 Gb/s.

[R40] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *CIR* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed CIR Values Element in the 9-tuple at all times.

[R41] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of *CIR* for that CoS Name that is not contained in the value of the Allowed CIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R40] means that the value of *CIR* can only be an allowed value no matter what technique is used to establish the value. [R41] enforces compliance with [R40] when a Service Modification Request is used to establish a value.

9.1.2.2.3 Allowed EIR Values Element

The Allowed EIR Values Element specifies the possible values for *EIR* that can be in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R42] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *EIR* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed EIR Values Element in the 9-tuple at all times.

[R43] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of *EIR* for that CoS Name that is not contained in the value of the Allowed EIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R42] means that the value of *EIR* can only be an allowed value no matter what technique is used to establish the value. [R43] enforces compliance with [R42] when a Service Modification Request is used to establish a value.

9.1.2.2.4 Allowed CIR_{max} Values Element

The Allowed CIR_{max} Values Element specifies the possible values for CIR_{max} that can be in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R44] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = x, then the value of CIR_{max} for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple at all times.

[R45] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of CIR_{max} for that CoS Name that is not contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R44] means that the value of CIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R45] enforces compliance with [R44] when a Service Modification Request is used to establish a value.

9.1.2.2.5 Allowed EIR_{max} Values Element

The Allowed EIR_{max} Values Element specifies the possible values for EIR_{max} that can be in the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R46] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of EIR_{max} for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple at all times.

[R47] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of EIR_{max} for that CoS Name that is not contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R46] means that the value of EIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R47] enforces compliance with [R46] when a Service Modification Request is used to establish a value.

9.1.2.2.6 Allowed CBS Values Element

The Allowed CBS Values Element specifies the possible values for *CBS* that can be in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R48] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *CBS* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed CBS Values Element in the 9-tuple at all times.

[R49] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of *CBS* for that CoS Name that is not contained in the value of the Allowed CBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R48] means that the value of *CBS* can only be an allowed value no matter what technique is used to establish the value. [R49] enforces compliance with [R48] when a Service Modification Request is used to establish a value.

9.1.2.2.7 Allowed EBS Values Element

The Allowed EBS Values Element specifies the possible values for *EBS* that can be in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R50] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *EBS* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed EBS Values Element in the 9-tuple at all times.

[R51] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of *EBS* for that CoS Name that is not contained in the value of the Allowed EBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R50] means that the value of *EBS* can only be an allowed value no matter what technique is used to establish the value. [R51] enforces compliance with [R50] when a Service Modification Request is used to establish a value.

9.1.2.2.8 Total IR Upper Bound Element

The Total IR Upper Bound Element specifies an upper bound on the value *CIR* + *EIR* in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is an integer > 0 in bits per second.

[R52] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the sum of the values of *CIR* and *EIR* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be less than or equal to the value of the Total IR Upper Bound Element in the 9-tuple at all times.

[R53] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Ingress Class of Service Name Bandwidth Profile Flow based on *x*, and *z* is greater than the value of the Total IR Upper Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R52] means that the value of *CIR* + *EIR* can only be less than or equal to the upper bound no matter what technique is used to establish the value. [R53] enforces compliance with [R52] when a Service Modification Request is used to establish a value.

9.1.2.2.9 Total IR Lower Bound Element

The Total IR Lower Bound Element specifies a lower bound on the value *CIR* + *EIR* in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is an integer ≥ 0 in bits per second. This element might be useful to establish a constraint on the range of elasticity, e.g., 2 Gb/s at a UNI with port speed of 10 Gb/s, to facilitate better capacity planning within the Ethernet SP network.

[R54] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the sum of the values of *CIR* and *EIR* for that CoS Name in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **MUST** be greater than or equal to the value of the Total IR Lower Bound Element in the 9-tuple at all times.

[R55] If a 9-tuple in the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Ingress Class of Service Name Bandwidth Profile Flow based on *x*, and *z* is less than the value of the Total IR Lower Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R54] means that the value of *CIR* + *EIR* can only be greater than or equal to the lower bound no matter what technique is used to establish the value. [R55] enforces compliance with [R54] when a Service Modification Request is used to establish a value.

[R56] For the EVC EP CoS Name Ingress BWP Limits Service Attribute, for each 9-tuple, the value of the Total IR Upper Bound Element **MUST** be greater than or equal to the value of the Total IR Lower Bound Element.

9.1.2.3 EVC EP CoS Name Egress BWP Limits Service Attribute

The EVC EP CoS Name Egress BWP Limits Service Attribute specifies the allowable values that *CIR* and CIR_{max} can take on for each Egress Bandwidth Profile Flow based on Class of Service Name. The value for this Service Attribute is *None* or a *list* of 3-tuples, one for each CoS Name. The elements of the 3-tuple are:

1. CoS Name
2. Allowed CIR Values
3. Allowed CIR_{max} Values

Each element in the 3-tuple is described in the following sections.

[R57] When the value of the EVC EP Elastic Behavior Service Attribute does not contain the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute, then the value of the EVC EP CoS Name Egress BWP Limits Service Attribute **MUST** be *None*.

[R36] and [R57] means that when the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute is *None*, then the value of the EVC EP CoS Name Egress BWP Limits Service Attribute is *None.*

[R58] When the value of the EVC EP Elastic Behavior Service Attribute contains the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute, then the value of the EVC EP CoS Name Egress BWP Limits Service Attribute **MUST NOT** be *None*.

9.1.2.3.1 CoS Name Element

The value of the CoS Name Element is a Class of Service Name that is contained in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute (Section 10.11 in MEF 10.4 [5]) for the EVC EP. Per the definition in Section 10.11 in MEF 10.4 [5], the value of the CoS Name Element cannot be *Discard*.

[R59] When the value of the EVC EP CoS Name Egress BWP Limits Service Attribute is not *None*, then for each pair <*x*, *y*> in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute (Section 10.11 in MEF 10.4 [5]), the value of the EVC EP CoS Name Egress BWP Limits Service Attribute **MUST** contain exactly one list entry with CoS Name Element equal to x.

9.1.2.3.2 Allowed CIR Values Element

The Allowed CIR Values Element specifies the possible values for *CIR* that can be in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

An example of the value for this Service Attribute is {0, 10 x10^6, 20 x10^6, 30 x10^6, 40 x10^6, 50 x10^6, 60 x10^6, 70 x10^6, 80 x10^6, 90 x10^6, 100 x10^6, 200 x10^6, 300 x10^6, 400 x10^6, 500 x10^6, 600 x10^6, 700 x10^6, 800 x10^6, 900 x10^6, 1000 x10^6}. This example contains 10 Mb/s granularity for values of *CIR* under 100 Mb/s and 100 Mb/s granularity for values of *CIR* between 100 Mb/s and 1 Gb/s.

[R60] If a 3-tuple in the value of the EVC EP CoS Name Egress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *CIR* for that CoS Name in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed CIR Values Element in the 3-tuple at all times.

[R61] If a 3-tuple in the value of the EVC EP CoS Name Egress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of *CIR* for that CoS Name that is not contained in the value of the Allowed CIR Values Element in the 3-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R60] means that the value of *CIR* can only be an allowed value no matter what technique is used to establish the value. [R61] enforces compliance with [R60] when a Service Modification Request is used to establish a value.

9.1.2.3.3 Allowed CIR_{max} Values Element

The Allowed CIR_{max} Values Element specifies the possible values for CIR_{max} that can be in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R62] If a 3-tuple in the value of the EVC EP CoS Name Egress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of CIR_{max} for that CoS Name in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute **MUST** be contained in the value of the Allowed CIR_{max} Values Element in the 3-tuple at all times.

[R63] If a 3-tuple in the value of the EVC EP CoS Name Egress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Subscriber Ethernet Service has a requested value of CIR_{max} for that CoS Name that is not contained in the value of the Allowed CIR_{max} Values Element in the 3-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R62] means that the value of CIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R63] enforces compliance with [R62] when a Service Modification Request is used to establish a value.

9.2 Additional Service Attributes for Elastic Operator Ethernet Services

This section describes the additional Service Attributes used for Elastic Operator Ethernet Services. Section 9.2.1 describes additional Operator UNI Service Attributes. Section 9.2.2 describes additional ENNI Service Attributes. Section 9.2.3 describes additional OVC End Point Service Attributes. Additional OVC Service Attributes are described in Section 9.3.

9.2.1 Additional Operator UNI Service Attributes

This section describes new Operator UNI Service Attributes for Elastic Operator Ethernet Services.

9.2.1.1 Operator UNI Elastic Behavior Service Attribute

The value of the Operator UNI Elastic Behavior Service Attribute is either *None* or a non-empty list of Operator UNI Service Attribute names taken from the first column of Table 5. When a Service Attribute name is in the list, the value for the Service Attribute can be changed with a Service Modification Request. When the value is *None*, there are no Operator UNI Service Attributes that can be changed by a Service Modification Request.

The second column in Table 5 briefly summarizes the aspects of the Operator UNI Service Attribute value that can be changed by a Service Modification Request. Requirements constraining the Elastic behaviors follow Table 5.

Operator UNI Service Attribute	Elastic Behavior
Operator UNI Port Conversation ID to Aggregation Link Map	The value of the Operator UNI Port Conversation ID to Aggregation Link Map. See [R66] and [R67] for constraints.

Table 5 – List Entries for the Operator UNI Elastic Behavior Service Attribute

[R64] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value of an Operator UNI Service Attribute that is not listed in the value of the Operator UNI Elastic Behavior Service Attribute **MUST** be declared *Invalid*.

Given the definition for Operator UNI Elastic Behavior Service Attribute and [R64], all Operator UNI Service Attributes other than the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute cannot be Elastic. When the value of the Operator UNI Elastic Behavior Service Attribute is *None*, then no Operator UNI Service Attributes are Elastic.

[R65] If a Service Modification Request for an Elastic Operator Ethernet Service includes a change to the value of an Operator UNI Service Attribute, and the *Connection ID* parameter in the Service Modification Request identifies an OVC that does not have an OVC EP at that UNI, then the Service Modification Request **MUST** be declared *Invalid*.

Consider the case when the OVC End Point Map is included in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1) and the value of the Operator UNI Link Aggregation Service Attribute is *All Active* (per Section 14.5 in MEF 26.2). It might be desirable to include the Operator UNI Port Conversation ID to Aggregation Link Map in the value of the Operator UNI Elastic Behavior Service Attribute in order to ensure the CE-VLAN ID values listed in the OVC End Point Map and the CE-VLAN ID values listed in the Operator UNI Port Conversation ID to Aggregation Link Map remain consistent.

[R66] If the value of the Operator UNI Link Aggregation Service Attribute (Section 14.5 in MEF 26.2) is not *All Active*, the value of the Operator UNI Elastic Behavior Service Attribute **MUST NOT** include Operator UNI Port Conversation ID to Aggregation Link Map.

[R67] If a Service Modification Request for an Elastic Operator Ethernet Service requests a value for the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute for a given UNI such that the resulting value would change the Link Selection Priority List for a Port Conversation ID value whose CE-VLAN ID value is contained in the value of OVC End Point Map for an OVC End Point at the UNI that is not in the OVC identified by the *Connection ID* parameter, then the Service Modification Request **MUST** be declared *Invalid*.

[R67] means that a Service Modification Request can only change the Link Selection Priority List for CE-VLAN ID values that map to OVC End Points in the OVC identified by the *Connection ID* parameter or that do not map to any OVC End Point. As described in Section 8.1, a Service Modification Request for an Elastic Operator Ethernet Service always applies to a

particular OVC, and can only modify Service Attributes for that OVC or OVC End Points in that OVC. Similarly, if the Service Modification Request includes changes to the Operator UNI Port Conversation ID to Aggregation Link Map, it can only change the parts of the map that affect that OVC (or that don't affect any OVC).

Note that a Service Modification Request might only change the value of the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute, and not the value of any OVC or OVC End Point Service Attributes; however, the Service Modification Request still applies to a particular OVC.

In the case where a UNI has multiple OVC End Points, a Service Modification Request for changing the value of the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute might put all of the OVCs with OVC End Points at this UNI into a Modification Maintenance Interval.

A single Service Modification Request can change the value of the Operator UNI Port Conversation ID to Aggregation Link Map at multiple UNIs. A Service Modification Request can also change both the value of the Operator UNI Port Conversation ID to Aggregation Link Map at a UNI and the OVC End Point Map for an OVC End Point Map at the same UNI.

When the UNI is used to implement an Elastic Subscriber Ethernet Service, it is the responsibility of the Ethernet SP to match the value for the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute with the value for the Subscriber UNI Port Conversation ID to Aggregation Link Map Service Attribute. These values need to be matched through changes made to these Service Attribute values including changes made via Service Modification Requests.

When the UNI is not used to implement a Subscriber Ethernet Service (e.g., UNI to ENNI such as in Figure 6), the Cloud SP is responsible for conveying the value for the Operator UNI Port Conversation ID to Aggregation Link Map Service Attribute to the Cloud Subscriber or Cloud Operator so that the Cloud Subscriber or Cloud Operator can configure a complementary mapping in the appropriate equipment owned by the Cloud Subscriber or Cloud Operator.

9.2.1.2 Operator UNI Envelope Limits Service Attribute

The value for this Service Attribute is a *list* of 2-tuples of the form <x,y> where,

- x is an Envelope ID value,
- y is an integer > 0 in bits per second (b/s).

y specifies the upper bound on the Envelope Aggregate CIR for the Envelope identified by x. Envelope Aggregate CIR is defined as the sum of CIR values over all the Bandwidth Profile Flows in the Envelope. This can be expressed as $\sum_{i=1}^{n} CIR^i$, where CIR^i is the *CIR* value for the Bandwidth Profile Flow of rank *i* within the Envelope and *n* is the number of Bandwidth Profile Flows in the Envelope.

[R68] The value of the Operator UNI Envelope Limits Service Attribute **MUS**T include exactly one entry for each Envelope ID in the value of the Operator UNI Envelopes Service Attribute (Section 14.19 in MEF 26.2) that contains at least one Bandwidth Profile Flow for an OVC End Point for which the Ingress Bandwidth Profile per Class of Service Name or the Egress Bandwidth Profile per Egress Equivalence Class Name is in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1).

[R68] means that if an Envelope contains a Bandwidth Profile Flow whose parameters can be modified using a Service Modification Request, then the Envelope must be included in the value of the Envelope Limits Service Attribute.

[R69] For each Envelope in the value of the Operator UNI Envelope Limits Service Attribute, the Envelope Aggregate CIR **MUST** be less than or equal to the value of y for that Envelope in the value of the Operator UNI Envelope Limits Service Attribute at all times.

[R70] For each Envelope in the value of the Operator UNI Envelope Limits Service Attribute, a Service Modification Request for an Elastic Operator Ethernet Service that would result in the Envelope Aggregate CIR being greater than the value of y, any time, for that Envelope in the value of the Operator UNI Envelope Limits Service Attribute **MUST** be declared *Invalid*.

[R69] means that the value of Envelope Aggregate CIR can only be less than or equal to the value of y no matter what technique is used to establish the value. [R70] enforces compliance with [R69] when a Service Modification Request is used to establish a value. Note that the impact of value changes resulting from Accepted Service Modification Requests whose requested changes have not yet been instantiated might need to be considered in order to comply with [R70].

9.2.2 Additional ENNI Service Attributes

MEF 26.2 [8] specifies ENNI Service Attributes for Operator Ethernet Services. For Elastic Operator Ethernet Services additional Service Attributes are needed as specified in this section. There are no ENNI Service Attributes, ENNI Common Attributes or Operator Multilateral Attributes that can be Elastic.

9.2.2.1 ENNI Envelope Limits Service Attribute

The value for this Service Attribute is a *list* of 2-tuples of the form <x,y> where,

- x is an Envelope ID value,
- y is an integer > 0 in bits per second (b/s).

y specifies the upper bound on the Envelope Aggregate CIR for the Envelope identified by x. Envelope Aggregate CIR is defined as the sum of CIR values over all the Bandwidth Profile Flows in the Envelope. This can be expressed as $\sum_{i=1}^{n} CIR^i$, where CIR^i is the *CIR* value for the Bandwidth Profile Flow of rank *i* within the Envelope and *n* is the number of Bandwidth Profile Flows in the Envelope.

[R71] The value of the ENNI Envelope Limits Service Attribute **MUS**T include exactly one entry for each Envelope ID in the value of the ENNI Envelopes Service Attribute (Section 13.6 in MEF 26.2) that contains at least one Bandwidth Profile Flow of frames mapped to an OVC End Point for which the Ingress Bandwidth Profile per Class of Service Name or the Egress Bandwidth Profile per Egress Equivalence Class Name is in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1).

[R71] means that if an Envelope contains a Bandwidth Profile Flow whose parameters can be modified using a Service Modification Request, then the Envelope must be included in the value of the Envelope Limits Service Attribute.

[R72] For each Envelope in the value of the ENNI Envelope Limits Service Attribute, the Envelope Aggregate CIR **MUST** be less than or equal to the value of y for that Envelope in the value of the ENNI Envelope Limits Service Attribute at all times.

[R73] For each Envelope in the value of the ENNI Envelope Limits Service Attribute, a Service Modification Request for an Elastic Operator Ethernet Service that would result in the Envelope Aggregate CIR being greater than the value of y, at any time, for that Envelope in the value of the ENNI Envelope Limits Service Attribute **MUST** be declared *Invalid*.

[R72] means that the value of Envelope Aggregate CIR can only be less than or equal to the value of y no matter what technique is used to establish the value. [R73] enforces compliance with [R72] when a Service Modification Request is used to establish a value. Note that the impact of value changes resulting from Accepted Service Modification Requests whose requested changes have not yet been instantiated might need to be considered in order to comply with [R73].

9.2.3 Additional OVC End Point Service Attributes

This section describes the new OVC EP Service Attributes for Elastic Operator Ethernet Services.

9.2.3.1 OVC End Point Elastic Behavior Service Attribute

The value of the OVC End Point Elastic Behavior Service Attribute is either *None* or a non-empty list of OVC End Point Service Attribute names taken from the first column of Table 6. When a Service Attribute name is in the list, the value for the Service Attribute can be changed with a Service Modification Request. When the value is *None*, there are no OVC End Point Service Attributes that can be changed by a Service Modification Request.

The second column in Table 6 briefly summarizes the aspects of the OVC End Point Service Attribute value that can be changed by a Service Modification Request. Note that even though only some aspects can be changed via a Service Modification Request, the entire Service Attribute value needs to be included in the Service Modification Request. The requirements constraining the Elastic behaviors follow Table 6.

See Section 9.2.3.2 and 9.2.3.3 for additional constraints.

OVC End Point Service Attributes	Elastic Behavior
OVC End Point Map	When the OVC End Point is of Form U: Only entries in the list of CE-VLAN ID values. When the OVC End Point is of Form E: Only entries in the list of S-VLAN ID values. See [R76] and [R77] for constraints.
OVC End Point Class of Service Identifier	When the OVC End Point is at a UNI: only entries of *M* in <*F*, *M*, *P*> for *F* = *C-Tag PCP* or *DSCP*. When the OVC End Point is at an ENNI: only entries of *M* in <*F*, *M*, *P*> for *F* = *S-Tag PCP*. See [R78] for a constraint.
OVC End Point Egress Equivalence Class Identifier	When the OVC End Point is at a UNI: only entries of *M* in <*F*, *M*, *P*> for *F* = *C-Tag PCP* or *DSCP*. When the OVC End Point is at an ENNI: only entries of *M* in <*F*, *M*, *P*> for *F* = *S-Tag PCP*. See [R79] for a constraint.
Ingress Bandwidth Profile per Class of Service Name	One or more of <*CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, *EBS*> for each Bandwidth Profile Flow. See [R80] and [R82] for constraints.
Egress Bandwidth Profile per Egress Equivalence Class Name	One or more of <*CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, *EBS*> for each Bandwidth Profile Flow. See [R81] and [R83] for constraints.

Table 6 – List Entries for the OVC End Point Elastic Behavior Service Attribute

[R74] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value of an OVC End Point Service Attribute that is not listed in the value of the OVC End Point Elastic Behavior Service Attribute **MUST** be declared *Invalid*.

Given the definition for the OVC End Point Elastic Behavior Service Attribute and [R74], all OVC End Point Service Attributes other than those listed in Table 6 cannot be Elastic. When the value of the OVC is *None*, then no OVC End Point Service Attributes are Elastic.

[R75] A Service Modification Request for an Elastic Operator Ethernet Service that requests changes in the value of one or more OVC End Point Service Attributes for an OVC End Point that is not associated by the OVC identified by the value of the *Connection ID* Parameter in the Service Modification Request **MUST** be declared *Invalid*.

For simplicity, OVC End Point Maps of Form V or T cannot be Elastic. This means the OVC End Point Map Service Attribute cannot be Elastic for OVC End Points that are in a VUNI or for OVC End Points whose value of the OVC End Point Role Service Attribute is *Trunk*.

[R76] When the value of the OVC End Point Map Service Attribute is Form T or Form V, the OVC End Point Map Service Attribute **MUST NOT** be in the value of the OVC End Point Elastic Behavior Service Attribute for the OVC End Point.

[R77] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value of the OVC End Point Map Service Attribute **MUST** be declared *Invalid* if the requested new value is not Form E when the OVC End Point is at an ENNI or not Form U when the OVC End Point is at a UNI.

[R78] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value $\langle F, M, P \rangle$ of the OVC End Point Class of Service Identifier Service Attribute **MUST** be declared *Invalid* if the requested new values of F or P are different from the values at the Request Time.

[R79] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value $\langle F, M, P \rangle$ of the OVC End Point Egress Equivalence Class Identifier Service Identifier Service Attribute **MUST** be declared *Invalid* if the requested new values of F or P are different from the values at the Request Time.

[R80] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute (a list of entries of the form <x, y>) **MUST** be declared *Invalid* if the requested new value contains any of the following:

- Entries for a different set of Class of Service Names (i.e. with different values for x) from the value at the Request Time,
- An entry with y = *Parameters* for any Class of Service Name which has y = *Disabled* at the Request Time,
- An entry with y = *Disabled* for any Class of Service Name which has y = P*arameters* at the Request Time,
- An entry with different values for *CF*, *CM*, *ER*, or *F* in the Bandwidth Profile Flow parameters (i.e., y) compared to the values for that Class of Service Name at the Request Time.

[R81] A Service Modification Request for an Elastic Operator Ethernet Service that includes a change to the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute (a list of entries of the form <x, y>) **MUST** be declared *Invalid* if the requested new value contains any of the following:

- Entries for a different set of Egress Equivalence Class Names (i.e. with different values for x) from the value at the Request Time,

- An entry with y = *Parameters* for any Egress Equivalence Class Name which has y = *Disabled* at the Request Time,

- An entry with y = *Disabled* for any Egress Equivalence Class Name which has y = *Parameters* at the Request Time,

- An entry with different values for *CF*, *CM*, *ER*, or *F* in the Bandwidth Profile Flow parameters (i.e., y) compared to the values for that Egress Equivalence Class Name at the Request Time.

[R82] When the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute is either empty or has y = *Disabled* in every entry in the list of <x, y> pairs, then the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST NOT** be in the value of the OVC End Point Elastic Behavior Service Attribute.

[R83] When the value of the Egress Bandwidth Profile per Equivalence Class Name Service Attribute is either empty or has y = *Disabled* in every entry in the list of <x, y> pairs, then the Egress Bandwidth Profile per Equivalence Class Name Service Attribute **MUST NOT** be in the value of the OVC End Point Elastic Behavior Service Attribute.

Note that [R80] and [R82] mean that the set of Bandwidth Profile Flows specified in the value of the OVC End Point Ingress Bandwidth Profile per Class of Service Name Service Attribute used for an OVC End Point cannot be changed elastically; all Bandwidth Profile Flows based on Class of Service Name (i.e., Bandwidth Profile Flows meeting criterion 2 of [R230] in MEF 26.2 [8]) that might be needed need to be listed in the agreed value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute via some non-elastic process (for example when the service is originally ordered). However, whether any frames map to a given CoS Name (and hence to a given Bandwidth Profile Flow) at the OVC End Point can be changed elastically, by modifying the value of the OVC End Point Class of Service Identifier Service Attribute using a Service Modification Request. Additionally, if some Bandwidth Profile Flows are initially unused, the parameters can be set such that all frames are declared Red and discarded (e.g. by setting *CBS* and *EBS* to 0), and later these Bandwidth Profile Flows can be activated by using a Service Modification Request to change the parameter values. [R81] and [R83] have a similar implication for the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute.

9.2.3.2 OVC End Point CoS Name Ingress BWP Limits Service Attribute

The OVC End Point CoS Name Ingress BWP Limits Service Attribute limits the allowable values that *CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, and *EBS* can take on for each Bandwidth Profile Flow based on Class of Service Name. The value for this Service Attribute is *None* or a list of 9-tuples, one for each CoS Name. The elements of the 9-tuple are:

1. CoS Name

2. Allowed CIR Values

3. Allowed EIR Values

4. Allowed CIR_{max} Values
5. Allowed EIR_{max} Values
6. Allowed CBS Values
7. Allowed EBS Values
8. Total IR Upper Bound
9. Total IR Lower Bound

Each element in the 9-tuple is described in Sections 9.2.3.2.1 through 9.2.3.2.9.

[R84] When the value of the OVC End Point Elastic Behavior Service Attribute does not contain the Ingress Bandwidth Profile per Class of Service Name Service Attribute, then the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute **MUST** be *None*.

[R82] and [R84] mean that when the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute is either empty or has y = *Disabled* in every entry in the list of <x, y> pairs, then the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute is *None.*

[R85] When the value of the OVC End Point Elastic Behavior Service Attribute contains the Ingress Bandwidth Profile per Class of Service Name Service Attribute, then the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute **MUST NOT** be *None*.

9.2.3.2.1 CoS Name Element

The value of the CoS Name Element is a Class of Service Name that is contained in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute (Section 16.12 in MEF 26.2 [8]) for the OVC End Point.

[R86] If the OVC End Point Elastic Behavior Service Attribute includes the Ingress Bandwidth Profile per Class of Service Name Service Attribute, then for each pair <*x*, *y*> in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute (Section 16.12 in MEF 26.2 [8]), the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute **MUST** contain exactly one list entry with CoS Name Element equal to *x*.

9.2.3.2.2 Allowed CIR Values Element

The Allowed CIR Values Element specifies the possible values for *CIR* that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

An example of the value for the Allowed CIR Values Element is {0, 10 x10^6, 20 x10^6, 30 x10^6, 40 x10^6, 50 x10^6, 60 x10^6, 70 x10^6, 80 x10^6, 90 x10^6, 100 x10^6, 200 x10^6, 300 x10^6, 400 x10^6, 500 x10^6, 600 x10^6, 700 x10^6, 800 x10^6, 900 x10^6, 1000 x10^6}. This example contains 10 Mb/s granularity for values of *CIR* under 100 Mb/s and 100 Mb/s granularity for values of *CIR* between 100 Mb/s and 1 Gb/s.

[R87] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *CIR* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed CIR Values Element in the 9-tuple at all times.

[R88] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *CIR* for that CoS Name that is not contained in the value of the Allowed CIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R87] means that the value of *CIR* can only be an allowed value no matter what technique is used to establish the value. [R88] enforces compliance with [R87] when a Service Modification Request is used to establish a value.

9.2.3.2.3 Allowed EIR Values Element

The Allowed EIR Values Element specifies the possible values for *EIR* that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R89] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *EIR* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed EIR Values Element in the 9-tuple at all times.

[R90] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *EIR* for that CoS Name that is not contained in the value of the Allowed EIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R89] means that the value of *EIR* can only be an allowed value no matter what technique is used to establish the value. [R90] enforces compliance with [R89] when a Service Modification Request is used to establish a value.

9.2.3.2.4 Allowed CIR_{max} Values Element

The Allowed CIR_{max} Values Element specifies the possible values for CIR_{max} that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R91] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of CIR_{max} for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple at all times.

[R92] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of CIR_{max} for that CoS Name that is not contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R91] means that the value of CIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R92] enforces compliance with [R91] when a Service Modification Request is used to establish a value.

9.2.3.2.5 Allowed EIR_{max} Values Element

The Allowed EIR_{max} Values Element specifies the possible values for EIR_{max} that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R93] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of EIR_{max} for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple at all times.

[R94] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of EIR_{max} for that CoS Name that is not contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R93] means that the value of EIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R94] enforces compliance with [R93] when a Service Modification Request is used to establish a value.

9.2.3.2.6 Allowed CBS Values Element

The Allowed CBS Values Element specifies the possible values for *CBS* that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R95] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *CBS* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed CBS Values Element in the 9-tuple at all times.

[R96] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *CBS* for that CoS Name that is not contained in the value of the Allowed CBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R95] means that the value of *CBS* can only be an allowed value no matter what technique is used to establish the value. [R96] enforces compliance with [R95] when a Service Modification Request is used to establish a value.

9.2.3.2.7 Allowed EBS Values Element

The Allowed EBS Values Element specifies the possible values for *EBS* that can be in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R97] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the value of *EBS* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be contained in the value of the Allowed EBS Values Element in the 9-tuple at all times.

[R98] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *EBS* for that CoS Name that is not contained in the value of the Allowed EBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R97] means that the value of *EBS* can only be an allowed value no matter what technique is used to establish the value. [R98] enforces compliance with [R97] when a Service Modification Request is used to establish a value.

9.2.3.2.8 Total IR Upper Bound Element

The Total IR Upper Bound Element specifies an upper bound on the value *CIR* + *EIR* in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is an integer > 0 in bits per second.

[R99] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the sum of *CIR* and *EIR* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be less than or equal to the value of the Total IR Upper Bound Element in the 9-tuple at all times.

[R100] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Ingress Class of Service Name Bandwidth Profile Flow based on *x*, and *z* is greater than the value of the Total IR Upper Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R99] means that the value of *CIR* + *EIR* can only be less than or equal to the upper bound no matter what technique is used to establish the value. [R100] enforces compliance with [R99] when a Service Modification Request is used to establish a value.

9.2.3.2.9 Total IR Lower Bound Element

The Total IR Lower Bound Element specifies a lower bound on the value *CIR* + *EIR* in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute for a Valid Service Modification Request. The value for this element is an integer ≥ 0 in bits per second. This element might be useful to establish a constraint on the range of elasticity, e.g., 2 Gb/s at a UNI with port speed of 10 Gb/s, to facilitate better capacity planning within the Ethernet Operator network.

[R101] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, then the sum of *CIR* and *EIR* for that CoS Name in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute **MUST** be greater than or equal to the value of the Total IR Lower Bound Element in the 9-tuple at all times.

[R102] If a 9-tuple in the value of the OVC End Point CoS Name Ingress BWP Limits Service Attribute has the CoS Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Ingress Class of Service Name Bandwidth Profile Flow based on *x*, and *z* is less than the value of the Total IR Lower Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R101] means that the value of *CIR* + *EIR* can only be greater than or equal to the lower bound no matter what technique is used to establish the value. [R102] enforces compliance with [R101] when a Service Modification Request is used to establish a value.

[R103] For the OVC End Point CoS Name Ingress BWP Limits Service Attribute, for each 9-tuple, the value of the Total IR Upper Bound Element **MUST** be greater than or equal to the value of the Total IR Lower Bound Element.

9.2.3.3 OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute

The OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute specifies the allowable values that *CIR*, CIR_{max}, *EIR*, EIR_{max}, *CBS*, and *EBS* can take on for each Bandwidth Profile Flow based on Egress Equivalence Class Name (i.e., a Bandwidth Profile Flow meeting criterion 5 of [R230] in MEF 26.2 [8]). The value for this Service Attribute is *None* or a list of 9-tuples, one per Egress Equivalence Class Name. The elements of the 9-tuple are:

1. Egress Equivalence Class Name
2. Allowed CIR Values
3. Allowed EIR Values
4. Allowed CIR_{max} Values
5. Allowed EIR_{max} Values
6. Allowed CBS Values
7. Allowed EBS Values
8. Total IR Upper Bound
9. Total IR Lower Bound

Each element in the 9-tuple is described in Sections 9.2.3.3.1 through 9.2.3.3.9.

[R104] When the value of the OVC End Point Elastic Behavior Service Attribute does not contain the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute, then the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute **MUST** be *None*.

[R83] and [R104] mean that when the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute is either empty or has y = *Disabled* in every entry in the list of <x, y> pairs, then the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute is *None*.

[R105] When the value of the OVC End Point Elastic Behavior Service Attribute contains the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute, then the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute **MUST NOT** be *None*.

9.2.3.3.1 Egress Equivalence Class Name Element

The value of the Egress Equivalence Class Name Element is an Egress Equivalence Class Name that is contained in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute (Section 16.13 in MEF 26.2 [8]) for the OVC End Point.

[R106] When the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute is not *None*, then for each pair <*x*, *y*> in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute (Section 16.13 in MEF 26.2 [8]), the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute **MUST** contain exactly one list entry with Egress Equivalence Class Name Element equal to *x*.

9.2.3.3.2 Allowed CIR Values Element

The Allowed CIR Values Element specifies the possible values for the *CIR* that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

An example of the value for Allowed CIR Values Element is {0, 10 x10^6, 20 x10^6, 30 x10^6, 40 x10^6, 50 x10^6, 60 x10^6, 70 x10^6, 80 x10^6, 90 x10^6, 100 x10^6, 200 x10^6, 300 x10^6, 400 x10^6, 500 x10^6, 600 x10^6, 700 x10^6, 800 x10^6, 900 x10^6, 1000 x10^6}. This example contains 10 Mb/s granularity for values of *CIR* under 100 Mb/s and 100 Mb/s granularity for values of *CIR* between 100 Mb/s and 1 Gb/s.

[R107] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of *CIR* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed CIR Values Element in the 9-tuple at all times.

[R108] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *CIR* for that Egress Equivalence Class Name that is not contained in the value of the Allowed CIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R107] means that the value of *CIR* can only be an allowed value no matter what technique is used to establish the value. [R108] enforces compliance with [R107] when a Service Modification Request is used to establish a value.

9.2.3.3.3 Allowed EIR Values Element

The Allowed EIR Values Element specifies the possible values for *EIR* that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a

Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R109] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of *EIR* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed EIR Values Element in the 9-tuple at all times.

[R110] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *EIR* for that Egress Equivalence Class Name that is not contained in the value of the Allowed EIR Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R109] means that the value of *EIR* can only be an allowed value no matter what technique is used to establish the value. [R110] enforces compliance with [R109] when a Service Modification Request is used to establish a value.

9.2.3.3.4 Allowed CIR_{max} Values Element

The Allowed CIR_{max} Values Element specifies the possible values for CIR_{max} that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R111] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of CIR_{max} for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple at all times.

[R112] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of CIR_{max} for that Egress Equivalence Class Name that is not contained in the value of the Allowed CIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R111] means that the value of CIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R112] enforces compliance with [R111] when a Service Modification Request is used to establish a value.

9.2.3.3.5 Allowed EIR_{max} Values Element

The Allowed EIR_{max} Values Element specifies the possible values for EIR_{max} that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bits per second.

[R113] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of EIR_{max} for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple at all times.

[R114] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of EIR_{max} for that Egress Equivalence Class Name that is not contained in the value of the Allowed EIR_{max} Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R113] means that the value of EIR_{max} can only be an allowed value no matter what technique is used to establish the value. [R114] enforces compliance with [R113] when a Service Modification Request is used to establish a value.

9.2.3.3.6 Allowed CBS Values Element

The Allowed CBS Values Element specifies the possible values for *CBS* that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R115] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of *CBS* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed CBS Values Element in the 9-tuple at all times.

[R116] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *CBS* for that Egress Equivalence Class Name that is not contained in the value of the Allowed CBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R115] means that the value of *CBS* can only be an allowed value no matter what technique is used to establish the value. [R116] enforces compliance with [R115] when a Service Modification Request is used to establish a value.

9.2.3.3.7 Allowed EBS Values Element

The Allowed EBS Values Element specifies the possible values for *EBS* that can be in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is a non-empty set of non-negative integers in bytes.

[R117] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the value of *EBS* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be contained in the value of the Allowed EBS Values Element in the 9-tuple at all times.

[R118] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, and if a Service Modification Request for an Elastic Operator Ethernet Service has a requested value of *EBS* for that Egress Equivalence Class Name that is not contained in the value of the Allowed EBS Values Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R117] means that the value of *EBS* can only be an allowed value no matter what technique is used to establish the value. [R118] enforces compliance with [R117] when a Service Modification Request is used to establish a value.

9.2.3.3.8 Total IR Upper Bound Element

The Total IR Upper Bound Element specifies an upper bound on the value *CIR* + *EIR* in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is an integer > 0 in bits per second.

[R119] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the sum of *CIR* and *EIR* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be less than or equal to the value of the Total IR Upper Bound Element in the 9-tuple at all times.

[R120] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, if a Service Modification Request for an Elastic Operator Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Egress Bandwidth Profile Flow based on *x*, and *z* is greater than the value of the Total IR Upper Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R119] means that the value of *CIR* + *EIR* can only be less than or equal to the upper bound no matter what technique is used to establish the value. [R120] enforces compliance with [R119] when a Service Modification Request is used to establish a value.

9.2.3.3.9 Total IR Lower Bound Element

The Total IR Lower Bound Element specifies a lower bound on the value *CIR* + *EIR* in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute for a Valid Service Modification Request. The value for this element is an integer ≥ 0 in bits per second. This element might be useful to establish a constraint on the range of elasticity, e.g., 2 Gb/s at a UNI with port speed of 10 Gb/s, to facilitate better capacity planning within the Ethernet Operator network.

[R121] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, then the sum of *CIR* and *EIR* for that Egress Equivalence Class Name in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute **MUST** be greater than or equal to the value of the Total IR Lower Bound Element in the 9-tuple at all times.

[R122] If a 9-tuple in the value of the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute has the Egress Equivalence Class Name Element = *x*, if a Service Modification Request for an Elastic Operator Ethernet Service has requested values such that *CIR* + *EIR* = *z* for the Egress Bandwidth Profile Flow based on *x*, and *z* is less than the value of the Total IR Lower Bound Element in the 9-tuple, then the Service Modification Request **MUST** be declared *Invalid*.

[R121] means that the value of *CIR* + *EIR* can only be greater than or equal to the lower bound no matter what technique is used to establish the value. [R122] enforces compliance with [R121] when a Service Modification Request is used to establish a value.

[R123] For the OVC End Point Egress Equivalence Class Name Egress BWP Limits Service Attribute, for each 9-tuple, the value of the Total IR Upper Bound Element **MUST** be greater than or equal to the value of the Total IR Lower Bound Element.

9.3 Additional EVC and OVC Service Attributes

This section defines additional EVC and OVC Service Attributes. These Service Attributes are EVC Service Attributes in the case of Elastic Subscriber Ethernet Services and OVC Service Attributes in the case of Elastic Operator Ethernet Services.

Section 9.3.1 specifies the Elastic Ethernet Service Control SLS Service Attribute which details performance metrics and performance objectives related to Service Control.

Sections 9.3.2 through 9.3.7 specify Service Attributes whose values are used to determine the validity of a Service Modification Request independent of the requested value(s) for Elastic Ethernet Service Attribute(s). Sufficient conditions for a Service Modification Request to be declared *Invalid* are also specified.

For Elastic Subscriber Ethernet Services, EVC Service Attributes are not Elastic. For Elastic Operator Ethernet Services, OVC Service Attributes are not Elastic.

[R124] A Service Modification Request for an Elastic Subscriber Ethernet Service that requests changes in the value of one or more EVC Service Attributes for an EVC **MUST** be declared *Invalid*.

[R125] A Service Modification Request for an Elastic Operator Ethernet Service that requests changes in the value of one or more OVC Service Attributes for an OVC **MUST** be declared *Invalid*.

9.3.1 Elastic Ethernet Service Control SLS Service Attribute

The Elastic Ethernet Service Control SLS Service Attribute describes objectives relating to the Ethernet SP or Operator's handling of Service Modification Requests, in terms of the performance of Service Modification Request handling experienced by the Requestor. This contrasts with the EVC Service Level Specification Service Attribute (Section 8.8 in MEF 10.4 [5]) and the OVC Service Level Specification Service Attribute (Section 12.13 in MEF 26.2 [8]), which apply to the performance of qualified Ingress EI Frames as they are delivered across the network.

The Service Control Performance Metrics specified in the value of the Elastic Ethernet Service Control SLS Service Attribute can be evaluated over a different time period than the Performance Metrics in the EVC Service Level Specification Service Attribute or OVC Service Level Specification Service Attribute. The Service Control Performance Metrics apply during Available Time, during Unavailable Time, and during Maintenance Intervals. In addition, the Service Control Performance Metrics specified in the value of the Elastic Ethernet Service Control SLS Service Attribute are independent of CoS Names.

The value of the Elastic Ethernet Service Control SLS Service Attribute is *None* or a 3-tuple of the form $\langle tse, Te, PMe \rangle$ where:

- tse is a UTC time value specified to the second that represents the date and time for the start of the Service Control SLS.[1]
- Te is a time duration, e.g., 1 year, that is used in conjunction with tse to specify time intervals for determining when Service Control Performance Objectives are met.
- PMe is a non-empty list where each element in the list consists of a Service Control Performance Metric Name, a list of parameter values specific to the definition of the Service Control Performance Metric, and a Service Control Performance Objective.

Note that the units for Te are not constrained; in particular, 1 month is an allowable value for Te, corresponding to a calendar month, e.g. from midnight on the 10th of one month up to but not including midnight the 10th of the following month.

A Service Control Performance Metric is a quantitative characterization of the Service Control quality experienced by the Requestor. This section specifies the following Service Control Performance Metrics all of which apply to an Elastic Ethernet Service:

[1] Note that tse is the start of the Service Control SLS and might not be the time that a service is first turned up.

- Acceptance Decision Duration Performance Metric (Section 9.3.1.1),
- Change Duration Performance Metric (Section 9.3.1.2),
- Request Acceptance Ratio Performance Metric (Section 9.3.1.3), and
- Change Success Ratio Performance Metric (Section 9.3.1.4).

Performance Objectives are represented by symbols with a "hat", e.g., $\widehat{ADD}$, and a function value that is to be compared to a Performance Objective is indicated by a "bar", e.g., $\overline{ADD}$.

A Service Control Performance Metric has a Performance Objective whose values reflect the agreed Service Control quality.

[R126] If PMe contains an entry with a given Service Control Performance Metric Name, then the entry **MUST** specify the related parameters, if any, and the Service Control Performance Objective for that Service Control Performance Metric as specified in the Sections 9.3.1.1 through 9.3.1.4.

When the value of the Elastic Ethernet Service Control SLS Service Attribute is a 3-tuple, PMe always contains at least one, but not necessarily all, Service Control Performance Metrics. For example, PMe can contain only the Request Acceptance Ratio Performance Metric. Furthermore, PMe can contain multiple instances of a given Service Control Performance Metric. However, each repeated Service Control Performance Metric needs to have a unique parameter value and Performance Objective value in order to be meaningful. For example, PMe might equal $\{\{\text{Change Duration}, 60{,}000\ ms, 0.5\}, \{\text{Change Duration}, 900{,}000\ ms, 0.8\}, \{\text{Change Duration}, 3.6 \times 10^6\ ms, 0.99\}\}$ which means, per Section 9.3.1.2, that the Ethernet SP or Operator is committed to making at least 50 percent of changes in no more than 1 minute, at least 80 percent of the changes in no more than 15 minutes, and at least 99 percent of the changes in no more than 60 minutes.

For the Elastic Ethernet Service Control SLS Service Attribute, the sequence $\{Te_k, k = 0,1,2, \dots\}$ is used where, using notation [x,y) to identify a range of values that is inclusive of x but exclusive of y,

$$Te_k = [tse + kTe, tse + (k+1)Te)$$

Each element of $\{Te_k\}$ is used for assessing the success in meeting the Service Control Performance Objectives in the value of the Elastic Ethernet Service Control SLS Service Attribute.

9.3.1.1 Acceptance Decision Duration Performance Metric

The Acceptance Decision Duration Performance Metric characterizes how quickly the Ethernet SP or Operator sends the Request Disposition Notification (Section 8.3.3) to the Requestor. Informally, the Acceptance Decision Duration Performance Metric indicates the proportion of Valid Modification Requests made by the Requestor that the Ethernet SP or Operator *Accepted* or *Rejected* within a specified duration.

Let Total Valid Requests, $TVR\ (Te_k)$, be the number of Service Modification Requests for a given Elastic Ethernet Service received by the Ethernet SP or Operator during the time interval Te_k that were declared to be *Valid* and ultimately either *Accepted* or *Rejected*. The value of $TVR\ (Te_k)$ might not be known until sometime after the end of Te_k, since there might be some Service Modification Requests that were received during Te_k and subsequently declared *Valid*, but which have not yet been *Accepted* or *Rejected* at the end of Te_k. The value of $TVR\ (Te_k)$ is not known until all such requests are *Accepted*, *Rejected*, declared *Invalid*, or cancelled. Note that a Service Modification Request that is cancelled before it is *Accepted* or *Rejected* is not included in $TVR\ (Te_k)$.

The Acceptance Duration Target (ADT) is a parameter for the Acceptance Decision Duration Performance Metric expressed as a positive integer in milliseconds. Let $\widehat{TVR}(Te_k)$ be the number of Service Modification Requests counted in $TVR\ (Te_k)$ for which $\Delta t_{AD} \leq ADT$, where Δt_{AD} is the duration of the time interval between the time when the Ethernet SP or Operator sends the Request Response Notification to the Requestor and the time when the Ethernet SP or Operator sends the Request Disposition Notification to the Requestor. Note that a Service Modification Request that is cancelled before it is *Accepted* or *Rejected* is not included in $\widehat{TVR}(Te_k)$.

[R127] ADT **MUST** be less than the value of the Minimum Lead Time Service Attribute (Section 9.3.2).

Then the Acceptance Decision Duration Performance Metric, $\overline{ADD}(Te_k)$, is defined as

$$\overline{ADD}(Te_k) = \begin{cases} \dfrac{\widehat{TVR}(Te_k)}{\text{TVR}\ (Te_k)} & \text{if TVR}\ (Te_k) > 0 \\ 1 \text{ otherwise} \end{cases}$$

Table 7 shows what is contained in the PMe entry for the Acceptance Decision Duration Performance Metric.

Item	Value
Service Control Performance Metric Name	Acceptance Decision Duration
ADT	A time duration in milliseconds
$\widehat{ADD}$	Performance Objective as a number between 0 and 1 inclusive

Table 7 – *PMe* Entry for the Acceptance Decision Duration Performance Metric

[R128] The Service Control SLS **MUST** define the Acceptance Decision Duration Performance Objective as met over Te_k for a PMe entry of the form in Table 7 if and only if $\overline{ADD}(Te_k) \geq \widehat{ADD}$.

9.3.1.2 Change Duration Performance Metric

The Change Duration Performance Metric characterizes how quickly changes resulting from an Accepted Service Modification Request are enacted by the Ethernet SP or Operator. Informally,

the Change Duration Performance Metric indicates the proportion of changes that were completed (successfully or unsuccessfully) within a specified duration.

Define the Total Accepted Changes, $TAC(Te_k)$, as the sum of:

- The number of changes that were scheduled to be initiated during Te_k when the value of the *Start Time* parameter was not *ASAP*.
- The number of changes that were initiated during Te_k when the value of the *Start Time* parameter was *ASAP*.

Note that Accepted Service Modification Requests (Section 8) can result in changes that are scheduled to be initiated in a time interval Te_k after the time interval in which the Service Modification Request was received by the Ethernet SP or Operator. Note also that Service Modification Requests with a *Request Type* parameter = *Reverting Change*, *Periodic Change*, or *Reverting Periodic Change* can result in multiple changes being scheduled, and that these might not all be scheduled to be initiated in the same time interval Te_k. Note that a change that is not initiated because of the cancellation of the corresponding Service Modification Request is not included in $TAC(Te_k)$.

The Change Duration Target (CDT) is a parameter for the Change Duration Performance Metric expressed as a positive integer in milliseconds.

Define Δt_{CD} as follows:

- If the value of the *Start Time* parameter is not *ASAP*, Δt_{CD} is the duration of the time interval between the time when the change was scheduled to start and the time when the Ethernet SP or Operator sends the End Change Notification to the Requestor.
- If the value of the *Start Time* parameter is *ASAP*, Δt_{CD} is the duration of the time interval between when the changes are initiated and the time when the Ethernet SP or Operator sends the End Change Notification to the Requestor.

Define $\widetilde{TAC}(Te_k)$ as the sum of:

- The number of changes that were scheduled to be initiated during Te_k for which $\Delta t_{CD} \leq CDT$ when the value of the *Start Time* parameter was not *ASAP*.
- The number of changes that were initiated during Te_k for which $\Delta t_{CD} \leq CDT$ when the value of the *Start Time* parameter was *ASAP*.

Note that a change that is not initiated because of the cancellation of the corresponding Service Modification Request is not included in $\widetilde{TAC}(Te_k)$.

Then the Change Duration Performance Metric is defined as

$$\overline{CD}(Te_k) = \begin{cases} \dfrac{\widetilde{TAC}(Te_k)}{\text{TAC }(Te_k)} & \text{if TAC } (Te_k) > 0 \\ 1 \text{ otherwise} \end{cases}$$

[R129] The value of CDT **MUST** be strictly less than the value of Modification Maintenance Interval Limit Service Attribute (Section 9.3.7).

Table 8 shows what is contained in the PMe entry for the Change Duration Service Control Performance Metric.

Item	Value
Service Control Performance Metric Name	Change Duration
CDT	A time duration in milliseconds
$\widehat{CD}$	Performance Objective as a number between 0 and 1 inclusive

Table 8 – *PMe* entry for the Change Duration Performance Metric

[R130] The Service Control SLS **MUST** define the Change Duration Performance Objective as met over Te_k for a PMe entry of the form in Table 8 if and only if $\overline{CD}(Te_k) \geq \widehat{CD}$.

9.3.1.3 Request Acceptance Ratio Performance Metric

The Request Acceptance Ratio Performance Metric characterizes the proportion of Valid Service Modification Requests that are *Accepted* by the Ethernet SP or Operator.

Let $TVR(Te_k)$ be defined as described in Section 9.3.1.1. Let Total Accepted Requests, $TAR(Te_k)$, be the number of Service Modification Requests counted in $TVR(Te_k)$ that were *Accepted*. Note that a Service Modification Request that is not *Accepted* because of the cancellation of the corresponding Service Modification Request is not included in $TAR(Te_k)$ since it is not included in $TVR(Te_k)$.

Then the Request Acceptance Ratio Performance Metric is defined as

$$\overline{RAR}(Te_k) = \begin{cases} \dfrac{TAR(Te_k)}{TVR(Te_k)} & \text{if } TVR(Te_k) > 0 \\ 1 \text{ otherwise} \end{cases}$$

Table 9 shows what is contained in the PMe entry for the Request Acceptance Ratio Performance Metric.

Item	Value
Service Control Performance Metric Name	Request Acceptance Ratio
$\widehat{RAR}$	Performance Objective as a number between 0 and 1 inclusive

Table 9 – *PMe* entry for the Request Acceptance Ratio Performance Metric

[R131] The Service Control SLS **MUST** define the Request Acceptance Ratio Performance Objective as met over Te_k for a PMe entry of the form in Table 9 if and only if $\overline{RAR}(Te_k) \geq \widehat{RAR}$.

9.3.1.4 Change Success Ratio Performance Metric

The Change Success Ratio Performance Metric characterizes the proportion of changes specified by Accepted Service Modification Requests that are successfully fulfilled by the Ethernet SP or Operator.

Let Total Accepted Changes, $TAC(Te_k)$, be as defined in Section 9.3.1.2. Let Total Fulfilled Changes, $TFC(Te_k)$, be the sum of:

- The number of changes that were scheduled to be initiated during Te_k and that were successfully fulfilled when the value of the *Start Time* parameter was not ASAP.
- The number of changes that were initiated during Te_k and that were successfully fulfilled when the value of the *Start Time* parameter was *ASAP*.

Note that a change that is scheduled but that is not initiated cannot be successfully fulfilled, and therefore is not included in $TFC(Te_k)$. Note also that the time of successful fulfillment may occur outside of Te_k. In other words, the Modification Maintenance Interval may begin in Te_k and end outside of Te_k. These successful fulfillments are still counted in the Te_k in which they were initiated.

Then the Change Success Ratio Performance Metric is defined as

$$\overline{CSR}(Te_k) = \begin{cases} \dfrac{TFC(Te_k)}{TAC(Te_k)} & \text{if } TAC(Te_k) > 0 \\ 1 \text{ otherwise} \end{cases}$$

Table 10 shows what is contained in the PMe entry for the Change Success Ratio Performance Metric.

Item	Value
Service Control Performance Metric Name	Change Success Ratio
$\widehat{CSR}$	Performance Objective as a number between 0 and 1 inclusive

Table 10 – *PMe* entry for the Change Success Ratio Performance Metric

[R132] The Service Control SLS **MUST** define the Change Success Ratio Performance Objective as met over Te_k for a PMe entry of the form in Table 10 if and only if $\overline{CSR}(Te_k) \geq \widehat{CSR}$.

9.3.2 Minimum Lead Time Service Attribute

The Minimum Lead Time Service Attribute provides a lower bound on the difference between the time a change is scheduled for and the time that the Service Modification Request is received by the Ethernet SP or Operator. The value for this Service Attribute is an integer > 0 in seconds.

[R133] A Service Modification Request for a given Elastic Ethernet Service **MUST** be declared *Invalid* if the value of the *Start Time* parameter is not *ASAP* and the value of the *Start Time* parameter minus the value of the Request Time is less than the value of the Minimum Lead Time Service Attribute for that service.

[R134] For a Service Modification Request for a given Elastic Ethernet Service with the *Request Type* parameter = *One-Time Change* and the value of the *Start Time* parameter = *ASAP*, the time that the change is initiated **MUST** be at or before the value of the Request Time plus the value of the Minimum Lead Time Service Attribute.

9.3.3 Maximum Lead Time Service Attribute

The Maximum Lead Time Service Attribute provides an upper bound on the difference between the time the change is scheduled for and the time that the Service Modification Request is received by the Ethernet SP or Operator. The value for this Service Attribute is an integer > 0 in hours.

[R135] A Service Modification Request for a given Elastic Ethernet Service **MUST** be declared *Invalid* if the value of the *Start Time* parameter is not *ASAP* and if any of the following conditions hold:

1. The value of the *Start Time* parameter minus the value of the Request Time is greater than the value of the Maximum Lead Time Service Attribute for that service.

2. The value of the *Revert Time* parameter minus the value of the Request Time is greater than the value of the Maximum Lead Time Service Attribute for that service.

3. The value of the *Period* parameter is greater than the value of the Maximum Lead Time Service Attribute for that service.

Because of [R135], it is important that the value of the Maximum Lead Time Service Attribute be sufficiently large to meet the needs of the Requestor. For example, suppose the Requestor needs to change an Elastic Service Attribute value annually. Then item 3 of [R135] means that the value of the Maximum Lead Time Service Attribute needs to be at least one year to allow the Requestor to use a Periodic Change Service Modification Request to effect the annual changes.

9.3.4 Maximum Request Density Service Attribute

The Maximum Request Density Service Attribute provides upper bounds on the number of Service Modification Requests for a given Elastic Ethernet Service that can be declared *Valid* in one or more time durations. The value for this Service Attribute is a non-empty list of 2-tuples of the form $\langle r, \omega \rangle$ where r is an integer > 0 and ω is an integer > 0 in minutes. The number of

Service Modification Requests that can be declared *Valid* during any interval of duration ω is limited to at most r.

[R136] A Service Modification Request for a given Elastic Ethernet Service **MUST** be declared *Invalid* if there exists a 2-tuple $\langle r, \omega \rangle$ in the value of the Maximum Request Density Service Attribute such that counting this Service Modification Request results in more than r Service Modification Requests for that service having a Request Time value within the time interval of duration ω that ends at the Request Time of this Service Modification Request.

For example, suppose the value is {<12, 1440>, <1000, 525600>}. If a Service Modification Request has the Request Time = t, and there were one thousand Service Modification Requests for the same service with Request Time values in the 525600 min before t, then this Service Modification Request is mandated to be declared *Invalid* per [R136].

9.3.5 Minimum Change Separation Service Attribute

The Minimum Change Separation Service Attribute provides a lower bound on the separation in time of consecutive changes to the value of an Elastic Ethernet Service Attribute for a given Elastic Ethernet Service. In other words, the value of the Elastic Ethernet Service Attribute cannot be changed by a Service Modification Request until the value of the Minimum Change Separation Service Attribute has elapsed since it was last changed by a Service Modification Request. The changes can be a result of a single or multiple Service Modification Requests. The value for this Service Attribute is an integer > 0 seconds.

[R137] A Service Modification Request for a given Elastic Ethernet Service **MUST** be declared *Invalid* if one or more of the following conditions hold:

1. The value of the *Request Type* parameter is *Reverting Change* or *Reverting Periodic Change* and the value of the *Revert Time* parameter minus the value of the *Start Time* parameter is less than the value of the Minimum Change Separation Service Attribute for that service.

2. The value of the *Request Type* parameter is *Reverting Periodic Change* and the value of the *Start Time* parameter plus the value of the *Period* parameter minus the value of the *Revert Time* parameter is less than the value of the Minimum Change Separation Service Attribute for that service.

Condition 1 of [R137] also means that a Service Modification Request will be declared *Invalid* if the value of *Revert Time* parameter is earlier than the value of *Start Time* parameter.

[R137] is for checking a single Service Modification Request. See additional discussion in Section 10.2 for validation of multiple Service Modification Requests for a Service Attribute at the same UNI, EVC EP and OVC End Point.

9.3.6 Minimum Period Service Attribute

The Minimum Period Service Attribute provides a lower bound on the period between successive changes when the value of the *Request Type* parameter in the Service Modification Request is *Periodic Change* or *Reverting Periodic Change*. The value for this Service Attribute is an integer > 0 seconds.

[R138] The value for the Minimum Period Service Attribute **MUST** be greater than two times the value of the Minimum Change Separation Service Attribute (Section 9.3.5).

[R139] A Service Modification Request for a given Elastic Ethernet Service **MUST** be declared *Invalid* if the value of *Period* parameter is less than the value of the Minimum Period Service Attribute for that service.

9.3.7 Modification Maintenance Interval Limit Service Attribute

The Modification Maintenance Interval Limit Service Attribute limits the amount of time that an Elastic Ethernet Service can be in the Modification Maintenance Interval invoked when the changes in Elastic Ethernet Service Attribute values requested by a Service Modification Request are being instantiated. The value for this Service Attribute is an integer > 0 seconds.

When the Ethernet SP or Operator enacts a requested change, they need to either complete the change successfully within the Modification Maintenance Interval Limit or restore the initial state within the Modification Maintenance Interval Limit.

[R140] If the Ethernet SP or Operator enacts a change resulting from an Accepted Service Modification Request for a given Elastic Ethernet Service in which the value of the *Start Time* parameter is not equal to *ASAP*, then by a time equal to the time the change was scheduled to be initiated plus the value of the Modification Maintenance Interval Limit Service Attribute, one of the following conditions **MUST** hold:

- The change has been successfully applied and the new values are operational and an End Change Notification has been sent indicating *Success*, or
- The values in force, before the change was initiated, remain in force as if no change had been made and an End Change Notification has been sent indicating *Fail*.

[R141] If the Ethernet SP or Operator enacts a change resulting from an Accepted Service Modification Request for a given Elastic Ethernet Service in which the value of the *Start Time* parameter is equal to *ASAP*, then by a time equal to the time the change was initiated plus the value of the Modification Maintenance Interval Limit Service Attribute, one of the following conditions **MUST** hold:

- The change has been successfully applied and the new values are operational and an End Change Notification has been sent indicating *Success*, or
- The values in force, before the change was initiated, remain in force as if no change had been made and an End Change Notification has been sent indicating *Fail*.

[R140] and [R141] mean that, if the Ethernet SP or Operator cannot make a change within a Modification Maintenance Interval of duration less than or equal to the value of the Modification Maintenance Interval Limit Service Attribute, then they are mandated to make none of the changes in the Service Modification Request.

[R142] The value of the Modification Maintenance Interval Limit Service Attribute for a given Elastic Ethernet Service **MUST** be less than the value of the Minimum Change Separation Service Attribute value (Section 9.3.5) for that service.

9.3.8 Allowed Request Types Service Attribute

The value of the Allowed Request Types Service Attributes is a non-empty list containing 1, 2, 3, or 4 items. Each item is a value for the *Request Type* Parameter (Section 8.1.1) with a given such value appearing at most once as an item in the list.

[R143] A Service Modification Request for a given Elastic Ethernet Service with a value of the *Request Type* parameter that is not in the value of the Allowed Request Types Service Attribute for that service **MUST** be declared *Invalid*.

10 Service Control Behavior

This section specifies the required behavior of the Ethernet SP or Operator when handling Service Modification Requests.

10.1 State Machine

The behavior required of an Ethernet SP or Operator when handling Service Modification Requests is described in terms of a state machine; however, the Ethernet SP or Operator is not required to implement this directly. Any implementation that exhibits the same externally visible behavior as the state machine described in this section is acceptable. The state machine is described using the following states for each Service Modification Request received by the Ethernet SP or Operator. The states:

- **Check Valid:** The Service Modification Request is being checked to see if it is *Valid* by the Ethernet SP or Operator.
- **Is Valid:** The Service Modification Request was determined to be *Valid* and the Ethernet SP or Operator is determining if the Service Modification Request can be *Accepted*.
- **Accepted:** The Service Modification Request is *Accepted* and the committed changes are not yet initiated.
- **One-Time Change Process:** Changes in the values of the Elastic Ethernet Service Attributes specified in a One-Time Change Service Modification Request type are being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.
- **Periodic Change Process:** Changes in the values of the Elastic Ethernet Service Attributes specified in a Periodic Change Service Modification Request type are being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.
- **Initial Change Process:** Changes to the first values of the Elastic Ethernet Service Attributes specified in a Reverting Change Service Modification Request type are being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.
- **Wait Revert:** Changes to the first values of the Elastic Ethernet Service Attributes specified in a Reverting Change Service Modification Request type have been made and it is too early to change to the second values.
- **Revert Process:** Changes to the second values of the Elastic Ethernet Service Attributes specified in a Reverting Change Service Modification Request type are

being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.

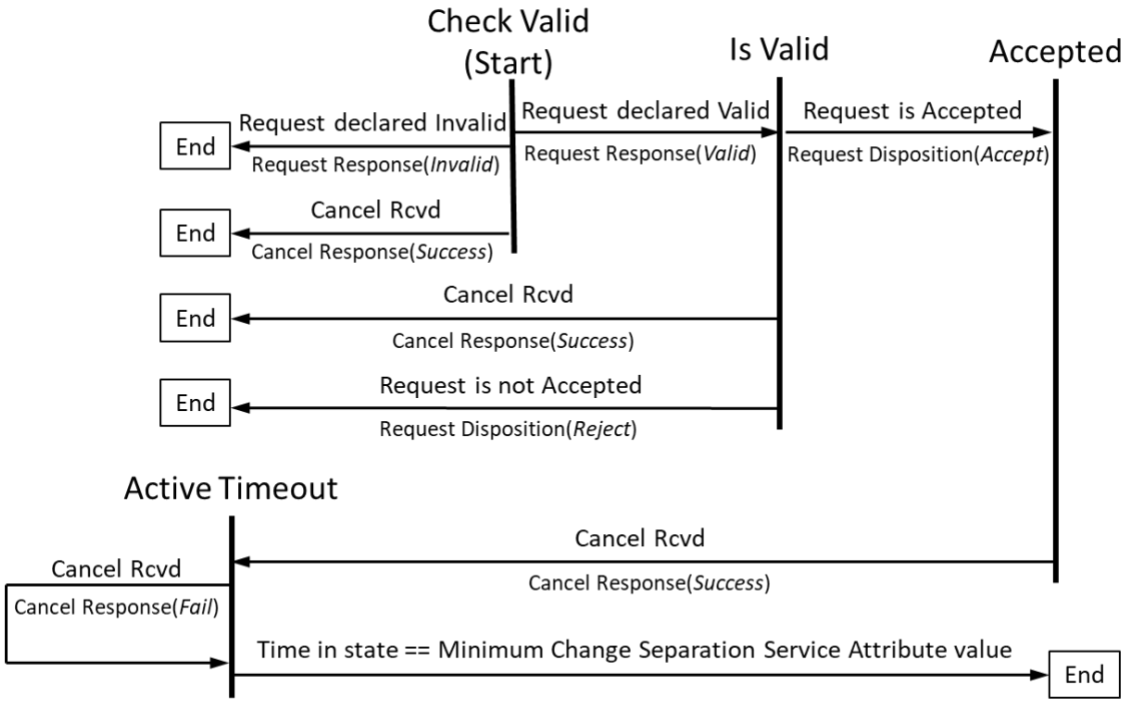
- **Begin Reverting Periodic Process:** Changes to the first values of the Elastic Ethernet Service Attributes specified in a Reverting Periodic Change Service Modification Request type are being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.

- **Wait Reverting Periodic Revert:** Changes to the first values of the Elastic Ethernet Service Attributes specified in a Reverting Periodic Change Service Modification Request type have been made and it is too early to change to the second values.

- **Reverting Periodic Revert Process:** Changes to the second values of the Elastic Ethernet Service Attributes specified in a Reverting Periodic Change Service Modification Request type are being attempted. A Modification Maintenance Interval is in effect for the Service Modification Request.

- **Active Timeout:** No further actions will be taken by the Ethernet SP or Operator regarding the Service Modification Request but the state machine continues to exist.

Due to the complexity of the state machine, the specification is broken up into Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19. Transitions between states are represented by arrows. The text above each arrow specifies the events and/or conditions that trigger the state transition. The text below each arrow, when present, specifies the Notification that is sent from the Ethernet SP or Operator to the Requestor. The current time is represented by “t”.



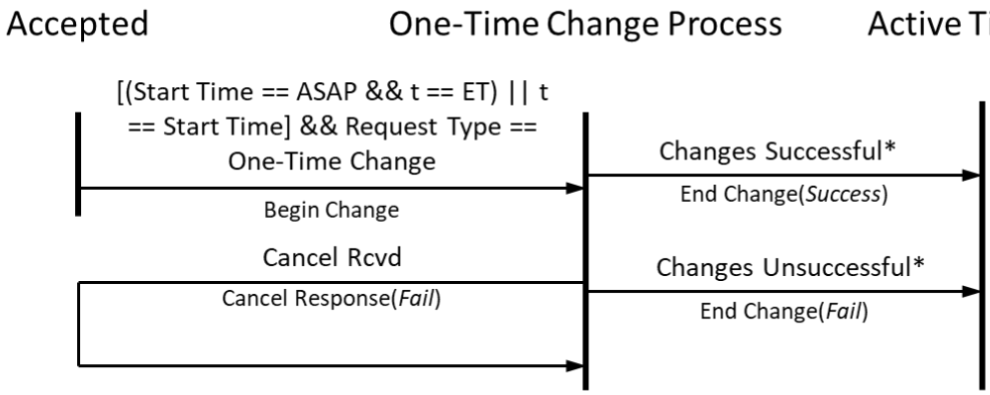
Start: The Service Modification Request is received by the Ethernet SP or Operator and the State Machine is created.
End: Processing of the Service Modification Request is completed and the State Machine is destroyed.

Figure 15 – State Machine Part 1: Initial Handling

The duration of the time interval between the receiving of the Service Modification Request by the Ethernet SP or Operator and the sending of the Request Response Notification by the Ethernet SP or Operator is referred to as Δt_{req}.

[D1] Δt_{req} **SHOULD** be less than or equal to 30 seconds.

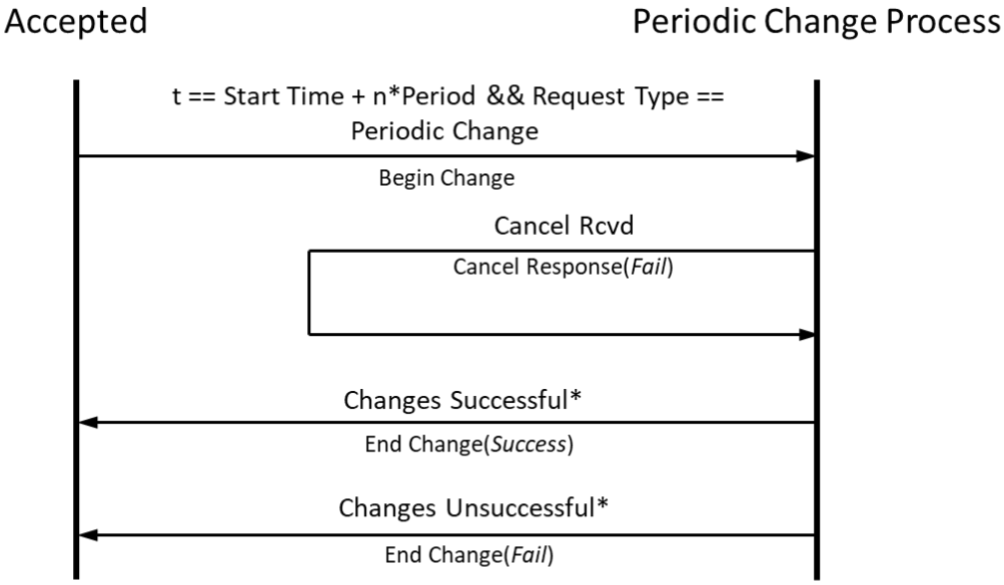
Additional transitions into and out of the Accepted state are included in Figure 16, Figure 17, Figure 18, and Figure 19. Additional transitions into the Active Timeout State are included in Figure 16, Figure 18, and Figure 19.



ET: ET stands for the earliest time that the Ethernet SP or Operator is able to initiate the change.

* Either the Changes Successful event or the Changes Unsuccessful event always occurs while the Service Modification Request is in the One-Time Change Process state.

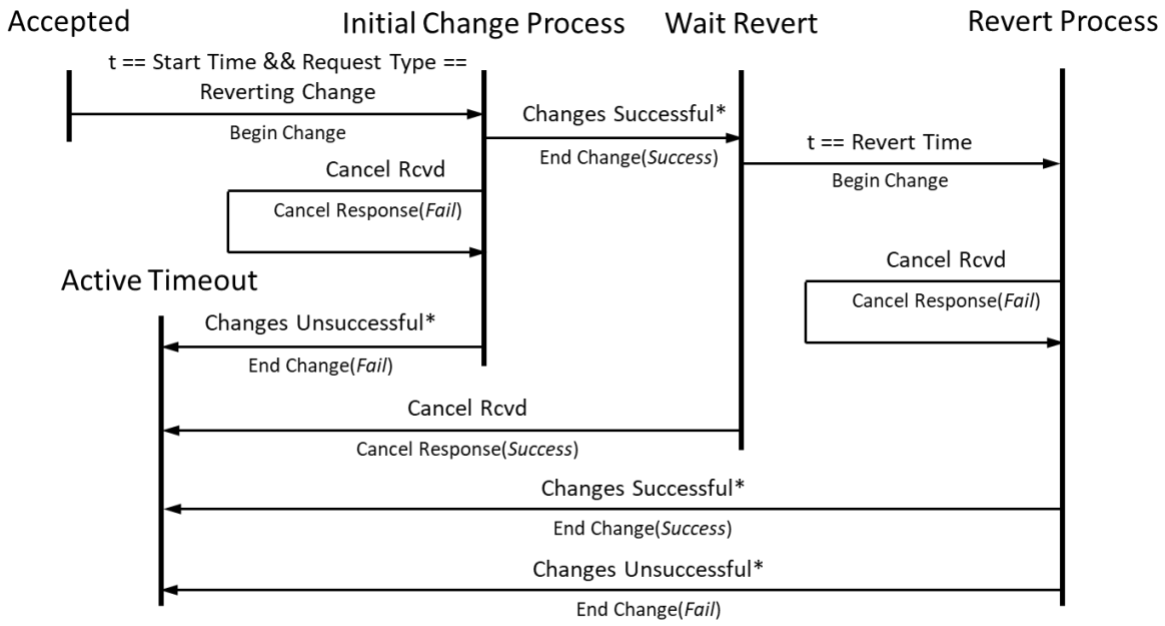
Figure 16 – State Machine Part 2: One Time Change



n = 0, 1, ….

* Either the Changes Successful event or the Changes Unsuccessful event always occurs while the Service Modification Request is in the Periodic Change Process state.

Figure 17 – State Machine Part 3: Periodic Change

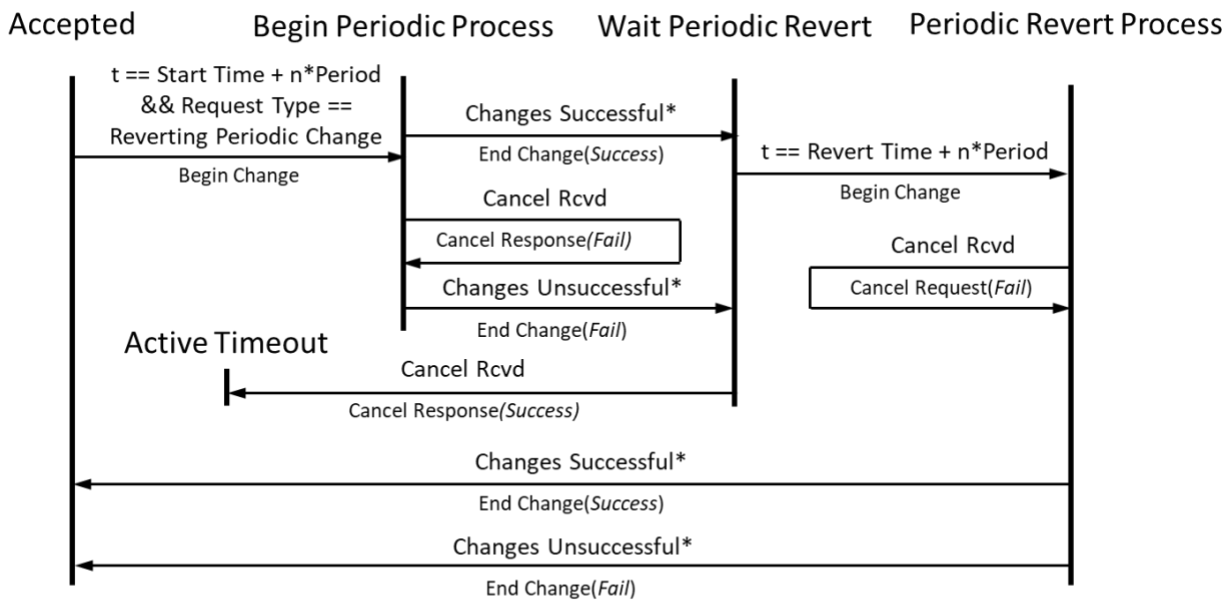


* Either the Changes Successful event or the Changes Unsuccessful event occurs while the Service Modification Request is in the Initial Change Process state and the Revert Process State.

Figure 18 – State Machine Part 4: Reverting Change

Regarding Figure 18, note that the values of the Elastic Ethernet Service Attributes impacted by the Service Modification Request will not revert to their second requested values if either:

- There is a transition from the Revert Process state to the Active Timeout state due to the Changes Unsuccessful event, or
- There is a transition from the Wait Revert state to the Active Timeout state due to the Cancel Received event.



n = 0, 1, 2, ...

* Either the Changes Successful event or the Changes Unsuccessful event occurs while the Service Modification Request is in the Begin Periodic Process state and the Periodic Revert Process State.

Figure 19 – State Machine Part 5: Reverting Periodic Change

[R144] The externally visible behavior of the Elastic Ethernet Service relating to handling Service Modification Requests, in terms of the Service Attribute values observed and the Notifications received by the Requestor, **MUST** be indistinguishable from that specified by the state machine described in Figure 15, Figure 16, Figure 17, Figure 18, and Figure 19.

10.2 Conflicting Service Modification Requests

Part of the process of determining the validity of a Service Modification Request is to check to see if it conflicts with a Valid Service Modification Request.

For the purpose of describing when Service Modification Requests conflict, the "change time" for a change resulting from a Service Modification Request with the value of *Start Time* parameter = *ASAP* is taken to be the Request Time plus the value of the Minimum Lead Time Service Attribute, if the change has not yet been initiated, or the time the change was initiated otherwise; for other Service Modification Requests, the "change time" is the time the change is scheduled to be initiated. Recall that Service Modification Requests with *Request Type* parameter = *Periodic Change*, *Reverting Change* or *Reverting Periodic Change* can result in multiple changes.

A Service Modification Request whose state machine is in the Check Valid state is said to overlap with a Valid Service Modification Request if any change resulting from the Service Modification Request in the Check Valid state has a change time that differs from the change time of any change resulting from the Valid Service Modification Request by less than the value of the Minimum Change Separation Service Attribute. In other words, the Service Modification

Requests overlap if there is any pair of changes, one for each Service Modification Request, whose change times differ by less than the value of the Minimum Change Separation Service Attribute.

Note that when the state machine for a Service Modification Request ends by exiting the Active Timeout state (see Figure 15), all changes made via the Service Modification Request have been in place for at least the value of the Minimum Change Separation Service Attribute. Thus a Service Modification Request in the Check Valid state cannot overlap with a Service Modification Request whose state machine has ended.

Note that in the case of comparing a Service Modification Request with *Request Type* parameter = *Periodic Change* or *Reverting Periodic Change* against a Service Modification Request with *Request Type* parameter = *Periodic Change* or *Reverting Periodic Change*, the above condition naively involves checking an infinite number of change times from one Service Modification Request against an infinite number of change times from the other Service Modification Request; but of course in practice, it is sufficient to consider the *Start Time* parameter and *Period* parameter values of the two requests in order to determine whether any of the resulting infinite series of changes will overlap. Note that at a given time, a Service Modification Request whose state machine is in the Check Valid State might overlap with a Valid Service Modification Request whose state machine is in the Active Timeout state. Also note that such an overlap might cease if the state machine for the new Service Modification Request remains in the Check Valid State sufficiently long but see [D1]. The exact time that a Service Modification Request whose state machine is in the Check Valid State is assessed for overlap with Valid Service Modification Requests is beyond the scope of this standard.

A Service Modification Request whose state machine is in the Check Valid state at a given time for a given Elastic Ethernet Service is said to conflict with a Valid Service Modification Request for the Elastic Ethernet Service when it:

- Overlaps with the Valid Service Modification Request and
- Requests a change to a value of the same Elastic Ethernet Service Attribute and the same UNI, EVC EP or OVC End Point as the Valid Service Modification Request.

[R145] A Service Modification Request for an Elastic Ethernet Service whose state machine is in the Check Valid State **MUST** be declared *Invalid* if it conflicts with a Valid Service Modification Request.

[R146] A Service Modification Request for an Elastic Subscriber Ethernet Service **MUST** be declared *Invalid* if enacting the requested changes, given existing Valid Service Modification Requests, would at any time cause a mandatory requirement in MEF 10.4 [5] to be violated.

[R147] A Service Modification Request for an Elastic Operator Ethernet Service **MUST** be declared *Invalid* if enacting the requested changes, given existing Valid Service Modification Requests, would at any time cause a mandatory requirement in MEF 26.2 [8] to be violated.

11 Elastic Ethernet Cloud Connectivity Services

The Service Attribute values for Elastic Subscriber Ethernet Services and Elastic Operator Ethernet Services defined in Section 9 can be constrained to define Elastic Ethernet Cloud Connectivity Services to support the use cases discussed in Section 7. Two Elastic Cloud Connectivity Services are defined in this section:

- Elastic Subscriber Ethernet Cloud Connectivity Service which is based on MEF 6.3 [4] services, and
- Elastic Operator Ethernet Cloud Connectivity Service which is based on MEF 51.1 [11] services.

[R148] An Elastic Subscriber Ethernet Cloud Connectivity Service **MUST** comply with the requirements for one of the EPL, EVPL, EP-LAN, EVP-LAN, EP-Tree, or EVP-Tree services specified in MEF 6.3 [4].

[R149] An Elastic Operator Ethernet Cloud Connectivity Service **MUST** comply with the requirements for one of the Access E-Line, Transit E-Line, Access E-LAN or Transit E-LAN services specified in MEF 51.1 [11].

Given [R1], Elastic Subscriber Ethernet Cloud Connectivity Service and Elastic Operator Ethernet Cloud Connectivity Service are mandated to meet the requirements in this standard.

11.1 Elastic Subscriber Ethernet Cloud Connectivity Services

Subscriber Ethernet Services are defined in MEF 6.3 [4] with Service Attributes specified in MEF 10.4 [5] and MEF 45.1 [9]. This section provides the complete list of Service Attributes and specifies additional requirements or constraints for the Elastic Subscriber Ethernet Cloud Connectivity Service.

In Table 11, Table 12, and Table 13:

- A row with shaded cells indicates a new Service Attribute from this standard.
- "No additional constraints from appropriate service in MEF 6.3 [4]" means that, for an Elastic Subscriber Cloud Connectivity Service, the Service Attribute value can be any value allowed by MEF 6.3 where "appropriate service" refers to the MEF 6.3 service that this Elastic Subscriber Ethernet Cloud Connectivity Service is based on.
- "No additional constraints from an Elastic Ethernet Service" means that, for an Elastic Subscriber Cloud Connectivity Service, the Service Attribute value can be any value allowed by Section 8 and Section 9.

11.1.1 EVC Service Attributes

EVC Service Attributes are specified in MEF 10.4 [5] for Subscriber Ethernet Services defined in MEF 6.3 [4]. This section provides the complete list of EVC Service Attributes and specifies additional requirements or constraints for the Elastic Subscriber Ethernet Cloud Connectivity Service.

EVC Service Attribute	Constraints
EVC ID	No additional constraints from appropriate service in MEF 6.3 [4].
EVC List of EVC EPs	No additional constraints from appropriate service in MEF 6.3 [4].
EVC Type	No additional constraints from appropriate service in MEF 6.3 [4].
EVC Data Service Frame Disposition	No additional constraints from appropriate service in MEF 6.3 [4].
EVC C-Tag PCP Preservation	No additional constraints from appropriate service in MEF 6.3 [4].
EVC C-Tag DEI Preservation	No additional constraints from appropriate service in MEF 6.3 [4].
EVC List of Class of Service Names	**[D2]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, the value of the EVC List of Class of Service Names Service Attribute **SHOULD** have at least two entries that are not *Discard*. See additional discussion in Section 11.3.
EVC Service Level Specification	No additional constraints from appropriate service in MEF 6.3 [4].
EVC Group Membership	No additional constraints from appropriate service in MEF 6.3 [4].
EVC Maximum Service Frame Size	No additional constraints from appropriate service in MEF 6.3 [4].
EVC Available MEG Level	No additional constraints from appropriate service in MEF 6.3 [4].
Elastic Ethernet Service Control SLS	No additional constraints from an Elastic Ethernet Service (Section 9.3.1).
Minimum Lead Time	No additional constraints from an Elastic Ethernet Service Section 9.3.2).
Maximum Lead Time	No additional constraints from an Elastic Ethernet Service (Section 9.3.3).
Maximum Request Density	No additional constraints from an Elastic Ethernet Service (Section 9.3.4).
Minimum Change Separation	No additional constraints from an Elastic Ethernet Service (Section 9.3.5).
Minimum Period	No additional constraints from an Elastic Ethernet Service (Section 9.3.6).
Modification Maintenance Interval Limit	**[D3]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, the value of the Modification Maintenance Interval Limit Service Attribute **SHOULD** be less than 7200 seconds. See also Section 9.3.7.
Allowed Request Types	No additional constraints from an Elastic Ethernet Service (Section 9.3.8).

Table 11 – Elastic Subscriber Ethernet Cloud Connectivity Service EVC Service Attributes

11.1.2 Subscriber UNI Service Attributes

Subscriber UNI Service Attributes are specified in MEF 10.4 [5] for Subscriber Ethernet Services defined in MEF 6.3 [4]. This section provides the list of Subscriber UNI Service Attributes and specifies additional requirements or constraints at each UNI in the Elastic Subscriber Ethernet Cloud Connectivity Service. Requirements specified for the UNI apply to all UNIs in the EVC.

Subscriber UNI Service Attribute	Constraints
Subscriber UNI ID	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Elastic Behavior	No additional constraints from an Elastic Ethernet Service (Section 9.1.1.1).
Subscriber UNI Instantiation	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Virtual Frame Map	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI List of Physical Links	**[D4]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, the value of fs and ts **SHOULD** be *Disabled* for each entry in the value of the Subscriber UNI List of Physical Links Service Attribute. **[D5]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, if the value of the Subscriber UNI Instantiation Service Attribute is *Physical*, then the value of the Subscriber UNI List of Physical Links Service Attribute **SHOULD** be a non-empty list containing at least two 4-tuples.
Subscriber UNI Link Aggregation	No additional constraints from appropriate service in MEF 6.3 [4]. See also Section 9.1.1.1 and [R23] for impact to possible values.
Subscriber UNI Port Conversation ID to Aggregation Link Map	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Service Frame Format	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Maximum Service Frame Size	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Maximum Number of EVC EPs	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Maximum Number of C-Tag VLAN IDs per EVC EP	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Token Share	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Envelopes	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI Envelope Limits	No additional constraints from an Elastic Ethernet Service (Section 9.1.1.2).
Subscriber UNI Link OAM	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI MEG	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI LAG Link MEG	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI L2CP Address Set	No additional constraints from appropriate service in MEF 6.3 [4].
Subscriber UNI L2CP Peering	No additional constraints from appropriate service in MEF 6.3 [4].

Table 12 – Elastic Subscriber Ethernet Cloud Connectivity Service Subscriber UNI Service Attributes

11.1.3 EVC EP Service Attributes

EVC EP Service Attributes are specified in MEF 10.4 [5] for Subscriber Ethernet Services defined in MEF 6.3 [4]. This section provides the complete list of Service Attributes and specifies additional requirements or constraints for Elastic Subscriber Ethernet Cloud Connectivity Service.

EVC EP Service Attribute	Constraints
EVC EP ID	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP UNI	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Role	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Map	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Ingress Class of Service Map	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Color Map	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Egress Map	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Ingress Bandwidth Profile	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Class of Service Name Ingress Bandwidth Profile	**[R150]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, if the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute is in the value of the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1), then for each entry in the value of the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute, the Envelope and Rank (ER) in the value of Bandwidth Profile Flow parameters **MUST** refer to an Envelope that only contains Bandwidth Profile Flows for Elastic Ethernet Services that have "EVC EP Class of Service Name Ingress Bandwidth Profile" in the value of the EVC EP Elastic Behavior Service Attribute. A brief explanation for [R150] is included after this table. **[D6]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, if the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute is in the value of the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1), then the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute **SHOULD** use one of the models specified in MEF 23.2.1 [7].
EVC EP CoS Name Ingress BWP Limits	No additional constraints from an Elastic Ethernet Service (Section 9.1.2.2).
EVC EP Egress Bandwidth Profile	No additional constraints from appropriate service in MEF 6.3 [4].

EVC EP Service Attribute	Constraints
EVC EP Egress Bandwidth Profile per Class of Service Name	**[R151]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, if the EVC EP Egress Bandwidth Profile per Class of Service Name Service Attribute is in the value of the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1), then for each entry in the value of the EVC EP Class of Service Name Egress Bandwidth Profile Service Attribute, the Envelope and Rank (ER) in the value of Bandwidth Profile Flow parameters **MUST** refer to an Envelope that only contains Bandwidth Profile Flows for Elastic Ethernet Services that have "EVC EP Class of Service Name Egress Bandwidth Profile" in the value of the EVC EP Elastic Behavior Service Attribute. A brief explanation for [R151] is included after this table.
EVC EP CoS Name Egress BWP Limits	No additional constraints from an Elastic Ethernet Service (Section 9.1.2.3).
EVC EP Source MAC Address Limit	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Subscriber MEG MIP	No additional constraints from appropriate service in MEF 6.3 [4].
EVC EP Elastic Behavior	**[R152]** For an Elastic Subscriber Ethernet Cloud Connectivity Service, the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1) **MUST NOT** have a value of *None*. **[D7]** When the EVC EP Map Service Attribute has the value of *List*, an Elastic Subscriber Ethernet Cloud Connectivity Service **SHOULD** include the EVC EP Map Service Attribute in the value of the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1). **[CD1]**<[D2] For an Elastic Subscriber Ethernet Cloud Connectivity Service supporting multiple CoS Names, the value of the EVC EP Elastic Behavior Service Attribute (Section 9.1.2.1) **SHOULD** include the EVC EP Ingress Class of Service Map Service Attribute. .

Table 13 – Elastic Subscriber Ethernet Cloud Connectivity Service EVC EP Service Attributes

An Elastic Ethernet Service can support Elastic modification of the service's Ingress and Egress Bandwidth Profiles. If an Envelope contains Bandwidth Profile Flows from more than one service, a modification to the Bandwidth Profile Flow parameters for one service could impact Bandwidth Profile Flows for other services in that Envelope. To avoid unexpected impact on Bandwidth Profile Flows for services that are not Elastic, [R150] and [R151] mandate that Bandwidth Profile Flows for Elastic Subscriber Ethernet Cloud Connectivity Services cannot be mixed in the same Envelope with Bandwidth Profile Flows for services that are not Elastic.

11.2 Elastic Operator Ethernet Cloud Connectivity Services

Operator Ethernet Services are defined in MEF 51.1 [11] with Service Attributes specified in MEF 26.2 [8] and MEF 45.1 [9]. This section provides the complete list of Service Attributes and specifies additional requirements or constraints for the Elastic Operator Ethernet Cloud Connectivity Service.

In Table 14, Table 15, Table 16, Table 17, Table 18, and Table 19:

- A row with shaded cells indicates a new Service Attribute from this standard.
- "No additional constraints from appropriate service in MEF 51.1 [11]" means that, for an Elastic Subscriber Cloud Connectivity Service, the Service Attribute value can be any value allowed by MEF 51.1 where "appropriate service" refers to the MEF 51.1 service that this Elastic Operator Ethernet Cloud Connectivity Service is based on.
- "No additional constraints from an Elastic Ethernet Service" means that, for an Elastic Operator Cloud Connectivity Service, the Service Attribute value can be any value allowed by Section 8 and Section 9.

11.2.1 OVC Service Attributes

OVC Service Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of OVC Service Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

A row in Table 14 with shaded cells indicates a new Service Attribute from this standard. When a Service Attribute can take on any value then this is indicated with "No additional constraints from appropriate service in MEF 51.1 [11]" or "No additional constraints from an Elastic Ethernet Service" with reference to a section in this standard. Note that "appropriate service" refers to the MEF 51.1 [11] service this Elastic Operator Ethernet Cloud Connectivity Service is based on.

OVC Service Attribute	Constraints
OVC Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
OVC Type	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point List	No additional constraints from appropriate service in MEF 51.1 [11].
Maximum Number of UNI OVC End Points	No additional constraints from appropriate service in MEF 51.1 [11].
Maximum Number ENNI OVC End Points	No additional constraints from appropriate service in MEF 51.1 [11].
OVC Maximum Frame Size	**[D8]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the OVC Maximum Frame Size Service Attribute **SHOULD** be ≥ 2000 bytes. Since MEF 6.3 [4] recommends that the value of the EVC Maximum Service Frame Size Service Attribute be ≥ 2000 bytes, [D8] facilitates support of EVCs with the EVC Maximum Service Frame Size value ≥ 2000 bytes.
OVC CE-VLAN ID Preservation	No additional constraints from appropriate service in MEF 51.1 [11].
OVC CE-VLAN PCP Preservation	No additional constraints from appropriate service in MEF 51.1 [11].
OVC CE-VLAN DEI Preservation	No additional constraints from appropriate service in MEF 51.1 [11].
OVC S-VLAN PCP Preservation	No additional constraints from appropriate service in MEF 51.1 [11].
OVC S-VLAN DEI Preservation	No additional constraints from appropriate service in MEF 51.1 [11].
OVC List of Class of Service Names	**[D9]** For an Elastic Operator Ethernet Cloud Connectivity Service, the OVC List of Class of Service Names Service Attribute **SHOULD** have at least two entries that are not *Discard.* See additional discussion in Section 11.3.
OVC Service Level Specification	No additional constraints from appropriate service in MEF 51.1 [11].
OVC Frame Delivery	No additional constraints from appropriate service in MEF 51.1 [11].
OVC Available MEG Level	No additional constraints from appropriate service in MEF 51.1 [11].
OVC L2CP Address Set	No additional constraints from appropriate service in MEF 51.1 [11].
Elastic Ethernet Service Control SLS	No additional constraints from an Elastic Ethernet Service (Section 9.3.1).
Minimum Lead Time	No additional constraints from an Elastic Ethernet Service (Section 9.3.2).
Maximum Lead Time	No additional constraints from an Elastic Ethernet Service (Section 9.3.3).
Maximum Request Density	No additional constraints from an Elastic Ethernet Service (Section 9.3.4).
Minimum Change Separation	No additional constraints from an Elastic Ethernet Service (Section 9.3.5).
Minimum Period	No additional constraints from an Elastic Ethernet Service (Section 9.3.6).
Modification Maintenance Interval Limit	**[D10]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the Modification Maintenance Interval Limit **SHOULD** be less than 7200 seconds. See also Section 9.3.7.
Allowed Request Types	No additional constraints from an Elastic Ethernet Service (Section 9.3.8).

Table 14 – Elastic Operator Ethernet Cloud Connectivity Service OVC Service Attributes

11.2.2 ENNI Common Attributes

ENNI Common Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of ENNI Common Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

Since there are no new ENNI Common Attributes for an Elastic Ethernet Service, Table 15 only contains ENNI Common Attributes defined in MEF 26.2 [8].

ENNI Common Attribute	Constraints
ENNI Peering Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Physical Layer	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Frame Format	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Number of Links	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Link Aggregation	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Port Conversation ID to Aggregation Link Map	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI MEG	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI LAG Link MEG	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Link OAM	No additional constraints from appropriate service in MEF 51.1 [11].

Table 15 – Elastic Operator Ethernet Cloud Connectivity Service ENNI Common Attributes

11.2.3 Operator Multilateral Attributes

Operator Multilateral Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of Operator Multilateral Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

Since there are no new Operator Multilateral Attributes for an Elastic Ethernet Service, Table 16 only contains Operator Multilateral Attributes defined in MEF 26.2 [8].

Operator Multilateral Attribute	Constraints
ENNI L2CP Peering	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Tagged L2CP Frame Processing	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Maximum Frame Size	**[D11]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the ENNI Maximum Frame Size Multilateral Attribute **SHOULD** be ≥ 2000 bytes.

Table 16 – Elastic Operator Ethernet Cloud Connectivity Service Operator Multilateral Attributes

11.2.4 ENNI Service Attributes

ENNI Service Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of ENNI Service Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

ENNI Service Attribute	Constraints
Operator ENNI Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
S-VLAN ID Control	No additional constraints from appropriate service in MEF 51.1 [11].
Maximum Number of OVCs	No additional constraints from appropriate service in MEF 51.1 [11].
Maximum Number of OVC End Points per OVC	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Token Share	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Envelopes	No additional constraints from appropriate service in MEF 51.1 [11].
ENNI Envelope Limits	No additional constraints from an Elastic Ethernet Service (Section 9.2.2.1).

Table 17 – Elastic Operator Ethernet Cloud Connectivity Service ENNI Service Attributes

11.2.5 Operator UNI Service Attributes

Operator UNI Service Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of Operator UNI Service Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

Operator UNI Service Attribute	Constraints
Operator UNI Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Physical Layer	**[D12]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the Operator UNI Physical Layer Service Attribute **SHOULD** be a non-empty list containing at least two entries.
Operator UNI Synchronous Mode	**[D13]** For an Elastic Operator Ethernet Cloud Connectivity Service, each entry in the Operator UNI Synchronous Mode Service Attribute **SHOULD** have a value of *Disabled*.
Operator UNI Number of Links	**[D14]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the Operator UNI Number of Links Service Attribute **SHOULD** be greater than or equal to 2.
Operator UNI Link Aggregation	No additional constraints from appropriate service in MEF 51.1 [11]. (See [R66] in Section 9.2.1.1).
Operator UNI Port Conversation ID to Aggregation Link Map	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Service Frame Format	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Maximum Service Frame Size	**[D15]** For an Elastic Operator Ethernet Cloud Connectivity Service, the value of the Operator UNI Service Frame Size Service Attribute **SHOULD** be ≥ 2000 bytes.
Operator UNI Default CE-VLAN ID	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Maximum Number of OVC End Points	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Maximum Number of CE-VLAN IDs per OVC End Point	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Ingress Bandwidth Profile	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Egress Bandwidth Profile	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Link OAM	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI MEG	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI LAG Link MEG	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI E-LMI	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Token Share	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Envelopes	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI L2CP Address Set	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI L2CP Peering	No additional constraints from appropriate service in MEF 51.1 [11].
Operator UNI Elastic Behavior	No additional constraints from an Elastic Ethernet Service (Section 9.2.1.1).
Operator UNI Envelope Limits	No additional constraints from an Elastic Ethernet Service (Section 9.2.1.2).

Table 18 – Elastic Operator Ethernet Cloud Connectivity Service Operator UNI Service Attributes

11.2.6 OVC End Point Service Attributes

OVC End Point Service Attributes are specified in MEF 26.2 [8] for Operator Ethernet Services defined in MEF 51.1 [11]. This section provides the complete list of OVC End Point Service Attributes and specifies additional requirements or constraints for Elastic Operator Ethernet Cloud Connectivity Service.

OVC End Point Service Attribute	**Constraints**
OVC End Point Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point External Interface Type	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point External Interface Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Role	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Map	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Class of Service Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Color Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Egress Map	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Egress Equivalence Class Identifier	No additional constraints from appropriate service in MEF 51.1 [11].
Ingress Bandwidth Profile Per OVC End Point	No additional constraints from appropriate service in MEF 51.1 [11].
Egress Bandwidth Profile Per End Point	No additional constraints from appropriate service in MEF 51.1 [11].

OVC End Point Service Attribute	Constraints
Ingress Bandwidth Profile Per Class of Service Name	See [R82] in Section 9.2.3.1 **[R153]** For an Elastic Operator Ethernet Cloud Connectivity Service, if the Ingress Bandwidth Profile Per Class of Service Name Service attribute is in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1), then for each entry in the value of the Ingress Bandwidth Profile per Class of Service Name Service Attribute, the Envelope and Rank (ER) in the value of Bandwidth Profile Flow parameters **MUST** refer to an Envelope that only contains Bandwidth Profile Flows for Elastic Ethernet Services that have "Ingress Bandwidth Profile per Class of Service Name" in the value of the OVC End Point Elastic Behavior Service Attribute. A brief explanation for [R153] is included after this table. **[D16]** For an Elastic Operator Ethernet Cloud Connectivity Service, if the Ingress Bandwidth Profile per Class of Service Name Service Attribute is in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1), the Ingress Bandwidth Profile per Class of Service Name Service Attribute **SHOULD** use one of the models specified in MEF 23.2.1 [7].
OVC End Point CoS Name Ingress BWP Limits	No additional constraints from an Elastic Ethernet Service (Section 9.2.3.2).
Egress Bandwidth Profile Per Egress Equivalence Class Name	See [R83] in Section 9.2.3.1 **[R154]** For an Elastic Operator Ethernet Cloud Connectivity Service, if the Egress Bandwidth Profile Per Egress Equivalence Class Name Service Attribute is in value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1), then for each entry in the value of the Egress Bandwidth Profile per Egress Equivalence Class Name Service Attribute, the Envelope and Rank (ER) in the value of Bandwidth Profile Flow parameters **MUST** refer to an Envelope that only contains Bandwidth Profile Flows for Elastic Ethernet Services that have "Egress Bandwidth Profile per Egress Equivalence Class Name" in the value of the OVC End Point Elastic Behavior Service Attribute. A brief explanation for [R154] is included after this table.
OVC End Point Egress Equivalence Class Name Egress BWP Limits	No additional constraints from an Elastic Ethernet Service (Section 9.2.3.3).

OVC End Point Service Attribute	Constraints
OVC End Point Aggregation Link Depth	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Source MAC Address Limit	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point MIP	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Maintenance End Point List	No additional constraints from appropriate service in MEF 51.1 [11].
OVC End Point Elastic Behavior	**[R155]** For an Elastic Operator Ethernet Cloud Connectivity Service, the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1) **MUST NOT** have a value of *None*. **[D17]** When the value of the OVC End Point Map Service Attribute is Form E or is Form U, an Elastic Operator Ethernet Cloud Connectivity Service **SHOULD** include the OVC End Point Map Service Attribute in the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1). **[CD2]**<[D9] For an Elastic Operator Ethernet Cloud Connectivity Service supporting multiple CoS Names, the value of the OVC End Point Elastic Behavior Service Attribute (Section 9.2.3.1) **SHOULD** include the OVC End Point Class of Service Identifier Service Attribute..

Table 19 – Elastic Operator Ethernet Cloud Connectivity Service OVC End Point Service Attributes

An Elastic Ethernet Service can support Elastic modification of the service's Ingress and Egress Bandwidth Profiles. If an Envelope contains Bandwidth Profile Flows from more than one service, a modification to the Bandwidth Profile Flow parameters for one service could impact Bandwidth Profile Flows for other services in that Envelope. To avoid unexpected impact on Bandwidth Profile Flows for services that are not Elastic, [R153] and [R154] mandate that Bandwidth Profile Flows for Elastic Operator Ethernet Cloud Connectivity Services cannot be mixed in the same Envelope with Bandwidth Profile Flows for services that are not Elastic.

11.3 CoS Considerations

This section recommends an approach to setting the value of the EVC Service Level Specification Service Attribute for an Elastic Subscriber Ethernet Cloud Connectivity Service or setting the value of the OVC Service Level Specification Service Attribute for an Elastic Operator Ethernet Cloud Connectivity Service.

Cloud Interconnect services could need more stringent performance objectives than Cloud Access services. For example, Cloud Interconnect services might need to support live migration of virtual machines, real-time database synchronization, or storage networks, all of which require

low delay and frame loss performance. Cloud Access services can include secure and reliable access to cloud-based applications, but these seldom include stringent performance. However, if a Cloud Access service is used to connect a Cloud Subscriber's data center to a Cloud Operator's data center, it is possible that the EVC Performance Objectives and/or OVC Performance Objectives might be similar to that of a typical Cloud Interconnect service. CPOs defined in MEF 23.2 [6] are expected to be sufficient for Cloud applications. Appendix C (see Table 38) in MEF 23.2 [6] discusses example application objectives and the appropriate CoS Label to use to meet the objectives across different Performance Tiers.

Different Cloud applications can use different Classes of Service. For example, with CoS Labels (MEF 23.2 [6]), file transfer can use CoS Label L while video streaming might need CoS Label M and virtual machine migration might require CoS Label H. MEF 23.2 [6] has CPOs and parameter values for CoS Labels.

An Elastic Ethernet Cloud Connectivity Service can have multiple CoS Names to enable use for a variety of cloud applications. By making the value of *M* Elastic in the EVC EP Ingress Class of Service Map Service Attribute, a Cloud Subscriber can change the usage of CoS Names without having to change the configuration of the PCP or DSCP values in the Cloud Subscriber equipment. As described in Sections 9.1.2.1 and 9.2.3.1, by modifying the map *M*, a given application can be mapped to a different CoS Name and therefore to a different Bandwidth Profile Flow associated with that CoS Name. A different set of SLS Performance Objectives would also apply to this application.

The list of CoS Names, and the SLS Performance Objectives and existence of Bandwidth Profile Flows for each CoS Name, are not Elastic and must be agreed on between the Cloud Subscriber and the Cloud SP in advance of any Service Modification Requests for an Elastic Ethernet Service.

12 References

[1] IEEE Std 802.1Q™ – 2018, *(Revision of IEEE Std 802.1Q-2014) - IEEE Standard for Local and metropolitan area networks--Bridges and Bridged Networks*, May 2018.

[2] RFC 2119. *Key words for use in RFCs to Indicate Requirement Levels*, March 1997.

[3] RFC 8174. *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, May 2017.

[4] MEF 6.3, *Subscriber Ethernet Services Definitions*, November 2019.

[5] MEF 10.4, *Subscriber Ethernet Services Attributes*, December 2018.

[6] MEF 23.2, *Carrier Ethernet Class of Service – Phase 3*, August 2016.

[7] MEF 23.2.1, *Models for Bandwidth Profiles with Token Sharing*, January 2017.

[8] MEF 26.2, *External Network Network Interfaces (ENNI) and Operator Service Attributes*, August 2016.

[9] MEF 45.1, *Layer 2 Control Protocol in Ethernet Services*, December 2018.

[10] MEF 47, *Carrier Ethernet Services for Cloud Implementation Agreement*, October 2014.

[11] MEF 51.1, *Operator Service Definitions*, December 2018.

[12] MEF 55, *Lifecycle Service Orchestration (LSO): Reference Architecture and Framework*, March 2016.

Appendix A Example of Cloud Access to Public Cloud Operators (Informative)

This appendix provides an example for an Elastic Subscriber Ethernet Cloud Connectivity Service, showing values for all of the Service Attributes. In this example a Cloud Subscriber, Bank of MEF, is accessing a Cloud Service from 48 sites. Two Cloud Operator locations are used to support the Cloud Service. The Cloud SP agrees on an Elastic Subscriber Ethernet Cloud Connectivity Service with an Ethernet SP, SP Alpha, with UNIs at the Bank of MEF sites and the two Cloud Operator locations. The example uses an EVP-Tree service.

Figure 20 shows the configuration details for an example of EVP-Tree for distance learning which is based on Appendix A.4 in MEF 6.3 [4]. Note that Ethernet SP Alpha might use one or more Operators with MEF 51.1 [11] E-Access and/or E-Transit Services to reach some of the UNIs in the EVCs, but such details are not visible to the Bank of MEF and the Cloud SP.

Subscriber UNI Elastic Behavior Service Attribute
- UNIs 1…50: *None*

EVC EP Elastic Behavior Service Attribute
- For all EVC EPs in the Solid EVC: *EVC EP Ingress Class of Service Map, EVC EP Class of Service Name Ingress Bandwidth Profile*

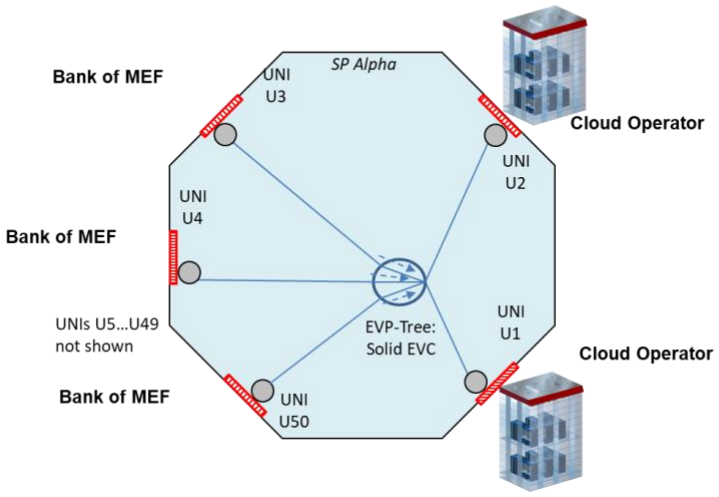


Figure 20 – Example Elastic Subscriber Cloud Connectivity Service for Cloud Access

This example expands the EVP-Tree Service to highlight Elastic Ethernet Service Attributes with the EVC EP Ingress Class of Service Map Service Attribute having multiple classes and with the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute. Appendix A in MEF 6.3 [4] is used as starting point for most of the values assigned to Service Attributes.

Note that the Cloud Subscriber and Cloud Operator could be using IP routing, e.g., with BGP, to establish the overlay IP connection between Cloud Subscriber site(s) and the Cloud Operator(s). These overlay IP connection aspects are outside the scope of this standard. The underlay Elastic Subscriber Ethernet Cloud Connectivity Service used in this example complies with the definition in this standard.

By using Cloud Services to host video storage and streaming encoding/decoding services, the Bank of MEF can deliver distance learning video formats based on employee device type such as desktop computer or mobile handset connected to a Local Area Network (LAN) in the Bank of MEF locations. In this Cloud Service, there is no need to carry traffic between Bank of MEF sites. Hence, in this example, UNIs U1 and U2, which connect to the Cloud Operator, have the value of the EVC EP Role Service Attribute = *Root*, and the EVC EPs at UNIs U3-U50, which connect to the Bank of MEF, have the value of the EVC EP Role Service Attribute = *Leaf*. In this example, all EVC EPs have *List* as the value of the EVC EP Map Service Attribute, although the list only contains 1 VLAN ID value at all UNIs. The EVC EP Ingress Class of Service Map Service Attribute is Elastic at all EVC EPs in order to use the Class of Service Name, Krypton or Neon, that is consistent with the EVC performance needed for the content being distributed. The SLS value for Krypton and Neon is as described in Table 25 and Table 26 of MEF 6.3 [4]. This allows Bank of MEF to select Class of Service Names as shown in Table 20. Class of Service Name Krypton is chosen for a CEO All Hands video broadcast while Class of Service Name Neon is chosen for compulsory employee training. By making the value of *M* Elastic, Bank of MEF can change the usage of CoS Names, i.e., Krypton vs Neon, without having to change the configuration of the PCP values in their equipment.

Additionally, at UNIs U1 and U2, the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute is Elastic within limits specified by the value of the EVC EP CoS Name Ingress BWP Limits Service Attribute. The allowed values, for *CIR* and *CBS* in the 9-tuple, include zero and two positive values with one being twice the other. The EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute being Elastic allows the requesting of different parameters such as the *CIR* value based on the type of training video, e.g., standard definition vs high definition. The use of Elastic behavior for *CIR* in this example is useful when the SP Alpha applies a higher charge when the service has a higher *CIR* value.

In the remainder of this Appendix the following notation is used to specify values:

- {} denotes a set or a list, e.g., {a, b, c, d} denotes a set containing a, b, c, and d.
- <> denotes an n-tuple which is a set of n ordered items, e.g., <x,y,z> denotes the 3-tuple containing x, y, and z.
- → denotes a map element, e.g., f → g denotes that f maps to g.

A.1 Example Using Request Type with One-Time Change

Table 20 shows some of the information in the Service Modification Requests with *Request Type* parameter = *One-Time Change* and the values of the Service Attributes that are modified for the EVC EPs at UNIs U1 and U2.

Video Broadcast	Service Modification Request	Value for M in the EVC EP Ingress Class of Service Map with F= *C-Tag PCP*	Value of CIR in the EVC EP Ingress Class of Service Name Bandwidth Profile

CEO All Hands (CEO convenience)	*Request Type* = *One-Time Change*
	
	Start Time = 2020-10-05 09:00:00
		{
		5 → Krypton,
		0 → *Discard*,
		1 → *Discard*,
		2 → *Discard*,
		3 → *Discard*,
		4 → *Discard*,
		6 → *Discard*,
		7 → *Discard*,
		Untagged → *Discard*
		}
			CIR = 200 x10^6 b/s for Krypton
			CIR = 0 b/s for Neon

Employee Training (not overlapping with CEO video)	*Request Type* = *One-Time Change*
	
	Start Time = 2020-10-05 11:00:00
		{
		5 → Neon,
		0 → *Discard*,
		1 → *Discard*,
		2 → *Discard*,
		3 → *Discard*,
		4 → *Discard*,
		6 → *Discard*,
		7 → *Discard*,
		Untagged → *Discard*
		}
			CIR = 100 x10^6 b/s for Neon
			CIR = 0 b/s for Krypton

Table 20 – Example Service Modification Requests for One-Time Change

The Elastic behavior is requested with a Service Modification Request with value for the *Start Time* parameter such that [R133] is likely to be satisfied for the Minimum Lead Time Service Attribute value based on the expected Request Time. The values for *Start Time* parameter in Table 20 indicate a time before each video session is expected to begin.

A.2 Example Using Request Type with Reverting Change

Table 21 shows some of the information in the Service Modification Requests with *Request Type* parameter = *Reverting Change* and the values of the Service Attributes that are modified for the EVC EPs at UNIs U1 and U2.

Traffic	Service Modification Request	First Value for M in the EVC EP Ingress Class of Service Map with *F = C-Tag PCP*	Second Value for M in the EVC EP Ingress Class of Service Map with *F = C-Tag PCP*	First Values of *CIR* and *CBS* in the EVC EP Ingress Class of Service Name Bandwidth Profile	Second Values of *CIR* and *CBS* in the EVC EP Ingress Class of Service Name Bandwidth Profile

CEO All Hands (CEO convenience)	*Request Type = Reverting Change*
	
	Start Time = 2020-06-01 09:00:00
	Revert Time = 2020-06-01 10:30:00
		{
		5 → Krypton,
		0 → *Discard*,
		1 → *Discard*,
		2 → *Discard*,
		3 → *Discard*,
		4 → *Discard*,
		6 → *Discard*,
		7 → *Discard*,
		Untagged → *Discard*
		}
			{
			5 → Neon,
			0 → *Discard*,
			1 → *Discard*,
			2 → *Discard*,
			3 → *Discard*,
			4 → *Discard*,
			6 → *Discard*,
			7 → *Discard*,
			Untagged → *Discard*
			}
				CIR = 200 x10^6 b/s
				CBS = 76,800 bytes for Krypton
				CIR = 0 b/s
				CBS = 0 bytes for Neon
					CIR = 0 b/s
					CBS = 0 bytes for Krypton
					CIR = 0 b/s
					CBS = 0 bytes for Neon

Employee Training (not overlapping with CEO video)	*Request Type = Reverting Change*
	
	Start Time = 2020-06-02 23:30:00
	Revert Time = 2020-06-03 04:30:00
		{
		5 → Neon,
		0 → *Discard*,
		1 → *Discard*,
		2 → *Discard*,
		3 → *Discard*,
		4 → *Discard*,
		6 → *Discard*,
		7 → *Discard*,
		Untagged → *Discard*
		}
			{
			5 → Neon,
			0 → *Discard*,
			1 → *Discard*,
			2 → *Discard*,
			3 → *Discard*,
			4 → *Discard*,
			6 → *Discard*,
			7 → *Discard*,
			Untagged → *Discard*
			}
				CIR = 0 b/s
				CBS = 0 bytes for Krypton
				CIR = 100 x10^6 b/s
				CBS = 76,800 bytes for Neon
					CIR = 0 b/s
					CBS = 0 bytes for Krypton
					CIR = 0 b/s
					CBS = 0 bytes for Neon

Table 21 – Example Service Modification Requests for Reverting Change

In this example, when employee training is scheduled, the schedule is such that the training does not conflict with any currently scheduled CEO All Hands video. Also, this example assumes that SP Alpha has a charge for having *CIR* available, independent of usage, and thus the Service Modification Request will set the *CIR* to 0 at the *Revert Time* value to reduce these charges. In contrast, the CEO can schedule an All Hands video at very short notice, including the interruption of an employee training video. Thus the Service Modification Request for a CEO All Hands video changes the CoS Map to use Krypton during the All Hands video, and then changes it back to Neon when done.

The Elastic behavior is requested with a Service Modification Request with value for the *Start Time* parameter such that [R133] is likely to be satisfied for the Minimum Lead Time Service Attribute value based on the expected Request Time. The values for *Start Time* parameter in Table 21 indicate the times before a video session is expected to begin. Since the Service

Modification Requests are for a Reverting Change, the values for the *Revert Time* parameter are also included in Table 21. The value of the *Revert Time* parameter controls when the process of making the change to their second requested values begins.

The following subsections show the Service Attribute values for EVC, EVC EP and Subscriber UNI Service Attributes.

A.3 EVC Service Attribute Values

Table 22 shows values for EVC Service Attributes for the service shown in Figure 20.

Service Attribute	Value
EVC ID	Solid EVC
EVC List of EVC EPs	{Solid-EVC-UNI1, …., Solid-EVC-UNI50}
EVC Type	*Rooted-Multipoint*
EVC Data Service Frame Disposition	< *Deliver Conditionally*, *Deliver Unconditionally*, *Deliver Unconditionally*> *Deliver Conditionally*: For unicast Destination MAC Addresses in Ingress Service Frames, deliver only to destination UNI and subject to the dynamic learning and filtering process as described in IEEE Std 802.1Q™-2018 [1];
EVC C-Tag PCP Preservation	*Enabled*
EVC C-Tag DEI Preservation	*Enabled*
EVC List of Class of Service Names	{Krypton, Neon, *Discard*}
EVC Service Level Specification	Values per Table 25 and 26 in MEF 6.3 [4] for Class of Service Names Krypton and Neon
EVC Group Membership	*None*
EVC Maximum Service Frame Size	9600 bytes
EVC Available MEG Level	6

EVC Elastic Ethernet Service Control SLS	<2019-04-01 00:00:00, 1 year, PMe>
	$PMe =$
	{
	{Acceptance Decision Duration, 900000 ms, 0.95},
	{Change Duration, 1800000 ms, 0.90},
	{Change Duration, 2700000 ms, 0.95}
	{Request Acceptance Ratio, 0.95},
	{Change Success Ratio, 0.99}
	}

Minimum Lead Time	900 seconds
Maximum Lead Time	720 hours, i.e., 30 days
Maximum Request Density	<10 requests, 60 minutes>
Minimum Change Separation	3600 seconds
Minimum Period	14400 seconds
Modification Maintenance Interval Limit	60 minutes
Allowed Request Types	{*One-Time Change*, *Reverting Change*}

Table 22 – EVC Service Attribute Values for Cloud Access Example

A.4 Subscriber UNI Service Attribute Values

Table 23 below shows the values for UNI Service Attributes for the service shown in Figure 20. The notation U3,…,U50 is used to identify UNIs U3 through U50, for the example. UNIs U1 and U2 are for Cloud Operator locations.

Service Attribute	Value at UNIs U1 and U2	Value at UNIs U3,…,U50
Subscriber UNI ID	U1: BankofMEF-U1 U2: BankofMEF-U2	BankofMEF-U3,…,BankofMEF-U50
Subscriber UNI Elastic Behavior	*None*	*None*
Subscriber UNI Instantiation	*Physical*	*Physical*
Subscriber UNI Virtual Frame Map	*Not Applicable*	*Not Applicable*
Subscriber UNI List of Physical Links	<p1, 1000BASE-SX, *Disabled*, *Disabled*> <p2, 1000BASE-SX, *Disabled*, *Disabled*>	<p1, 1000BASE-SX, *Disabled*, *Disabled*>
Subscriber UNI Link Aggregation	*All Active*	*None*

Subscriber UNI Port Conversation ID to Aggregation Link Map	{
	{4000} → {1, 2},
	{Other values} → {2}
	}
		Not Applicable

Subscriber UNI Service Frame Format	Ethernet MAC frame conforming to Clause 3 of IEEE Std.802.3-2015	Ethernet MAC frame conforming to Clause 3 of IEEE Std.802.3-2015
Subscriber UNI Maximum Service Frame Size	9600 bytes	9600 bytes
Subscriber UNI Maximum Number of EVC EPs	8	8
Subscriber UNI Maximum Number of C-Tag VLAN IDs per EVC EP	8	8
Subscriber UNI Token Share	*Disabled*	*Disabled*
Subscriber UNI Envelopes	{<Env1,0>}	{<Env1,0>}
Subscriber UNI Envelope Limits Service Attribute	{<Env1, 200 x 10^6 b/s >}	{<Env1, 200 x 10^6 b/s >}
Subscriber UNI Link OAM	*Disabled*	*Disabled*
Subscriber UNI MEG	*Enabled*	*Enabled*
Subscriber UNI LAG Link MEG	*Disabled*	*Disabled*
Subscriber UNI L2CP Address Set	*CTA*	*CTA*
Subscriber UNI L2CP Peering	{< EtherType: 0x8809 Subtypes 01and 02, 01-80-C2-00-00-02>} (For LACP/LAMP)	{} (Empty list since no protocols are Peered)

Table 23 – Subscriber UNI Service Attribute Values for Cloud Access Example

A.5 EVC EP Service Attribute Values

Table 24 shows the values for the EVC EP Service Attributes for the service shown in Figure 20 before any SMRs are received by the Ethernet SP Alpha.

Service Attribute	**Value for EVC EPs at UNIs** U1,…,U50 (exceptions noted)
EVC EP ID	Solid-EVC-U1,…,Solid-EVC-U50
EVC EP UNI	Solid-EVC-UNI1: BankofMEF-U1,…, Solid-EVC-UNI50: BankofMEF-U50
EVC EP Role	Solid-EVC-U1: *Root* Solid-EVC-U2: *Root* Solid-EVC-U3: *Leaf*,…, Solid-EVC-U50: *Leaf*
EVC EP Map	{4000}
EVC EP Ingress Class of Service Map	*F = C-Tag PCP* *M* = {5 → Krypton, 0 → *Discard*, 1 → *Discard*, 2 → *Discard*, 3 → *Discard*, 4 → *Discard*, 6 → *Discard*, 7 → *Discard*, Untagged → *Discard*} *P=Null*
EVC EP Color Map	*F = C-Tag DEI* *M* = {0 → *Green*, 1 → *Yellow*}
EVC EP Egress Map	*None*
EVC EP Ingress Bandwidth Profile	*None*

EVC EP Class of Service Name Ingress Bandwidth Profile	{
	<Krypton, <$CIR = 100 \times 10^6$ b/s, $CIR_{max} = 200 \times 10^6$ b/s, $CBS =$ 76,800 bytes, $EIR = 0$ b/s, $EIR_{max} = 0$ b/s, $EBS = 0$ bytes, $CF =$ $0, CM =$ *color-blind*, $ER =$ <Env1, 1>, $F = 0$≫,
	<Neon,<$CIR = 0$ b/s, $CIR_{max} = 0$ b/s, $CBS = 0$ bytes, $EIR = 0$ b/s, $EIR_{max} = 0$ b/s, $EBS = 0$ bytes, $CF = 0, CM =$ *color-blind*, $ER =$ <Env1, 2>, $F = 0$≫
	}

EVC EP CoS Name Ingress BWP Limits	{
	
	CoS Name = Krypton,
	Allowed CIR Values = {0 b/s, 100 x10^6 b/s, 200 x10^6 b/s},
	Allowed EIR Values = {0 b/s},
	Allowed CIR_{max} Values = {200 x10^6 b/s },
	Allowed EIR_{max} Values = {0 b/s},
	Allowed CBS Values = {0 bytes, 76,800 bytes},
	Allowed EBS Values = {0 bytes},
	Total IR Upper Bound = 200 x10^6 b/s,
	Total IR Lower Bound = 0 b/s
	>,
	
	CoS Name = Neon,
	Allowed CIR Values = {0 b/s,100 x10^6 b/s, 200 x10^6 b/s},
	Allowed EIR Values = {0 b/s},
	Allowed CIR_{max} Values = {0 b/s, 200 x10^6 b/s},
	Allowed EIR_{max} Values = {0 b/s},
	Allowed CBS Values = {0 bytes, 76,800 bytes},
	Allowed EBS Values = {0 bytes},
	Total IR Upper Bound = 200 x10^6 b/s,
	Total IR Lower Bound = 0 b/s
	>
	}

Service Attribute	**Value for EVC EPs at UNIs** U1,…,U50 (exceptions noted)
EVC EP Egress Bandwidth Profile	*None*
EVC EP Class of Service Name Egress Bandwidth Profile	*None*
EVC EP CoS Name Egress BWP Limits	*None*
EVC EP Source MAC Address Limit	*Disabled*
EVC EP Subscriber MEG MIP	6

EVC EP Elastic Behavior	{
	EVC EP Ingress Class of Service Map,
	EVC EP Class of Service Name Ingress Bandwidth Profile
	}

Table 24 – EVC EP Service Attribute Values for Cloud Access Example

Appendix B Example of Cloud Interconnect Service (Informative)

This appendix provides an example showing how an Elastic Subscriber Ethernet Cloud Connectivity Service can be used for Cloud Interconnect between two cloud data centers, for example for virtual machine migration and storage replication.

For the Cloud Interconnect example, an Elastic Subscriber Ethernet Cloud Connectivity Service is based on EPL service (MEF 6.3, [4]) with the EVC EP ID Service Attribute values being 3 and 4. CoS Label H is used for virtual machine migration and CoS Label M is used for storage replication. An Ingress Bandwidth Profile Flow is setup for each CoS Label at each EVC EP with each Bandwidth Profile Flow in a separate Envelope.

Virtual machine migrations do not have a predefined schedule while storage replications are done periodically, once a day. Because the Ethernet SP charges higher rates for higher values of *CIR*, the Cloud SP negotiates the EVC EP Class of Service Name Ingress Bandwidth Profile Service Attribute to be Elastic for the two EVC EPs and uses higher values of *CIR* whenever virtual machine migration and storage replication is done.

Table 25 shows the value of the Allowed EVC EP CoS Name Ingress BWP Limits Service Attribute (Section 9.1.2.2). The initial value of the *CIR* is 0.5 Mb/s and the initial values of the other parameters are as in the table.

Parameter	**Values**	
CoS Name	H	M
Allowed CIR Values	500×10^3 b/s, 3×10^9 b/s	500×10^3 b/s, 1×10^9 b/s
Allowed EIR Values	0 b/s	0 b/s
Allowed CIR_{max} Values	3×10^9 b/s	1×10^9 b/s
Allowed EIR_{max} Values	0 b/s	0 b/s
Allowed CBS Values	90,000 bytes	90,000 bytes
Allowed EBS Values	0 bytes	0 bytes
Total IR Upper Bound	3×10^9 b/s	1×10^9 b/s
Total IR Lower Bound	0 b/s	0 b/s

Table 25 – EVC EP CoS Name Ingress BWP Limits Service Attribute Value

The value of the Elastic Ethernet Service Control SLS Service Attribute (Section 9.3.1) is <2020-11-01 00:00:00, 1 year, *PMe*> where *PMe* is shown in Table 26.

Performance Metric Name	**Parameter and Objective Values**
Acceptance Decision Duration	$ADT = 600{,}000$ ms, $\widehat{ADD} = .95$
Change Duration	$CDT = 900{,}000$ ms, $\widehat{CD} = .90$
Request Acceptance Ratio	$\widehat{RAR} = .95$
Change Success Ratio	$\widehat{CSR} = .99$

Table 26 – *PMe* Value for the Elastic Ethernet Service Control SLS Service Attribute

The duration of each virtual machine migration is difficult to predict. Thus, two One-Time Change Service Modification Requests are used, one to increase the value of *CIR* before the start of the migration and one to reduce the value of *CIR* after completion of the migration. Table 27 shows the key values in a Service Modification Request[2] for a virtual machine migration that is scheduled to start on 25 November 2020 at 1:00 PM Eastern Standard Time. The *Start Time* parameter value allows one half hour for the Ethernet SP to complete the modification. Per Table 26, if the Ethernet SP is meeting the Performance Objectives in the value of the Elastic Ethernet Service Control SLS Service Attribute, the success or failure of a change will be known in less than 15 minutes after the *Start Time* parameter value for 99% or more of the Service Modification Requests.

Request Type	Start Time	CIR Value for the H Bandwidth Profile Flow for EVC EP 3	CIR Value for the H Bandwidth Profile Flow for EVC EP 4
One-Time Change	2020-11-25 17:30:00	3×10^9 b/s	3×10^9 b/s

Table 27 – Key Values in the Service Modification Request Before the Virtual Machine Migration

Table 28 shows the key values in a Service Modification Request[2] for a virtual machine migration that completed on 25 November 2020 at 3:27 PM Eastern Standard Time. The *Start Time* parameter value is somewhat after the completion of the migration and accounts for the value of the Minimum Lead Time Service Attribute (Section 9.3.2).

Request Type	Start Time	CIR Value for the H Bandwidth Profile Flow for EVC EP 3	CIR Value for the H Bandwidth Profile Flow for EVC EP 4
One-Time Change	2020-11-25 20:40:00	500×10^3 b/s	500×10^3 b/s

Table 28 – Key Values in the Service Modification Request After the Virtual Machine Migration

Table 29 shows the key values in the Service Modification Request[2] for storage replications scheduled for 3 hours duration every day beginning at 2:00 AM Eastern Standard Time. The first of these storage replications starts on 5 December 2020. The *Start Time* parameter value allows one half hour for the Ethernet SP to complete the modification. The *Revert Time* parameter value includes some buffer in case a storage replication runs long. The Period is 24 hours expressed in seconds.

[2] The Service Modification Request contains all parameter values for all EVC EP Ingress Bandwidth Profile Service Attributes but only the values being modified are shown.

Request Type	Start Time	Revert Time	Period	First CIR Value for the M Bandwidth Profile Flow for EVC EP 3	Second CIR Value for the M Bandwidth Profile Flow for EVC EP 3	First CIR Value for the M Bandwidth Profile Flow for EVC EP 4	Second CIR Value for the M Bandwidth Profile Flow for EVC EP 4
Reverting Periodic Change	2020-12-05 06:30:00	2020-12-05 10:30:00	86,400 seconds	1×10^9 b/s	500×10^3 b/s	1×10^9 b/s	500×10^3 b/s

Table 29 – Key Values in the Service Modification Request for Storage Replications

A large number of Service Attribute values beyond those mentioned above in this appendix need to be established by agreement between the Cloud SP and SP Alpha. These values will be similar to those shown in Appendix A and are not repeated here in the interest of brevity.

For an example of the use of the Periodic Service Modification Request, suppose that "Ad_Hoc" is a third Class of Service Name that is used for occasional storage replications that are initiated as needed. Such storage replications are manually initiated at times so as to not to overlap with the automatic daily storage replications. Since the durations of these as needed storage replications are not known, a One-Time Service Modification Request with the value of the *Start Time* parameter = *ASAP* is used to request *CIR* ≥ 1 Gb/s for the Bandwidth Profile Flow based on the "Ad_Hoc" Class of Service Name. And a One-Time Service Modification Request is to be used to set the value of this *CIR* to zero after each as needed storage replication. However, the second One-Time Service Modification may not be sent due to the manual nature of the as needed storage replications. If this happens, the large *CIR* value will stay in force for a possibly long time incurring significant cost. To prevent this costly event, a "clean-up" Periodic Service Modification Request is used to set the *CIR* to zero with key values[2] as shown in Table 30. The value of the *Start Time* parameter is 11:00 PM Eastern Standard Time on December 1, 2020 and the period is 24 hours. Thus, going forward, the *CIR* value is requested to be set to zero every day shortly after 11:00 PM Eastern Standard Time.

Request Type	Start Time	Period	CIR Value for the "Ad_Hoc" Bandwidth Profile Flow for EVC EP 3	CIR Value for the "Ad_Hoc" Bandwidth Profile Flow for EVC EP 4
Periodic Change	2020-12-02 04:00:00	86,400 seconds	0 b/s	0 b/s

Table 30 – Key Values in the "Clean Up" Service Modification Request

Appendix C Request and Notification Sequencing Examples (Informative)

Figure 21 shows the Service Modification Request and Notifications for an Accepted Service Modification Request.

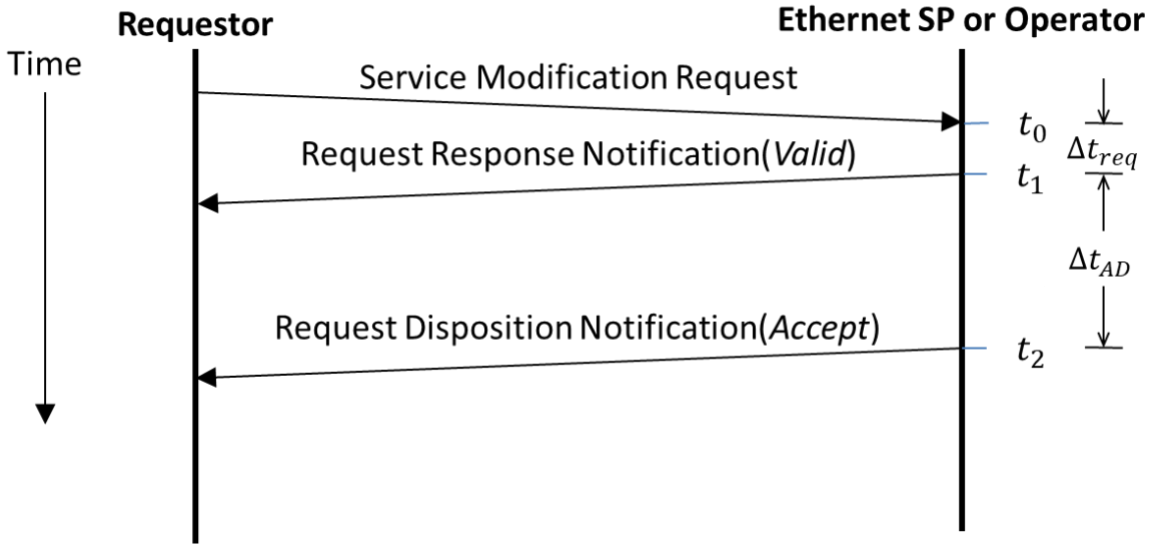


Figure 21 – Service Control Notifications for an Accepted, Valid Service Modification Request

In the case of an *Invalid* Service Modification Request, a Request Response(*Invalid*) Notification would occur at t_1 and there would be no Request Disposition Notification.

Figure 22 shows the Service Modification Request and Notifications for a successful One-Time Change. Note that a Modification Maintenance Interval is in effect from t_3 to t_4.

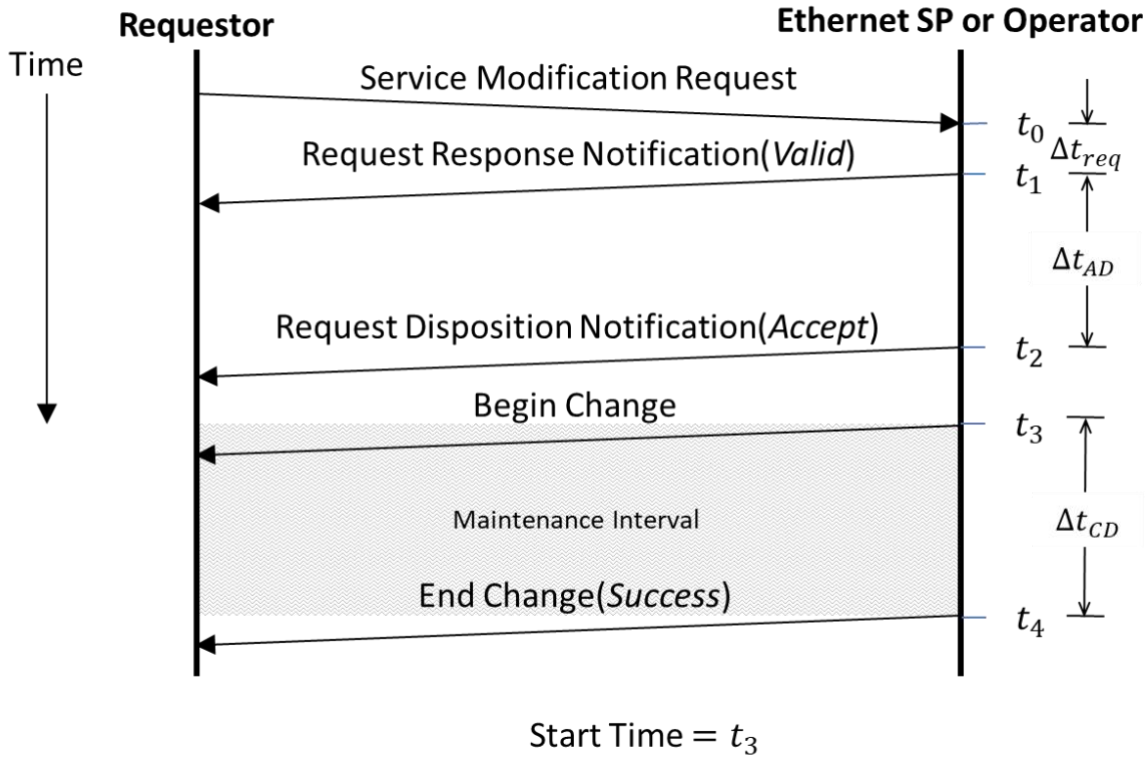


Figure 22 – Service Control Notifications for a Successful One-Time Change

Figure 23 shows the Service Modification Request and Notifications for two cycles of a successful Periodic Change.

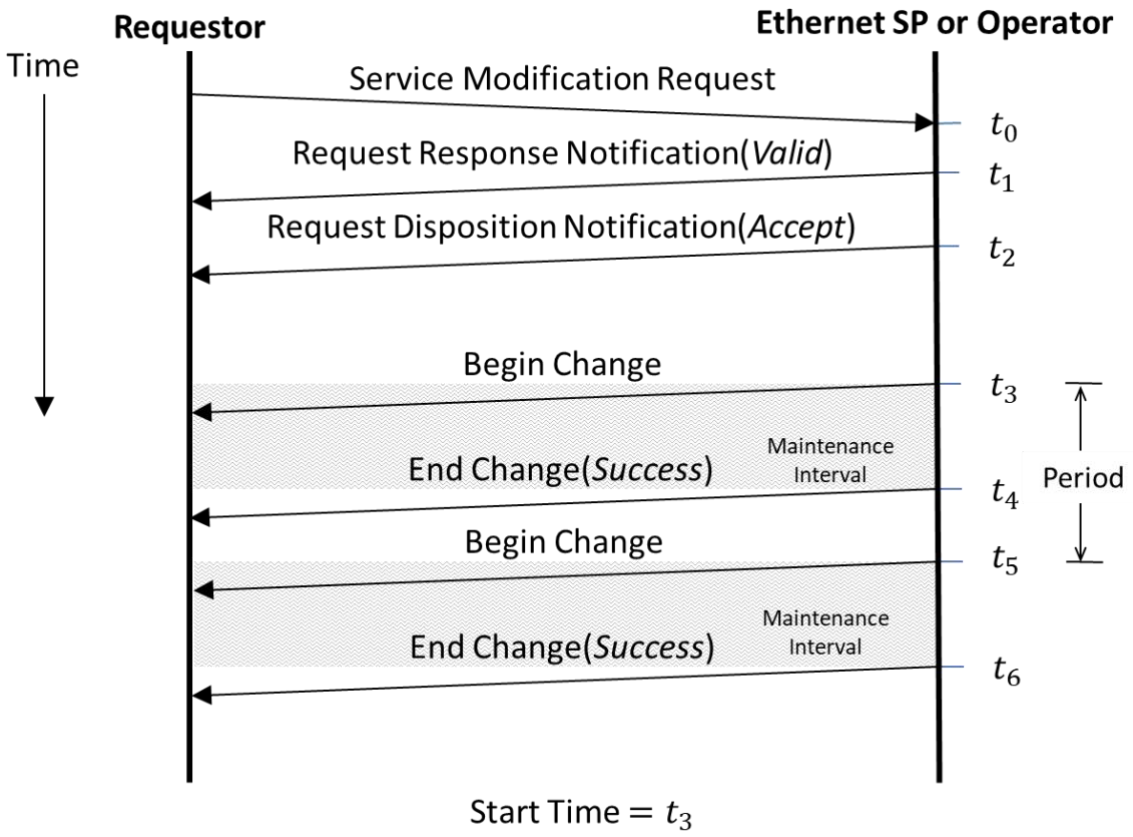


Figure 23 – Service Control Notifications for a Successful Periodic Change (2 Cycles)

Figure 24 shows the Service Modification Request and Notifications for a successful Reverting Change. The End Change(*Success*) Notification at time t_4 indicates that the first Elastic Ethernet Service Attribute values have been established. The End Change(*Success*) Notification at time t_6 indicates that the second Elastic Ethernet Service Attribute values have been established.

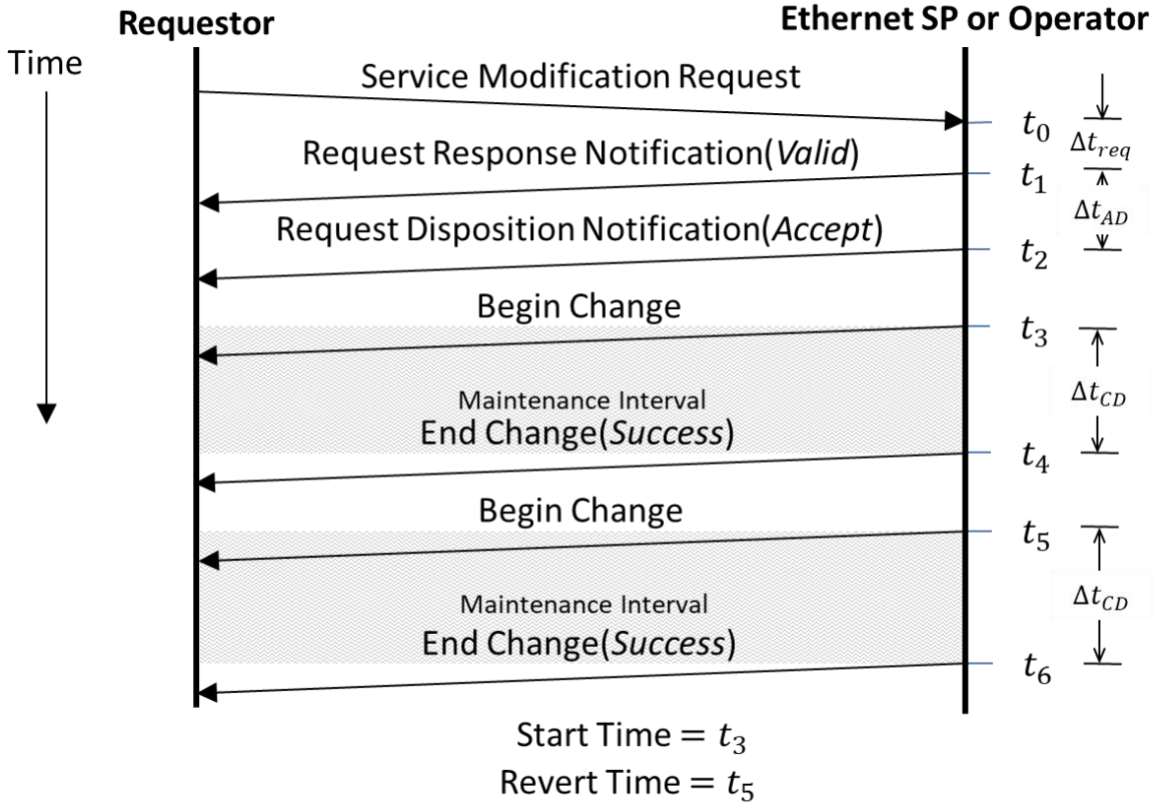


Figure 24 – Service Control Notification for a Successful Reverting Change

Figure 25 shows the Service Modification Request and Notifications for two cycles of a successful Reverting Periodic Change.

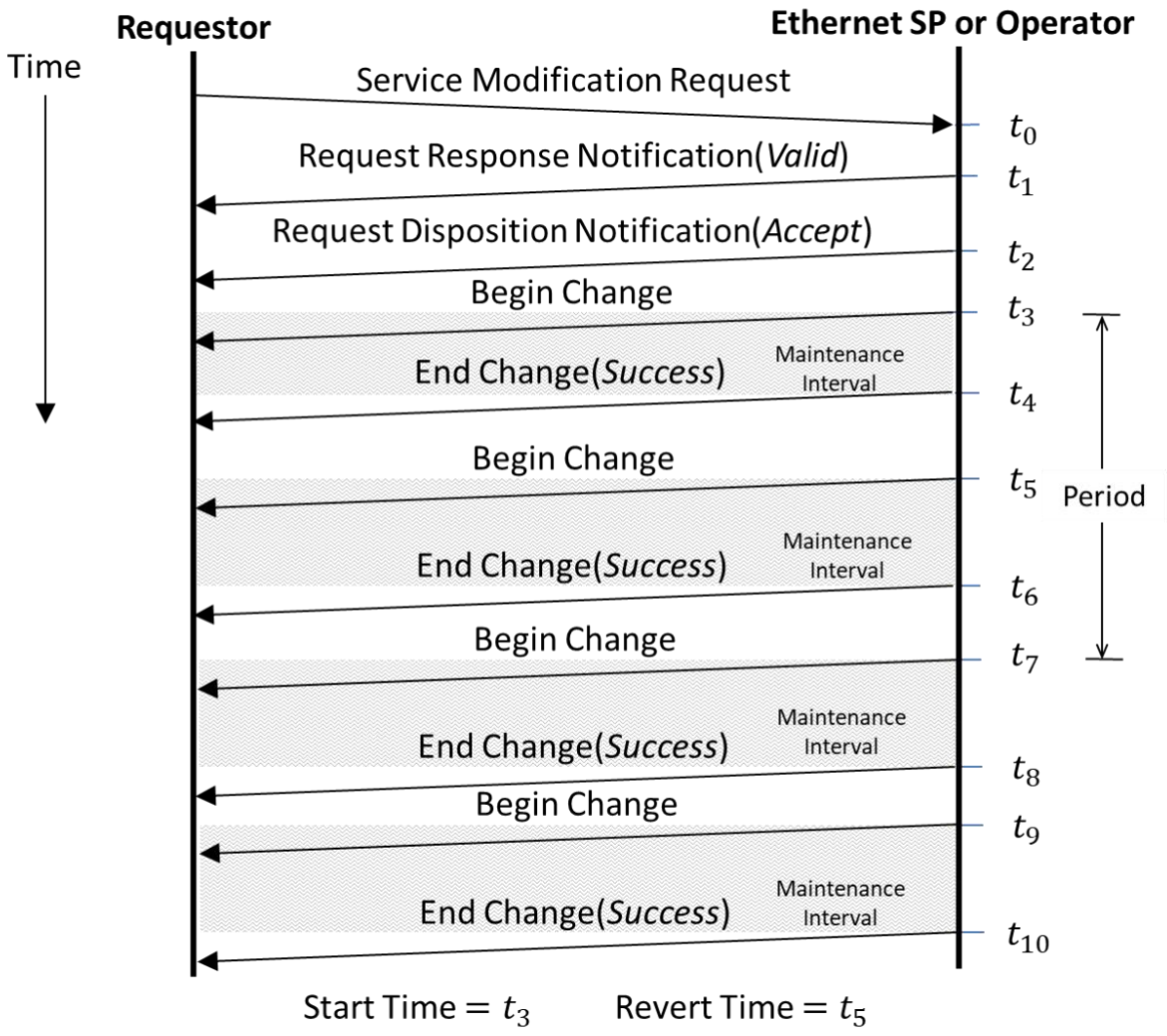


Figure 25 – Service Control Notifications for a Successful Reverting Periodic Change (2 Cycles)

Appendix D Changes from MEF 47 (Informative)

Key changes in this standard compared to MEF 47 [10] include:

- Detailed definitions of the Service Modification Request and associated parameters are included (Section 8).
- Service Modification Requests for immediate modifications are replaced with the *Start Time* parameter value = *ASAP* (Section 8.1.4).
- A Service Modification Request for a reverting change is modified to contain two values for each Elastic Ethernet Service Attribute being changed (Section 8.2).
- A Service Modification Request for a reverting periodic change is modified to contain two values for each Elastic Ethernet Service Attribute being changed (Section 8.2).
- A Service Modification Request for a periodic change with a single value and no reverting is added (Section 8.2).
- The messages (Requests) sent by the Subscriber are defined (Section 8.3).
- The messages (Notifications) sent by the Ethernet SP or Operator are defined and a state machine is specified that mandates when such Notifications are sent (Section 8.3).
- The list of Service Attributes that can be made Elastic is significantly expanded including attributes for Operator Ethernet Services (Section 9).
- The list of Bandwidth Profile Parameters that can be Elastic is significantly expanded along with Service Attributes limiting their values (Section 9).
- The Elastic Ethernet Service Control SLS Service Attribute is introduced that provides quantitative characterizations and objectives for the quality of the Requestor experience when using Service Modification Requests (Section 9.3).
- The list of Service Attributes that constrain the timing of service modifications is expanded (Section 9.3).
- The concept of Service Modification Request density is introduced along with a corresponding frequency limiting Service Attribute (Section 9.3).
- The Allowed Request Types Service Attribute is introduced (Section 9.3).
- The concept of Conflicting Service Modification Requests is in introduced and conditions for when there is a conflict are specified (Section 10.2).

- Extensive requirements are introduced for identifying *Invalid* Service Modification Requests (Sections 8, 9, and 10).

- Elastic Ethernet Cloud Connectivity Services (Section 11) are mandated to be based on the services defined in MEF 6.3 [4] and MEF 51.1 [11].

- Material relating to “Elastic Service Management Interface” is removed as being out of scope of this standard.

- The number of mandatory requirements is increased from 22 to 155.