



MEF Standard

MEF 126

Network Slice Performance Profiles

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1 List of Contributing Members

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

- Bell Canada
- Ericsson
- NEC/Netcracker
- Nokia
- Telus

2 Abstract

This document defines the Network Profile Attribute Connectivity Services Performance parameter whose value places requirements on the performance of Connectivity Services instantiated on the Network Slice used for the Network Service as defined in MEF 84 [12]. The Network Profile Attribute Connectivity Services Performance parameter includes three standardized Network Slice performance profiles (*Real-Time Connectivity*, *Premium Connectivity*, and *Business Connectivity*) that specify bounds on Performance Objectives which are based on Class of Service Labels and Performance Tiers. The standardized Network Slice performance profiles assist Subscribers with selecting the Network Service that best meets the performance requirements of their applications.

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.

In addition, terms defined in MEF 6.3 [4], MEF 10.4 [5], MEF 23.2 [7], MEF 23.2.2 [8], MEF 61.1 [9], MEF 63 [10], MEF 69.1 [11] and MEF 84 [12] are included in this document by reference, and are not repeated in the table below.

Term	Definition	Reference
Connectivity Service	A Subscriber Layer 1, Subscriber Ethernet or Subscriber IP VPN Service as defined in MEF 63 [10], MEF 6.3 [4] and MEF 69.1 [11] respectively.	This document

Table 1 – Terminology

Abbreviation	Definition	Reference
Connectivity Services Performance Parameter	Short for Network Profile Attribute Connectivity Services Performance parameter	This document
MNO	Mobile Network Operator	This document
RAN	Radio Access Network	MEF 22.3 [6]

Table 2 – Abbreviations

4 Compliance Levels

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 (RFC 2119 [2], RFC 8174 [3]) when, and only when, they appear in all capitals, as shown here. All key words must be in bold text.

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

5 Numerical Prefix Conventions

This document uses the prefix notation to indicate multiplier values as shown in Table 3.

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 3 – Numerical Prefix Conventions

6 Introduction

MEF 84 [12] introduces the Network Profile Attribute that describes certain characteristics of the Network Slice used for the Network Service defined in MEF 84. Note that MEF 84 defines Network Service as a Network Slice offered as a Service to one or more Subscribers. This document complements MEF 84 by defining the Network Profile Attribute Connectivity Services Performance parameter and parameter values that establish minimum performance levels, e.g., maximum packet loss, for Connectivity Services instantiated on the Network Slice. In this document, Connectivity Service is defined as a Subscriber Layer 1 Service, Subscriber Ethernet Service or Subscriber IP VPN Service as defined in MEF 63 [10], MEF 6.3 [4] and MEF 69.1 [11] respectively. The term Network Profile Attribute Connectivity Services Performance parameter is abbreviated to Connectivity Services Performance Parameter in this document.

Further, this document defines three standardized Network Slice performance profiles for different levels of Connectivity Services performance supported by the Network Slice. When information about a Service Provider internal Network Slice is provided to Subscribers and when this Network Slice is offered as a Service to a Subscriber, the Service Attribute and parameter values must be agreed between the Subscriber and the Service Provider. Standardized Network Slice performance profiles establish common expectations for Service Providers and Subscribers and allow Subscribers to select the Network Service that works best for their applications, regardless of the Network Slice's underlying connectivity technology.

Section 7 reviews the key MEF 84 concepts and introduces the Connectivity Services Performance Parameter.

In Section 8 the Connectivity Services Performance Parameter is specified along with requirements on its values for pairs of Class of Service Name and Performance Tier. The requirements in this section are aligned with the corresponding requirements in MEF 23.2 [7], MEF 23.2.2 [8], MEF 63 [10], and MEF 69.1 [11]. The Connectivity Services Performance Parameter includes three standardized Network Slice performance profiles (*Real-Time Connectivity*, *Premium Connectivity*, *Business Connectivity*).

Appendix A describes how the Performance Metric bounds defined for Subscriber Layer 1 Service *Delay* in Section 8 were derived.

Appendix B illustrates the use of the Network Profile Attribute parameter specified in this document to support a 3GPP 5G slice.

Appendix C provides an example that illustrates the use of the Network Profile Attribute parameters specified in this document, where a non-MEF-standardized Class of Service Name List item is used in the Network Profile Attribute parameters.

7 Review of Key Concepts

For the convenience of the reader, this section briefly reviews concepts from MEF 23.2 [7], MEF 23.2.2 [8], MEF 63 [10], MEF 69.1 [11], and MEF 84 [12] that are used in this document.

Key concepts of Network Slicing, Network Slices and Network Service are described in MEF 84 [12].

7.1 The Network Profile Attribute

The Network Profile Attribute (defined in Section 7.2.3 of MEF 84 [12]) contains parameters whose values govern Subscriber visible characteristics of the Network Slice used for the Network Service.

The value of the Network Profile Attribute is either *None* or a list of parameter values. This document defines the Connectivity Services Performance Parameter whose values impact the value of the Service Level Specification (SLS)¹ for supported service types (see Section 7.2) instantiated on the Network Slice.

7.1.1 Network Profile Attribute Connectivity Services Performance Parameter

The value of the Connectivity Services Performance Parameter indicates the level of performance for a supported Connectivity Service type instantiable on the Network Slice. It does this by placing bounds on the values of the Performance Objectives and related parameters specified within the value of the SLS of the corresponding Connectivity Service instance. Section 8 specifies possible values for this parameter and how the values impact the SLS values possible for instances of supported Connectivity Service types.

7.2 Supported Service Types Attribute

Per MEF 84 [12], the Supported Service Types Attribute lists the types of services that can be instantiated on the Network Slice. This document (MEF 126) applies to the subset of the Supported Service Types specified in MEF 84 section 7.2.4 that are Subscriber services and have an SLS: Subscriber Layer 1 (MEF 63 [10]), Subscriber Ethernet (MEF 6.3 [4]) and Subscriber IP VPN (MEF 69.1 [11]).

7.3 Classes of Service

A Subscriber Ethernet Service (MEF 6.3 [4]) and a Subscriber IP VPN Service (MEF 69.1 [11]) can support one or several Class of Service Names. Different CoS Names can indicate different values for the Performance Objectives in the SLS.

Note that a Subscriber Layer 1 Service does not have the concept of Class of Service Names.

¹ An SLS provides the technical details of the service level, in terms of Performance Objectives, agreed between the Service Provider and the Subscriber as part of the Service Level Agreement (SLA).

Per MEF 23.2 [7] and MEF 69.1 [11], a Class of Service Label (CoS Label) is a standardized CoS Name with standardized bounds on the values of SLS parameters and Performance Objectives. The following CoS Labels for Subscriber Ethernet Service² and Subscriber IP VPN Service are defined (see MEF 23.2 [7], MEF 69.1 [11]). The text from these documents is quoted below:

- **H** – intended for applications that are very sensitive to loss, delay and delay variation such as VoIP and mobile backhaul control.
- **M** – intended for applications that are sensitive to loss but more tolerant of delay and delay variation such as near-real-time or critical data applications.
- **L** – intended for applications that are more tolerant of loss as well as delay and delay variation such as non-critical data applications.

CoS Labels *H*, *M* and *L* informally refer to High, Medium and Low, and are differentiated by their performance requirements.

7.4 Performance Tiers

MEF 23.2 [7], MEF 23.2.2 [8] and MEF 69.1 [11] introduce the concept of the Performance Tier (PT). The Performance Tier addresses the fact that the physical distance between the ingress UNI and the egress UNI and network implementation details for a Connectivity Service will dictate a lower bound for delay and possibly bounds on other Performance Metrics such as loss.

There are six Performance Tiers defined with the format: PT Number (PT Name) - Description (distance, derived propagation delay used in CoS Performance Objective constraints to establish a minimum per PT):

- **PT0.3** (City PT) – derived from distances less than Metro in extent (<75km, 0.6ms),
- **PT1** (Metro PT) – derived from typical Metro distances (<250km, 2ms),
- **PT2** (Regional PT) – derived from typical Regional distances (<1200km, 8ms),
- **PT3** (Continental PT) – derived from typical National/Continental distances (<7000km, 44ms),
- **PT4** (Global PT) – derived from typical Global/Intercontinental distances (<27500km, 172ms), and
- **PT5** (Satellite PT) – derived from typical Geosynchronous Earth Orbit (GEO) satellite distances (<72000km, 277ms).

Note that the assigned Performance Tier for a pair of UNIs can be different than that implied by the physical distance between them. Per Appendix A of MEF 23.2 [7], distance was used to derive the PT objectives, but PTs can be assigned based on other factors.

In addition to the Connectivity Service type and Class of Service Name, the performance for traffic going from one Network Service UNI to another Network Service UNI is highly dependent on the Performance Tier that applies to it. Consequently, Performance Tiers need to be considered in the values of the Connectivity Services Performance Parameter.

² Note that this document uses the term Subscriber Ethernet Service as defined in MEF 6.3 while MEF 23.2 and MEF 23.2.2 use the name Carrier Ethernet.

8 Network Profile Attribute Connectivity Services Performance Parameter

Per MEF 84 [12], the value of the Network Profile Attribute is *None* or a list of parameter values. When the value is *None*, the MEF 84 [12] Network Service Agreement does not impose performance constraints on Connectivity Services instantiated on the Network Slice.

When the value is not *None*, the values of the parameters specify the externally observable behavior of the Network Slice used for the Network Service. This section defines one such parameter, the Network Profile Attribute Connectivity Services Performance parameter, and its possible values.

The value of the Connectivity Services Performance Parameter specifies the bounds on the level of performance for each Connectivity Service instantiated on the Network Slice. It does this by specifying bounds on the Performance Objectives and bounds on the parameters in the value of the SLS for each Connectivity Service instance.

Note that a subset of the traffic for a given Connectivity Service is subject to the Performance Objectives addressed in this document:

- For a Subscriber Layer 1 Service, the Performance Objectives apply to Layer 1 Characteristic Information during Available Time per Section 8.2.3.2 in MEF 63 [10].
- For a Subscriber Ethernet Service, the Performance Objectives apply to Qualified Service Frames per Section 8.8.1.4 in MEF 10.4 [5].
- For a Subscriber IP VPN Service, the Performance Objectives apply to Qualified Packets per Section 10.9.2 in MEF 61.1 [9].

The value of a Connectivity Services Performance Parameter is either *None* or consists of six items:

- Class of Service Name List – a list of one or more Class of Service Names and/or Class of Service Labels,
- Performance Name – a string that can be used to delineate different sets of values of the other items,
- Performance Tier List – a list of Performance Tiers that are associated with the Network Slice used for the Network Service,
- Ordered Network Service UNI Pair Performance Tier Information – a list of tuples containing information about Performance Tiers that can apply to instantiated Connectivity Services that associate selected ordered Network Service UNI pairs,
- Common Parameter Bounds Table – a table with bounds on the common parameter values in the SLSs for Services instantiated on the Network Slice, and
- Performance Objective Bounds Tables – a set of tables with bounds on Performance Objectives, one table for each possible pair $\langle x, y \rangle$ where x is an item in the value of the Class of Service Name List and y is a Performance Tier.

If the value of the Connectivity Services Performance Parameter is *None* then there are no constraints on the value of the SLS Service Attribute for any Subscriber Layer 1 Service, Subscriber Ethernet Service, or Subscriber IP VPN Service instantiated on the Network Slice.

Sections 8.1 through 8.6 specify the possible values and related requirements for the six items. Figure 1 illustrates the relationship of the Connectivity Services Performance Parameter and its six items in the hierarchy of MEF 84 [12] Network Service attributes.

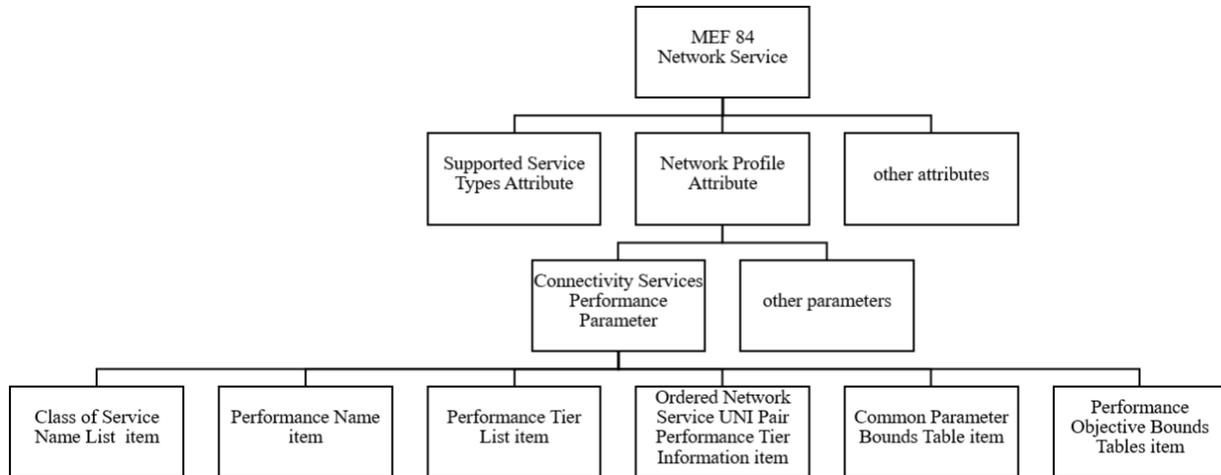


Figure 1 – Connectivity Services Performance Parameter in MEF 84 Network Service Attributes

8.1 Class of Service Name List Item

The Class of Service Name List item is a list of one or more Class of Service Names and/or Class of Service Labels. It is used by the Subscriber and the Service Provider to agree on the value of the Performance Objectives in the Performance Objective Bounds Tables item (see Section 8.6).

Note, for Subscriber Ethernet Services and Subscriber IP VPN Services, its value also corresponds to the Connectivity Service’s Class of Service Names, including Class of Service Labels (as defined in MEF 23.2 [7], MEF 69.1 [11]), which can be invoked for such Connectivity Services instantiated on the Network Slice.

Refer to Appendix C for an example of how the Class of Service Name List item is used in the Network Profile Attribute.

- [R1] If a Subscriber Ethernet Service is instantiated on the Network Slice and if the value of the EVC List of Class of Service Names Service Attribute (Section 8.7 of MEF 10.4 [5]) contains a Class of Service Name other than *Discard*, then that Class of Service Name **MUST** be contained in the value of the Class of Service Name List item.

As an example of the implication of [R1], suppose a request is made to instantiate a Subscriber Ethernet Service on the Network Slice whose value of the EVC List of Class of Service Names Attribute contains *Gold*. If *Gold* is not in the value of the Class of Service Name List item, then the request will be rejected.

- [R2] If a Subscriber IP VPN Service is instantiated on the Network Slice and if the value of the IPVC List of Class of Service Names Service Attribute (Section 10.8 of MEF 61.1 [9]) contains a Class of Service Name other than *Discard*, then that Class of Service Name **MUST** be contained in the value of the Class of Service Name List item.

Note that for Subscriber Layer 1 Services, which do not have the concept of differentiated Classes of Service, there are no requirements similar to [R1] and [R2]. However, Class of Service Names can be used to specify different Performance Objective Bounds Tables (see section 8.6).

To see how the Class of Service Name List item is used in Performance Objective Bounds Tables, refer to section 8.6 and Appendix C.

Three examples of the value of the Class of Service Name List are as follows:

- {*H, L*},
- {*Gold, Silver, Straw*}, and
- {*H, Platinum, Super DLT Ready, M*}.

The third bullet item above is an example of a list that contains both Class of Service Labels and other Class of Service Names.

8.2 Performance Name Item

The value of the Performance Name item is a string that meets [R3] and [R4]. Its purpose is to provide a short name for important values of the Connectivity Services Performance Parameter. For example, the value of this item might be “Flash Trading Connectivity” to indicate that the value of the Class of Service Name List item contains an entry with Performance Objective Bounds Tables item values containing very low delay upper bounds that are suitable for high speed, automated stock trading. In other words, it is possible to instantiate Connectivity Services on the Network Slice that can be used for high speed, automated stock trading.

- [R3] The value of the Performance Name item **MUST** be a string consisting of one or more UTF-8 characters in the range of 32–126 (0x20 to 0x7e), inclusive.
- [R4] The value of the Performance Name item **MUST** be less than or equal to 53 characters.

The following three values of the Performance Name item are standardized:

- *Real-Time Connectivity*,
- *Premium Connectivity*, and
- *Business Connectivity*.

- [R5] If the value of the Performance Name item is *Real-Time Connectivity*, then the value of the Connectivity Services Performance Parameter **MUST** be such that the value of the Class of Service Name List item contains only *H*.

- [R6] If the value of the Performance Name item is *Premium Connectivity*, then the value of the Connectivity Services Performance Parameter **MUST** be such that the value of the Class of Service Name List item contains only *H* and *M*.
- [R7] If the value of the Performance Name item is *Business Connectivity*, then the value of the Connectivity Services Performance Parameter **MUST** be such that the value of the Class of Service Name List item contains only *M* and *L*.

8.3 Performance Tier List Item

The Performance Tier List item is a list that specifies Performance Tiers that are associated with the Network Slice used for the Network Service. The value of the Performance Tier List item is a non-empty list of Performance Tiers consisting of one or more of {*PT0.3*, *PT1*, *PT2*, *PT3*, *PT4*, *PT5*}.

- [R8] A Performance Tier, *pt*, **MUST** be included in the value of the Performance Tier List item if and only if there exists:
- A Connectivity Service Type, *s*, in the value of the Supported Service Types Attribute, and
 - An ordered pair of Network Service UNIs, $\langle uni_x, uni_y \rangle$, in the Network Slice,

such that a Connectivity Service of type *s* instantiated between *x* and *y* can have Performance Tier *pt* apply to the traffic going from *uni_x* to *uni_y*.

8.4 Ordered Network Service UNI Pair Performance Tier Information Item

The Ordered Network Service UNI Pair Performance Tier Information item specifies the Performance Tiers that can apply to instantiated Connectivity Services that associate selected ordered Network Service UNI pairs. The value of the Ordered Network Service UNI Pair Performance Tier Information item is either *None* or a non-empty list of 4-tuples of the form $\langle Uni_Pair, Service_Type, CoS_Name, pt \rangle$ where:

- The value of *UNI_Pair* specifies an ordered Network Service UNI pair and is of the form $\langle id1, id2 \rangle$ where *id1* and *id2* are Network Service UNI Identifier values (see Section 7.2.5.1 in MEF 84 [12]),
- The value of *Service_Type*, is one of entries in the value of the Supported Service Types Attribute,
- The value of *CoS_Name* is one of the entries in the value of the Class of Service Name List item, and
- The value of *pt* is one of the entries in the value of the Performance Tier List item.

When the value of the Ordered Network Service UNI Pair Performance Tier Information item is not *None*, not all possible ordered Network Service UNI pairs need to appear in the list of 4-tuples. In other words, the Subscriber and Service Provider can agree that only a subset of all ordered Network Service UNI pairs appear in the list of 4-tuples. The use of a subset could result from the Subscriber needing to know the performance characteristics between only certain ordered Network

Service UNI pairs. For example, the Subscriber needs specific performance characteristics between branch and hub locations but not between branch locations.

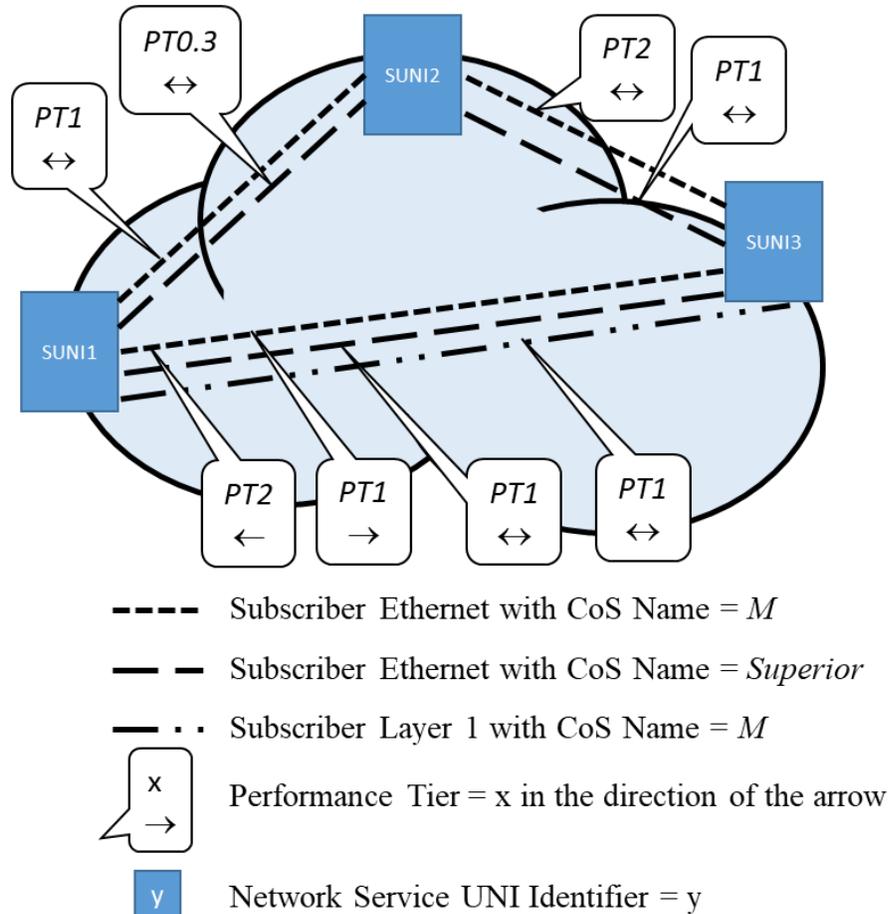
- [R9] If the 4-tuple $\langle\langle uni_x, uni_y \rangle, s, c, pt \rangle$ is contained in the value of the Ordered Network Service UNI Pair Performance Tier Information item and s equals either Subscriber Ethernet Service or Subscriber IP VPN Service, then it **MUST** be possible to instantiate a Connectivity Service of type s with the Class of Service name c between uni_x and uni_y such that Performance Tier pt applies to the traffic going from uni_x to uni_y .
- [R10] If the 4-tuple $\langle\langle uni_x, uni_y \rangle, s, c, pt \rangle$ is contained in the value of the Ordered Network Service UNI Pair Performance Tier Information item and s equals Subscriber Layer 1 Service, then it **MUST** be possible to instantiate a Connectivity Service of type s between x and y such that Performance Tier pt applies to the traffic going from uni_x to uni_y .

Once the Performance Tier is established, then the value of the pair $\langle c, pt \rangle$ determines the value of the Performance Objectives in the Performance Objective Bounds Tables item (see section 8.6). For Subscriber Layer 1 Services the value c can be used to distinguish between different Performance Objectives for a given Performance Tier when c is not a CoS Label.

Figure 2 illustrates an example of the value of the Ordered Network Service UNI Pair Performance Tier Information item. For this example, the Subscriber is only interested in the Performance Tiers that can apply between *SUN11* and *SUN13*. Note that the Performance Tier that applies for traffic going from *SUN11* to *SUN13* is different than the Performance Tier that applies for traffic going from *SUN13* to *SUN11* for *Subscriber Ethernet* with Class of Service Label *M* and this fact is captured in the first two 4-tuples. Also note that the figure shows Performance Tier information for the other two ordered Network Service UNI pairs but this information is not included in the value of the Ordered Network Service UNI Pair Performance Tier Information item for this example.

Class of Service Name List Item = $\{M, Superior\}$
 Supported Service Types Attribute = $\{Subscriber Ethernet, Subscriber Layer 1\}$

Possible Connectivity Service Instances



Ordered Network Service UNI Performance Tier Information Item =
 $\{$
 $\langle\langle SUNI1, SUNI3 \rangle, Subscriber Ethernet, M, PT1 \rangle,$
 $\langle\langle SUNI3, SUNI1 \rangle, Subscriber Ethernet M, PT2 \rangle,$
 $\langle\langle SUNI1, SUNI3 \rangle, Subscriber Layer 1, M, PT1 \rangle,$
 $\langle\langle SUNI3, SUNI1 \rangle, Subscriber Layer 1, M, PT1 \rangle,$
 $\langle\langle SUNI1, SUNI3 \rangle, Subscriber Ethernet, Superior, PT1 \rangle,$
 $\langle\langle SUNI3, SUNI1 \rangle, Subscriber Ethernet, Superior, PT1 \rangle,$
 $\}$

Figure 2 – Ordered Network Service UNI Pair Performance Tier Information Item Value Example

For the example in Figure 2, the value of the Performance Tier List item (section 8.3) is mandated by [R8] to be $\{PT0.3, PT1, PT2\}$ because *PT0.3* can apply between *SUNI1* and *SUNI2*.

8.5 Common Parameter Bounds Table Item

The value of the Common Parameter Bounds Table item specifies constraints on the values of the common parameters in the value of the SLS for any Connectivity Service instantiated on the Network Slice.

Table 4 shows the form of the Common Parameter Bounds Table item. The first column contains the types of Connectivity Service. The second column contains the common parameter names. The remaining columns contain upper bounds on the common parameter values. The units for the upper bounds are specified in the source documents MEF 63 [10], MEF 6.3 [4], and MEF 69.1 [11].

Note that while Table 4 and Table 5 contain information for all of Subscriber Layer 1 (MEF 63 [10]), Subscriber Ethernet (MEF 6.3 [4]) and Subscriber IP VPN (MEF 69.1 [11]) service types, the Common Parameter Bounds Table for a MEF 84 [12] Network Service agreed between a Subscriber and the Service Provider will contain only information related to service types listed in the Supported Service Types Attribute. For example, if there is no Subscriber Layer 1 Connectivity Service in the value of the Supported Service Types Attribute then the Layer 1 row would be omitted in the Common Parameter Bounds Table.

Subscriber Connectivity Service	Common Parameters	Class of Service Names and/or Labels			
		CoS Name 1	CoS Name 2	...	CoS Label <i>M</i>
Layer 1	<i>T</i>	upper bound			
Ethernet	<i>T</i>	upper bound			
	<i>C</i>	upper bound	upper bound	...	upper bound
	Δt	upper bound	upper bound	...	upper bound
	<i>n</i>	upper bound	upper bound	...	upper bound
IP VPN	<i>T</i>	upper bound			

Table 4 – Form of the Common Parameter Bounds Table Item

MEF 63 [10] defines the common parameter *T* for Subscriber Layer 1 Service and this document mandates its upper bound for all Class of Service Names. MEF 23.2 [7] mandates common parameter upper bound values for Class of Service Labels for Subscriber Ethernet Service. MEF 69.1 [11] mandates common parameter upper bound values for Class of Service Labels for Subscriber IP VPN Service. These mandated common parameter upper bound values are repeated in Table 5 for the convenience of the reader. If there is a discrepancy between a table entry in this document and the corresponding value in its source document, the table is to be interpreted as containing the value from the source document. Note that the bound on the value of *T* is the same for all CoS Names and CoS Labels for a given Connectivity Service.

[R11] The common parameter upper bound values for Class of Service Labels **MUST** be those in Table 5.

Subscriber Connectivity Service	Parameters	Class of Service Label		
		<i>H</i>	<i>M</i>	<i>L</i>
Layer 1	<i>T</i>	≤ 1 Month		
Ethernet	<i>T</i>	≤ 1 Month		
	<i>C</i>	≤ 0.1	≤ 0.1	≤ 0.5
	Δt	≤ 10 seconds	≤ 10 seconds	≤ 10 seconds
	<i>n</i>	≤ 10	≤ 10	≤ 10
IP VPN	<i>T</i>	≤ 1 Month		

Table 5 – Upper Bound Values for Common Parameters

8.6 Performance Objective Bounds Tables Item

The Performance Objective Bounds Table item is a set of tables with bounds on Connectivity Service Performance Objectives, one table for each possible pair $\langle x, y \rangle$ where x is a Class of Service Name contained in the Class of Service Name List item and y is a Performance Tier contained in the Performance Tier List item.

Each value of a Performance Objective Bounds Table has the form shown in Table 6.

<CoS Name, Performance Tier>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	Objective and Parameter Constraints	Not Applicable
Ethernet	FD (ms)	Objective and Parameter Constraints	Objective and Parameter Constraints
	MFD (ms)	Objective Constraint	Objective Constraint
	IFDV (ms)	Objective and Parameter Constraints	Objective and Parameter Constraints
	FDR (ms)	Objective and Parameter Constraints	Objective and Parameter Constraints
	FLR (%)	Objective Constraint	Objective Constraint
IP VPN	PD (ms)	Not Applicable	Objective and Parameter Constraints
	MPD (ms)	Not Applicable	Objective Constraint
	IPDV (ms)	Not Applicable	Objective and Parameter Constraints
	PDR (ms)	Not Applicable	Objective and Parameter Constraints
	PLR (%)	Not Applicable	Objective Constraint

Table 6 – Form of a Performance Objective Bounds Table

The abbreviation in the Performance Metric column in Table 6 for Subscriber Layer 1 Service is taken from MEF 63 [10]. The abbreviation D stands for One-way Delay. This Performance Metric and the Performance Metric parameter P_d (used in Table 8 – Table 25) are defined in MEF 63 [10]. Appendix A explains how the Delay Performance Metric Objective bounds in the Performance Objective Bounds Tables (Table 8 – Table 25) were derived.

The parentheses in the second column in Table 6 specify the units for the Performance Objectives in the third and fourth columns corresponding to the Connectivity Service type.

The abbreviations in the Performance Metric column in Table 6 for Subscriber Ethernet Service are taken from MEF 23.2 [7]. The abbreviation FD stands for One-way Frame Delay, MFD stands for One-way Mean Frame Delay, IFDV stands for One-way Inter-Frame Delay Variation, FDR

stands for One-way Frame Delay Range, and FLR stands for One-way Frame Loss Ratio. These Performance Metrics and the Performance Metric parameters ($P_d, P_v, \Delta\tau, P_r$) (used in Table 8 – Table 25) are defined in MEF 10.4 [5].

The abbreviations in the Performance Metric column in Table 6 for Subscriber IP VPN Service are taken from MEF 69.1 [11]. The abbreviation PD stands for One-way Packet Delay, MPD stands for One-way Mean Packet Delay, IPDV stands for One-way Inter-Packet Delay Variation, PDR stands for One-way Packet Delay Range and PLR stands for One-way Packet Loss Ratio. These Performance Metrics and the Performance Metric parameters (p, v, τ, r) (used in Table 8 – Table 25) are defined in MEF 61.1 [9].

Note that in the Performance Objective Bounds Tables the notation in Table 7 applies.

Notation	Meaning
Bounds shown in square brackets []	Mandated parameter constraints
Values shown in parentheses ()	Recommended values
Values shown without parentheses.	Mandated values

Table 7 – Notational Conventions

Note that while Table 6 through Table 25 contain information for all of Subscriber Layer 1 (MEF 63 [10]), Subscriber Ethernet (MEF 6.3 [4]) and Subscriber IP VPN (MEF 69.1 [11]) service types, the Performance Objective Bounds Tables for a MEF 84 [12] Network Service agreed between a Subscriber and the Service Provider will contain only information related to service types listed in the Supported Service Types Attribute. The number of tables is determined by the number of Performance Tiers listed in the Performance Tier List item and the number of CoS Names in the Class of Service Name List item. If the value of the Class of Service Name List item contains m CoS Names and if the value of the Performance Tier List contains n Performance Tiers, then there are at most $m \times n$ Performance Objective Bounds Tables to be agreed between the Service Provider and the Subscriber.

Table 8 through Table 25 contain Performance Objective Bounds Tables for each of $\langle H, PT0.3 \rangle$, $\langle H, PT1 \rangle$, $\langle H, PT2 \rangle$, $\langle H, PT3 \rangle$, $\langle H, PT4 \rangle$, $\langle H, PT5 \rangle$, $\langle M, PT0.3 \rangle$, $\langle M, PT1 \rangle$, $\langle M, PT2 \rangle$, $\langle M, PT3 \rangle$, $\langle M, PT4 \rangle$, $\langle M, PT5 \rangle$, $\langle L, PT0.3 \rangle$, $\langle L, PT1 \rangle$, $\langle L, PT2 \rangle$, $\langle L, PT3 \rangle$, $\langle L, PT4 \rangle$, and $\langle L, PT5 \rangle$. As a convenience for the reader, the entries in these tables for Subscriber Ethernet Services are taken from MEF 23.2 [7] and MEF 23.2.2 [8] while the entries in these tables for Subscriber IP VPN Services are taken from MEF 69.1 [11]. Note that MEF 69.1 does not define point-to-point IP VPN services, and MEF 63 does not define multipoint Subscriber Layer 1 Services, hence those table entries are shown as “Not Applicable”. If there is a discrepancy between a table entry in this document and the corresponding value in its source document, the table is to be interpreted as containing the value from the source document.

- [R12]** The value of the Performance Objective Bounds Table for each of $\langle H, PT0.3 \rangle$, $\langle H, PT1 \rangle$, $\langle H, PT2 \rangle$, $\langle H, PT3 \rangle$, $\langle H, PT4 \rangle$, $\langle H, PT5 \rangle$, $\langle M, PT0.3 \rangle$, $\langle M, PT1 \rangle$, $\langle M, PT2 \rangle$, $\langle M, PT3 \rangle$, $\langle M, PT4 \rangle$, $\langle M, PT5 \rangle$, $\langle L, PT0.3 \rangle$, $\langle L, PT1 \rangle$, $\langle L, PT2 \rangle$, $\langle L, PT3 \rangle$, $\langle L, PT4 \rangle$, and $\langle L, PT5 \rangle$ **MUST** be as specified in Table 8 through Table 25.

Since a Subscriber Layer 1 Connectivity Service does not have a Class of Service Names Service Attribute, the values of the Performance Objective Bounds Tables for Class of Service Labels *H*, *M* and *L* contain the same entries for Subscriber Layer 1 Service for all instances of a Performance Tier. For Class of Service Labels, the bounds for Subscriber Layer 1 Services are determined by the Performance Tier.

<i><H, PT0.3></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 1 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 3 [P_d \geq 99.9\%]$	$\leq 3 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 2	≤ 2
	IFDV (ms)	$\leq 1 \left[\begin{matrix} P_v \geq 99.9\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$	$\leq 1 \left[\begin{matrix} P_v \geq 98.5\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$
	FDR (ms)	$\leq 1.25 [P_r \geq 99.9\%]$	$\leq 1.25 [P_r \geq 98.5\%]$
	FLR (%)	$\leq .001$	$\leq .001$
IP VPN	PD (ms)	Not Applicable	$\leq 3 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 2
	IPDV (ms)	Not Applicable	$\leq 1 \left[\begin{matrix} v \geq 99.9\% \\ \tau \geq 1 \text{ sec} \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq 1.25 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	$\leq .001$

Table 8 – Performance Objective Bounds Table Value for *<H, PT0.3>*

<i><H, PT1></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 2 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 10 [P_d \geq 99.9\%]$	$\leq 10 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 7	≤ 9 (see footnote ³)
	IFDV (ms)	$\leq 3 \left[\begin{matrix} P_v \geq 99.9\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$	$\leq 3 \left[\begin{matrix} P_v \geq 98.5\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$
	FDR (ms)	$\leq 5 [P_r \geq 99.9\%]$	$\leq 5 [P_r \geq 98.5\%]$
	FLR (%)	$\leq .01$	$\leq .01$
IP VPN	PD (ms)	Not Applicable	$\leq 10 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 7
	IPDV (ms)	Not Applicable	$\leq 3 \left[\begin{matrix} v \geq 99.9\% \\ \tau \geq 1 \text{ sec} \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq 5 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	$\leq .01$

Table 9 – Performance Objective Bounds Table Value for *<H, PT1>*

³ MEF 23.2 [7] does not have a value for this entry and therefore cannot be controlling. By specifying this value, this document goes beyond MEF 23.2 [7].

<H, PT2>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 8 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 25 [P_d \geq 99.9\%]$	$\leq 25 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 18	≤ 20
	IFDV (ms)	$\leq 8 \left[\begin{matrix} P_v \geq 99.9\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$	$\leq 8 \left[\begin{matrix} P_v \geq 98.5\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$
	FDR (ms)	$\leq 10 [P_r \geq 99.9\%]$	$\leq 10 [P_r \geq 98.5\%]$
	FLR (%)	$\leq .01$	$\leq .01$
IP VPN	PD (ms)	Not Applicable	$\leq 25 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 18
	IPDV (ms)	Not Applicable	$\leq 8 \left[\begin{matrix} v \geq 99.9\% \\ \tau \geq 1 \text{ sec} \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq 10 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	$\leq .01$

Table 10 – Performance Objective Bounds Table Value for <H, PT2>

<H, PT3>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 44 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 77 [P_d \geq 99.9\%]$	$\leq 77 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 70	≤ 72
	IFDV (ms)	$\leq 10 \left[\begin{matrix} P_v \geq 99.9\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$	$\leq 10 \left[\begin{matrix} P_v \geq 98.5\% \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$
	FDR (ms)	$\leq 12 [P_r \geq 99.9\%]$	$\leq 12 [P_r \geq 98.5\%]$
	FLR (%)	$\leq .025$	$\leq .025$
IP VPN	PD (ms)	Not Applicable	$\leq 77 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 70
	IPDV (ms)	Not Applicable	$\leq 10 \left[\begin{matrix} v \geq 99.9\% \\ \tau \geq 1 \text{ sec} \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq 12 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	$\leq .025$

Table 11 – Performance Objective Bounds Table Value for <H, PT3>

<H, PT4>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
/Layer 1	D (ms)	$\leq 172 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 230 [P_d \geq 99.9\%]$	$\leq 230 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 200	≤ 202
	IFDV (ms)	$\leq 32 [P_v \geq 99.9\% \text{ } \Delta\tau \geq 1 \text{ sec}]$	$\leq 32 [P_v \geq 98.5\% \text{ } \Delta\tau \geq 1 \text{ sec}]$
	FDR (ms)	$\leq 40 [P_r \geq 99.9\%]$	$\leq 40 [P_r \geq 98.5\%]$
	FLR (%)	$\leq .05$	$\leq .05$
IP VPN	PD (ms)	Not Applicable	$\leq 230 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 200
	IPDV (ms)	Not Applicable	$\leq 32 [v \geq 99.9\% \text{ } \tau \geq 1 \text{ sec}]$
	PDR (ms)	Not Applicable	$\leq 40 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	$\leq .05$

Table 12 – Performance Objective Bounds Table Value for <H, PT4>

<H, PT5>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 277 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 370 [P_d \geq 99.9\%]$	$\leq 370 [P_d \geq 98.5\%]$
	MFD (ms)	≤ 300	≤ 302
	IFDV (ms)	$\leq 50 [P_v \geq 99.9\% \text{ } \Delta\tau \geq 1 \text{ sec}]$	$\leq 50 [P_v \geq 98.5\% \text{ } \Delta\tau \geq 1 \text{ sec}]$
	FDR (ms)	$\leq 75 [P_r \geq 99.9\%]$	$\leq 75 [P_r \geq 98.5\%]$
	FLR (%)	≤ 1.0	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 370 [p \geq 99.9\%]$
	MPD (ms)	Not Applicable	≤ 300
	IPDV (ms)	Not Applicable	$\leq 50 [v \geq 99.9\% \text{ } \tau \geq 1 \text{ sec}]$
	PDR (ms)	Not Applicable	$\leq 75 [r \geq 99.9\%]$
	PLR (%)	Not Applicable	≤ 1.0

Table 13 – Performance Objective Bounds Table Value for <H, PT5>

<i><M, PT0.3></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 1 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 6 [P_d \geq 99\%]$	$\leq 6 [P_d \geq 98\%]$
	MFD (ms)	≤ 4	≤ 5
	IFDV (ms)	$\leq (2.5) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (2.5) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (3) [P_r \geq (99\%)]$	$\leq (3) [P_r \geq (98\%)]$
	FLR (%)	$\leq .001$	$\leq .001$
IP VPN	PD (ms)	Not Applicable	$\leq 6 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 4
	IPDV (ms)	Not Applicable	$\leq (2.5) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (3) [r \geq (99\%)]$
	PLR (%)	Not Applicable	$\leq .001$

Table 14 – Performance Objective Bounds Table Value for *<M, PT0.3>*

<i><M, PT1></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 2 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 20 [P_d \geq 99\%]$	$\leq 20 [P_d \geq 98\%]$
	MFD (ms)	≤ 13	≤ 15
	IFDV (ms)	$\leq (8) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (8) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (10) [P_r \geq (99\%)]$	$\leq (10) [P_r \geq (98\%)]$
	FLR (%)	$\leq .01$	$\leq .01$
IP VPN	PD (ms)	Not Applicable	$\leq 20 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 13
	IPDV (ms)	Not Applicable	$\leq (8) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (10) [r \geq (99\%)]$
	PLR (%)	Not Applicable	$\leq .01$

Table 15 – Performance Objective Bounds Table Value for *<M, PT1>*

<i><M, PT2></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 8 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 75 [P_d \geq 99\%]$	$\leq 75 [P_d \geq 98\%]$
	MFD (ms)	≤ 30	≤ 32
	IFDV (ms)	$\leq (40) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (40) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (50) [P_r \geq (99\%)]$	$\leq (50) [P_r \geq (98\%)]$
	FLR (%)	$\leq .01$	$\leq .01$
IP VPN	PD (ms)	Not Applicable	$\leq 75 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 30
	IPDV (ms)	Not Applicable	$\leq (40) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (50) [r \geq (99\%)]$
	PLR (%)	Not Applicable	$\leq .01$

Table 16 – Performance Objective Bounds Table Value for *<M, PT2>*

<i><M, PT3></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 44 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 115 [P_d \geq 99\%]$	$\leq 115 [P_d \geq 98\%]$
	MFD (ms)	≤ 80	≤ 82
	IFDV (ms)	$\leq (40) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (40) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (50) [P_r \geq (99\%)]$	$\leq (50) [P_r \geq (98\%)]$
	FLR (%)	$\leq .025$	$\leq .025$
IP VPN	PD (ms)	Not Applicable	$\leq 115 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 80
	IPDV (ms)	Not Applicable	$\leq (40) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (50) [r \geq (99\%)]$
	PLR (%)	Not Applicable	$\leq .025$

Table 17 – Performance Objective Bounds Table Value for *<M, PT3>*

<i><M, PT4></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 172 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 250 [P_d \geq 99\%]$	$\leq 250 [P_d \geq 98\%]$
	MFD (ms)	≤ 220	≤ 222
	IFDV (ms)	$\leq (40) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (40) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (50) [P_r \geq (99\%)]$	$\leq (50) [P_r \geq (98\%)]$
	FLR (%)	$\leq .05$	$\leq .05$
IP VPN	PD (ms)	Not Applicable	$\leq 250 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 220
	IPDV (ms)	Not Applicable	$\leq (40) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (50) [\geq (99\%)]$
	PLR (%)	Not Applicable	$\leq .05$

Table 18 – Performance Objective Bounds Table Value for <M, PT4>

<i><M, PT5></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 277 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 450 [P_d \geq 99\%]$	$\leq 450 [P_d \geq 98\%]$
	MFD (ms)	≤ 350	≤ 352
	IFDV (ms)	$\leq (75) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$	$\leq (75) \left[\begin{matrix} P_v \geq (98\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (125) [P_r \geq (99\%)]$	$\leq (250) [P_r \geq (98\%)]$
	FLR (%)	≤ 1.0	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 450 [p \geq 99\%]$
	MPD (ms)	Not Applicable	≤ 350
	IPDV (ms)	Not Applicable	$\leq (75) \left[\begin{matrix} v \geq (99\%) \\ \tau \geq (1 \text{ sec}) \end{matrix} \right]$
	PDR (ms)	Not Applicable	$\leq (125) [\geq (99\%)]$
	PLR (%)	Not Applicable	≤ 1.0

Table 19 – Performance Objective Bounds Table Value for <M, PT5>

<i><L, PT0.3></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 1 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 11 [P_d \geq 95\%]$	$\leq 11 [P_d \geq 94\%]$
	MFD (ms)	≤ 9	≤ 10
	IFDV (ms)	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$
	FDR (ms)	no constraints $[P_r = \text{no constraints}]$	no constraints $[P_r = \text{no constraints}]$
	FLR (%)	$\leq .1$	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 11 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 9
	IPDV (ms)	Not Applicable	no constraints $[v = \text{no constraints}]$ $[\tau = \text{no constraints}]$
	PDR (ms)	Not Applicable	no constraints $[r = \text{no constraints}]$
	PLR (%)	Not Applicable	$\leq .1$

Table 20 – Performance Objective Bounds Table Value for *<L, PT0.3>*

<i><L, PT1></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 2 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 37 [P_d \geq 95\%]$	$\leq 37 [P_d \geq 94\%]$
	MFD (ms)	≤ 28	≤ 30
	IFDV (ms)	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$
	FDR (ms)	no constraints $[P_r = \text{no constraints}]$	no constraints $[P_r = \text{no constraints}]$
	FLR (%)	$\leq .1$	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 37 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 28
	IPDV (ms)	Not Applicable	no constraints $[v = \text{no constraints}]$ $[\tau = \text{no constraints}]$
	PDR (ms)	Not Applicable	no constraints $[r = \text{no constraints}]$
	PLR (%)	Not Applicable	$\leq .1$

Table 21 – Performance Objective Bounds Table Value for *<L, PT1>*

<i><L, PT2></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 8 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 125 [P_d \geq 95\%]$	$\leq 125 [P_d \geq 94\%]$
	MFD (ms)	≤ 50	≤ 52
	IFDV (ms)	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$
	FDR (ms)	no constraints $[P_r = \text{no constraints}]$	no constraints $[P_r = \text{no constraints}]$
	FLR (%)	$\leq .1$	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 125 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 50
	IPDV (ms)	Not Applicable	no constraints $[v = \text{no constraints}]$ $[\tau = \text{no constraints}]$
	PDR (ms)	Not Applicable	no constraints $[r = \text{no constraints}]$
	PLR (%)	Not Applicable	$\leq .1$

Table 22 – Performance Objective Bounds Table Value for *<L, PT2>*

<i><L, PT3></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 44 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 230 [P_d \geq 95\%]$	$\leq 230 [P_d \geq 94\%]$
	MFD (ms)	≤ 125	≤ 127
	IFDV (ms)	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$	no constraints $[P_v = \text{no constraints}]$ $[\Delta\tau = \text{no constraints}]$
	FDR (ms)	no constraints $[P_r = \text{no constraints}]$	$\leq (50) [P_r = \text{no constraints}]$
	FLR (%)	$\leq .1$	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 230 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 125
	IPDV (ms)	Not Applicable	no constraints $[v = \text{no constraints}]$ $[\tau = \text{no constraints}]$
	PDR (ms)	Not Applicable	no constraints $[r = \text{no constraints}]$
	PLR (%)	Not Applicable	$\leq .1$

Table 23 – Performance Objective Bounds Table Value for *<L, PT3>*

<i><L, PT4></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 172 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 390 [P_d \geq 95\%]$	$\leq 390 [P_d \geq 94\%]$
	MFD (ms)	≤ 240	≤ 242
	IFDV (ms)	no constraints [$P_v =$ no constraints] [$\Delta\tau =$ no constraints]	no constraints [$P_v =$ no constraints] [$\Delta\tau =$ no constraints]
	FDR (ms)	no constraints [$P_r =$ no constraints]	no constraints [$P_r =$ no constraints]
	FLR (%)	$\leq .1$	$\leq .1$
IP VPN	PD (ms)	Not Applicable	$\leq 390 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 240
	IPDV (ms)	Not Applicable	no constraints [$v =$ no constraints] [$\tau =$ no constraints]
	PDR (ms)	Not Applicable	no constraints [$r =$ no constraints]
	PLR (%)	Not Applicable	$\leq .1$

Table 24 – Performance Objective Bounds Table Value for *<L, PT4>*

<i><L, PT5></i>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Layer 1	D (ms)	$\leq 277 [P_d \geq 99.9\%]$	Not Applicable
Ethernet	FD (ms)	$\leq 600 [P_d \geq 95\%]$	$\leq 600 [P_d \geq 94\%]$
	MFD (ms)	≤ 470	≤ 472
	IFDV (ms)	no constraints [$P_v =$ no constraints] [$\Delta\tau =$ no constraints]	no constraints [$P_v =$ no constraints] [$\Delta\tau =$ no constraints]
	FDR (ms)	no constraints [$P_r =$ no constraints]	no constraints [$P_r =$ no constraints]
	FLR (%)	no constraints	no constraints
IP VPN	PD (ms)	Not Applicable	$\leq 600 [p \geq 95\%]$
	MPD (ms)	Not Applicable	≤ 470
	IPDV (ms)	Not Applicable	no constraints [$v =$ no constraints] [$\tau =$ no constraints]
	PDR (ms)	Not Applicable	no constraints [$r =$ no constraints]
	PLR (%)	Not Applicable	no constraints

Table 25 – Performance Objective Bounds Table Value for *<L, PT5>*

[R13] If the value of the Connectivity Services Performance Parameter is not *None*, if a Subscriber Layer 1 Service is instantiated on a Network Slice with the ordered pair of L1VC EPs *<a, b>* that belong to Performance Tier *y*, and the value of the SLS is not *None*, then the value of the SLS for the Subscriber Layer 1 Service **MUST** meet the bound on the Performance Objective and the bound on the associated parameter in the value of the *<x, y>* Performance Objective Bounds Table and the value of the Common Parameter Bounds table for the traffic going from *a* to *b*, where *x* is a value in the Class of Service Name List item that is agreed during Subscriber Layer 1 Service instantiation.

[R14] If the value of the Connectivity Services Performance Parameter is not *None*, if a Subscriber Ethernet Service is instantiated on a Network Slice where the

service's EVC List of Class of Service Names Service Attribute (Section 8.7 of MEF 10.4 [5]) contains a CoS Name x , if an ordered pair of the EVC EPs $\langle a, b \rangle$ belong to Performance Tier y , and the value of the SLS is not *None*, then the value of the SLS for the Subscriber Ethernet Service **MUST** meet the bounds on the Performance Objective values not in parentheses and the bounds on the associated parameter values not in parentheses in the value of the $\langle x, y \rangle$ Performance Objective Bounds Table and the value of the Common Parameter Bounds table for the traffic going from a to b .

[D1] If the value of the Connectivity Services Performance Parameter is not *None*, if a Subscriber Ethernet Service is instantiated on a Network Slice where the service's EVC List of Class of Service Names Service Attribute (Section 8.7 of MEF 10.4 [5]) contains a CoS Name x , if an ordered pair of the EVC EPs $\langle a, b \rangle$ belong to Performance Tier y , and the value of the SLS is not *None*, then the value of the SLS for the Subscriber Ethernet Service **SHOULD** meet the bounds on the Performance Objective values in parentheses and the bounds on the associated parameter values in parentheses in the value of the $\langle x, y \rangle$ Performance Objective Bounds Table and the value of the Common Parameter Bounds table for the traffic going from a to b .

[R15] If the value of the Connectivity Services Performance Parameter is not *None*, if a Subscriber IP VPN Service is instantiated on a Network Slice where the service's IPVC List of Class of Service Names Service Attribute (Section 10.8 of MEF 61.1 [9]) contains a CoS Name x , if an ordered pair of the IPVC EPs $\langle a, b \rangle$ belong to Performance Tier y , and the value of the SLS is not *None*, then the value of the SLS for the Subscriber IP VPN Service **MUST** meet the bounds on the Performance Objective values not in parentheses and the bounds on the associated parameter values not in parentheses in the value of the $\langle x, y \rangle$ Performance Objective Bounds Table and the value of the Common Parameter Bounds table for the traffic going from a to b .

[D2] If the value of the Connectivity Services Performance Parameter is not *None*, if a Subscriber IP VPN Service is instantiated on a Network Slice where the service's IPVC List of Class of Service Names Service Attribute (Section 10.8 of MEF 61.1 [9]) contains a CoS Name x , if an ordered pair of the IPVC EPs $\langle a, b \rangle$ belong to Performance Tier y , and the value of the SLS is not *None*, then the value of the SLS for the Subscriber IP VPN Service **SHOULD** meet the bounds on the Performance Objective values in parentheses and the bounds on the associated parameter values in parentheses in the value of the $\langle x, y \rangle$ Performance Objective Bounds Table and the value of the Common Parameter Bounds table for the traffic going from a to b .

Note that when x in [R14], [D1], [R15] or [D2] is a CoS Label, [R12] mandates the value of the Performance Objective Bounds Table for $\langle x, y \rangle$ and [R11] mandates the value for the Common Parameter Bounds Table for x .

Note if the value of the Supported Service Types Attribute (Section 7.2.4 of MEF 84 [12]) does not include Subscriber Layer 1 Service, then [R13] is irrelevant because Subscriber Layer 1

Service cannot be instantiated on the Network Slice. Similar logic applies to [R14], [R15], [D1] and [D2].

9 References

- [1] 3GPP TS 23.501 V17.4.0, *System architecture for the 5G System (5GS) Stage 2*, March 2022
- [2] IETF RFC 2119, *Key words for use in RFCs to Indicate Requirement Levels*, by Scott Bradner, March 1997
- [3] IETF RFC 8174, *Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words*, by B Leiba, May 2017, Copyright © 2017 IETF Trust and the persons identified as the document authors. All rights reserved.
- [4] MEF 6.3 *Subscriber Ethernet Services Definitions*, November 2019
- [5] MEF 10.4, *Subscriber Ethernet Service Attributes*, December 2018
- [6] MEF 22.3, *Transport Services for Mobile Networks*, January 2018
- [7] MEF 23.2, *Carrier Ethernet Class of Service – Phase 3, Implementation Agreement*, August 2016
- [8] MEF 23.2.2, *Amendment to MEF 23.2: Satellite Performance Tier*, January 2021
- [9] MEF 61.1, *IP Service Attributes*, May 2019
- [10] MEF 63, *Subscriber Layer 1 Service Attributes*, August 2018
- [11] MEF 69.1, *Subscriber IP Service Definitions*, February 2022
- [12] MEF 84, *Subscriber Network Slice Service and Attributes*, June 2021

Appendix A Subscriber Layer 1 Service Delay Performance Metric Objective Bounds Derivation (Informative)

The set of Performance Objective Bounds Tables include a Delay Performance Metric (defined in MEF 63 section 8.2.3.3 [10]) for the Subscriber Layer 1 Service. The following discussion explains the derivation of the Delay Performance Metric Objective bounds in the set of Performance Objective Bounds Tables.

Section 7.4 lists the six Performance Tiers from MEF 23.2 [7] and their associated maximum distances that are applicable to Subscriber Layer 1 Services. MEF 23.2 Appendix A uses those distances to calculate corresponding (Ethernet frame) delays based on the speed of light in a fiber multiplied by a scaling factor. The scaling factor accounts for the potential difference between a direct airline path between a pair of UNIs and the approximate route of the fiber connectivity and intermediate equipment delays. The L1CI⁴ delay through edge and intermediate transport equipment for a Subscriber Layer 1 Service adds a negligible amount to the MEF 23.2 Appendix A propagation delay values, even for *PT0.3* which has the lowest delay. For example, consider the following typical equipment delays:

- Edge mapper (10GbE client) delay, 10µs
- Line FEC encoder delay at 100Gb/s, 10µs
- Line FEC decoder delay at 100Gb/s, 10µs
- OTN Cross-connect or Add/Drop Multiplexer passthrough traffic delay, 10µs
- Edge demapper (10GbE client) delay, 10µs

The typical total one-way equipment delay for two links with one intermediate node is then 70µs, or 0.07ms (see Figure 3).

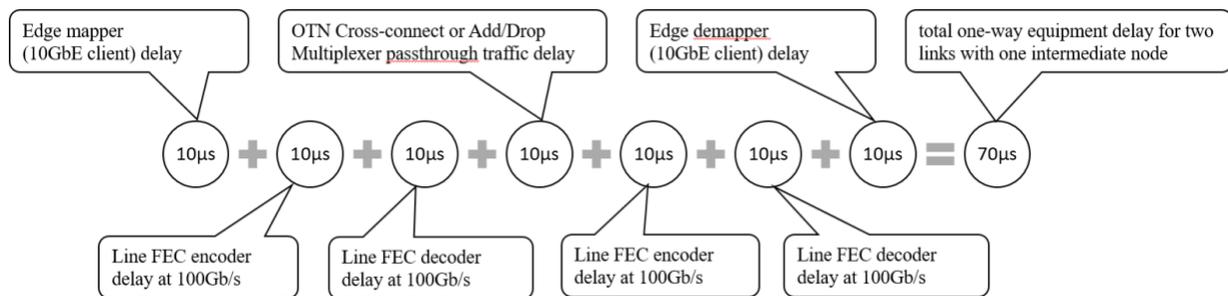


Figure 3 – Example Equipment Delays for Two Links with One Intermediate Node

To accommodate other deployment scenarios, a worst case of 1ms total one-way delay (propagation and equipment) was chosen for *PT0.3*.

For the larger Performance Tiers, such as *PT1* with a maximum distance of 250km and delay of 2ms, the equipment delay contribution becomes less significant (i.e., although there may be more equipment, the higher fiber propagation delay dominates).

⁴ Layer 1 Characteristic Information, defined in MEF 63 [10] section 7.

Thus, for the Performance Tiers *PT1* and larger the equipment delay is considered negligible and the MEF 23.2 Appendix A delay values are used for the Delay Performance Metric Objective bounds. Also, the delay percentile parameter value of $P_d \geq 99.9\%$ from MEF 23.2 Table 6 is used for Performance Tiers *PT0.3*, *PT1*, *PT2*, *PT3*, *PT4* and *PT5*, since the Subscriber Layer 1 Service is point-to-point and considered a high value service (e.g., CoS Label *H*). Note that the Delay Performance Metric Objective bounds in Table 8 - Table 13 for $\langle H, PTx \rangle$ are the same as in Table 14 - Table 19 for $\langle M, PTx \rangle$ and as in Table 20 - Table 25 for $\langle L, PTx \rangle$, as explained in section 8.6.

For convenience, the Delay Performance Metric Objective bounds for all the Performance Objective Bounds Tables are summarized in Table 26.

Subscriber Layer 1 Service Delay Performance Metric Objective Bounds		
Performance Objective Bounds Table Value	Point-to-Point (ms)	Multipoint
$\langle x, PT0.3 \rangle$	$\leq 1 [P_d \geq 99.9\%]$	Not Applicable
$\langle x, PT1 \rangle$	$\leq 2 [P_d \geq 99.9\%]$	Not Applicable
$\langle x, PT2 \rangle$	$\leq 8 [P_d \geq 99.9\%]$	Not Applicable
$\langle x, PT3 \rangle$	$\leq 44 [P_d \geq 99.9\%]$	Not Applicable
$\langle x, PT4 \rangle$	$\leq 172 [P_d \geq 99.9\%]$	Not Applicable
$\langle x, PT5 \rangle$	$\leq 277 [P_d \geq 99.9\%]$	Not Applicable

Table 26 – Subscriber Layer 1 Service Delay Performance Metric Objective Bounds

Appendix B Example Network Profile Attribute Parameters Supporting A 3GPP 5G Slice (Informative)

This example illustrates the use of the Network Profile Attribute parameter specified in this document to support a 3GPP 5G slice. In this example, the Subscriber is a Mobile Network Operator (MNO) who needs to purchase three Network Services in order to connect its RAN and core equipment. Figure 4 illustrates the overall network prior to the instantiation of the three Network Services.

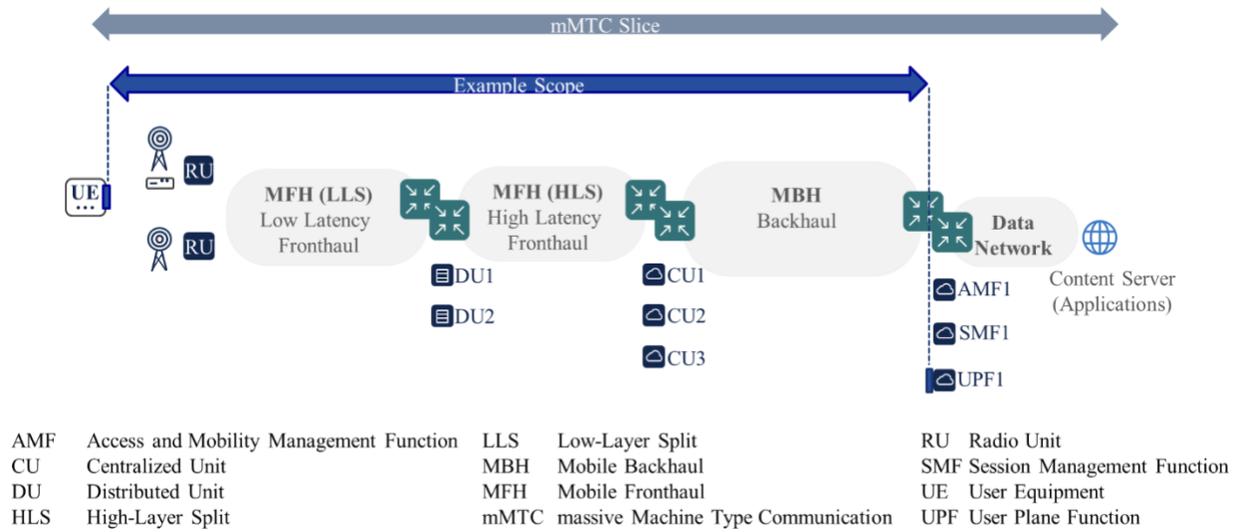


Figure 4 – Example Network Prior to Network Services

The MNO needs a Network Service for each of the low latency fronthaul, high latency fronthaul and backhaul networks between its RUs and DUs, DUs and CUs, CUs and core UPF equipment, respectively. For this example, it is assumed that the MNO has some other arrangement with a transport provider and cloud service provider for the data network connectivity and application computing, respectively, in order to complete the end-to-end mMTC slice. One example of the intended mMTC services is a Closed Circuit Television (CCTV) camera (UE in Figure 4) operating over a fixed wireless access connection through the end-to-end mMTC slice to a video server (Content Server in Figure 4).

The MNO determines by inspection of Table 5.7.4-1 of 3GPP TS 23.501 [1] that the value of the standardized 5G QoS class identifier (5QI) necessary to support a live streaming video service is 2. Further, the MNO interprets the:

- Packet Delay Budget metric as corresponding to the MEF 10.4 [5] One-Way Mean Frame Delay (MFD) Performance Metric for a Subscriber Ethernet Service (MEF 6.3 [4]) and the MEF 61.1 [9] Mean Packet Delay (MPD) Performance Metric for a Subscriber IP VPN Service (MEF 69.1 [11]),
- Packet Error Rate metric as corresponding to the MEF 10.4 [5] One-Way Frame Loss Ratio (FLR) Performance Metric for a Subscriber Ethernet Service and the MEF 61.1 [9] Packet Loss Ratio (PLR) Performance Metric for a Subscriber IP VPN Service.

All the Performance Metrics (i.e., in Table 5.7.4-1 of 3GPP TS 23.501 [1], MEF 10.4 [5] and MEF 61.1 [9]) are one-way. Further, the values of the Packet Delay Budget metric and the Packet Error Rate metric are symmetric for both the uplink and the downlink directions. The network scope of the Packet Delay Budget metric and the Packet Error Rate metric are between the UE and the UPF, as shown in Figure 4.

For the 5QI value of 2, the Packet Delay Budget metric value of 150ms and the Packet Error Rate metric value of 10^{-3} are the overall delay and error rate across the following segments of the live streaming video service:

- UE-to-RU
- RU
- Low latency fronthaul (referred to as Fronthaul in the remainder of this example)
- DU
- High latency fronthaul (referred to as Midhaul in the remainder of this example)
- CU
- Backhaul (to UPF)

Having identified the performance requirements for a live streaming video service, the MNO can now shop for the three Network Services needed to interconnect its RAN and core equipment. Based on its equipment, interfaces and locations, the MNO determines it will need Network Services capable of supporting the following Connectivity Service types and distances:

- Subscriber Ethernet MEF 6.3 [4] point-point <20km, for the Fronthaul Network Service
- Subscriber Ethernet MEF 6.3 [4] point-point <60km, for the Midhaul Network Service
- Subscriber IP VPN MEF 69.1 [11] multipoint <240km, for the Backhaul Network Service

The value of the MEF 84 [12] Supported Service Types Attribute for each Network Service is then:

- {*Subscriber Ethernet*}, for the Fronthaul Network Service
- {*Subscriber Ethernet*}, for the Midhaul Network Service
- {*Subscriber IP VPN*}, for the Backhaul Network Service

The MNO and the Service Provider agree on the value of each Connectivity Services Performance Parameter, Performance Tier List item [section 8.3] as:

- {*PT0.3*}, for the Fronthaul Network Service
- {*PT0.3*}, for the Midhaul Network Service
- {*PT1*}, for the Backhaul Network Service

For this example, the MNO and the Service Provider agree on the value of each Ordered Network Service UNI Pair Performance Tier Information item as *None*.

Using corresponding pairs of the Supported Service Types Attribute value and the Performance Tier List item value (e.g., {*Subscriber Ethernet*} and {*PT0.3*} for the Fronthaul Network Service), the MNO and the Service Provider can agree on the appropriate value of the Connectivity Services

Performance Parameter, Class of Service Name List item [section 8.1] for each Network Service by inspection of Table 8 through Table 25 (because the value of the Class of Service Name List item will only contain CoS Labels).

The portions of the value of the Performance Objective Bounds Tables item that are relevant are shown in Table 27 for a Subscriber Ethernet Service over either the Fronthaul Network Service or Midhaul Network Service and Table 28 for a Subscriber IP VPN Service over the Backhaul Network Service. In both tables the value $\langle x \rangle$ corresponds to the Class of Service Name List item value (i.e., Class of Service Labels H , M , or L for this example) with the associated Performance Objective Bounds Tables item table number noted.

$\langle x, PT0.3 \rangle$				
x	Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
H – Table 8	Ethernet	MFD (ms)	≤ 2	≤ 2
		FLR (%)	$\leq .001$	$\leq .001$
M – Table 14	Ethernet	MFD (ms)	≤ 4	≤ 5
		FLR (%)	$\leq .001$	$\leq .001$
L – Table 20	Ethernet	MFD (ms)	≤ 9	≤ 10
		FLR (%)	$\leq .1$	$\leq .1$

Table 27 – Relevant Portion of the Values of the $\langle x, PT0.3 \rangle$ Performance Objective Bounds Tables Items for a Subscriber Ethernet Service

$\langle x, PT1 \rangle$				
x	Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
H – Table 9	IP VPN	MPD (ms)	Not Applicable	≤ 7
		PLR (%)	Not Applicable	$\leq .01$
M – Table 15	IP VPN	MPD (ms)	Not Applicable	≤ 13
		PLR (%)	Not Applicable	$\leq .01$
L – Table 21	IP VPN	MPD (ms)	Not Applicable	≤ 28
		PLR (%)	Not Applicable	$\leq .1$

Table 28 – Relevant Portion of the Values of the $\langle x, PT1 \rangle$ Performance Objective Bounds Tables Items for a Subscriber IP VPN Service

Recall that the Packet Delay Budget metric value is 150ms and the Packet Error Rate metric value is 10^{-3} . From inspection, the Subscriber Ethernet Service FLR value and the Subscriber IP VPN Service PLR value are the limiting factors rather than the MFD and MPD values. Note that a FLR percentage of 0.001 is 10^{-5} and 0.1 is 10^{-3} . Selecting a Class of Service Name List item value of $\{M\}$ would provide some margin. The point-to-point Subscriber Ethernet Service Performance Objective Bounds Tables item value $\langle M, PT0.3 \rangle$ has values of $MFD \leq 4ms$ and $FLR \leq 10^{-5}$. The Subscriber IP VPN Service Performance Objective Bounds Tables item value $\langle M, PT1 \rangle$ has values of $MPD \leq 13ms$ and $PLR \leq 10^{-4}$. These values are well under the 150ms delay and 10^{-3} error rate requirements. Therefore, the agreed value of each Connectivity Services Performance Parameter, Class of Service Name List item is:

- {M}, for the Fronthaul Network Service
- {M}, for the Midhaul Network Service
- {M}, for the Backhaul Network Service

Using the Class of Service Name List item value {M}, the MNO and the Service Provider can agree on the corresponding subset of Table 5 for each Network Service. The value of the Connectivity Services Performance Parameter, Common Parameter Bounds Table item (section 8.5) is shown in Table 29 for the Fronthaul Network Service, Table 30 for the Midhaul Network Service and Table 31 for the Backhaul Network Service.

Subscriber Connectivity Service	Parameters	Class of Service Label
		<i>M</i>
Ethernet	<i>T</i>	≤ 1 Month
	<i>C</i>	≤ 0.1
	Δt	≤ 10 seconds
	<i>n</i>	≤ 10

Table 29 – Value of the Common Parameter Bounds Table Item for the Fronthaul Network Service

Subscriber Connectivity Service	Parameters	Class of Service Label
		<i>M</i>
Ethernet	<i>T</i>	≤ 1 Month
	<i>C</i>	≤ 0.1
	Δt	≤ 10 seconds
	<i>n</i>	≤ 10

Table 30 – Value of the Common Parameter Bounds Table Item for the Midhaul Network Service

Subscriber Connectivity Service	Parameters	Class of Service Label
		<i>M</i>
IP VPN	<i>T</i>	≤ 1 Month

Table 31 – Value of the Common Parameter Bounds Table Item for the Backhaul Network Service

Similarly, using the Class of Service Name List item value {M}, the MNO and the Service Provider can agree on the corresponding subset of Table 8 through Table 25 for each Network Service. The value of the Connectivity Services Performance Parameter, Performance Objective Bounds Tables item (section 8.6) is shown in Table 32 for the Fronthaul Network Service, Table 33 for the Midhaul Network Service and Table 34 for the Backhaul Network Service.

<M, PT0.3>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Ethernet	MFD (ms)	≤ 4	Not Applicable
	FLR (%)	≤ .001	Not Applicable

Table 32 – Value of the Performance Objective Bounds Tables Item for the Fronthaul Network Service

<M, PT0.3>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
Ethernet	MFD (ms)	≤ 4	Not Applicable
	FLR (%)	≤ .001	Not Applicable

Table 33 – Value of the Performance Objective Bounds Tables Item for the Midhaul Network Service

<M, PT1>			
Subscriber Connectivity Service	Performance Metric	Point-to-Point	Multipoint
IP VPN	MPD (ms)	Not Applicable	≤ 13
	PLR (%)	Not Applicable	≤ .01

Table 34 – Value of the Performance Objective Bounds Tables Item for the Backhaul Network Service

The Performance Name item values [section 8.2] for this example are:

- *Fronthaul Network Service,*
- *Midhaul Network Service,*
- *Backhaul Network Service.*

Note that standardized Performance Name item values *Premium Connectivity* or *Business Connectivity* could have been used, but as only Class of Service Label *M* is required, the Subscriber and Service Provider agree to use a non-standardized value for the Network Services in this example.

For completeness, Table 35 shows the Performance Metric Objective bounds values for the three Network Services and corresponding Connectivity Services.

Network Service	Subscriber Connectivity Service	Delays	Loss Ratios
Fronthaul	Ethernet	MFD ≤ 4ms	FLR ≤ .001%
Midhaul	Ethernet	MFD ≤ 4ms	FLR ≤ .001%
Backhaul	IP VPN	MPD ≤ 13ms	PLR ≤ .01%

Table 35 – Summary of Network Service and Connectivity Service Performance Metric Objective Bounds Values

Comparing those values with the UE-UPF Packet Delay Budget metric value of 150ms and the Packet Error Rate metric value of 10^{-3} , there is significant margin available for the remaining MNO components:

- UE-to-RU
- RU
- DU
- CU

The overall network with the three Network Services and corresponding Connectivity Service instances is shown in Figure 5. The MNO can instantiate additional Connectivity Service instances over other Network Service UNIs (not shown) as agreed with the Service Provider in the service agreement. Note that the MNO still needs to configure the UE-to-RU connectivity, UPF-to-server connectivity and intervening RAN and core equipment prior to establishing the end-to-end mMTC slice and supported services, such as the CCTV streaming video service.

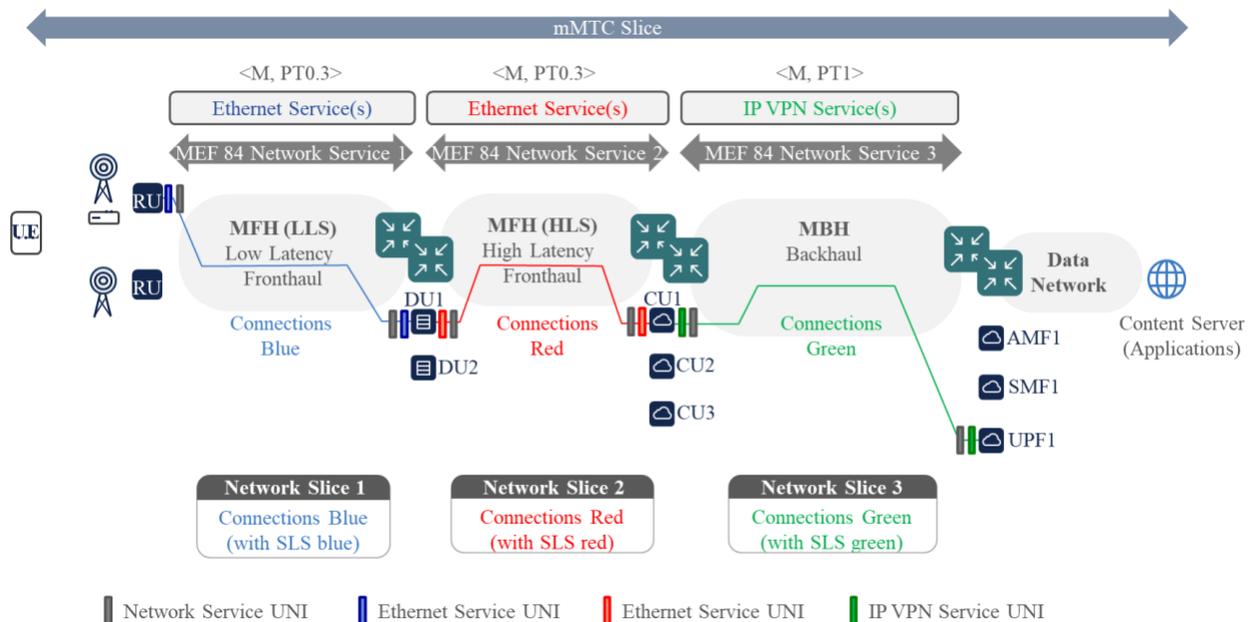


Figure 5 – Example Network with Network Services and Connectivity Services

Appendix C Example Use of the Network Profile Attribute Parameters with a Non-MEF-standardized CoS Name (Informative)

This example illustrates the use of the Network Profile Attribute parameter specified in this document. In this example, the Subscriber has purchased a Network Service with a Network Slice containing two Network Service UNIs, *UNI a* and *UNI b*. The value of the Supported Service Types Attribute for this Network Slice is the list {*Subscriber Layer 1*, *Subscriber Ethernet*}. Subscriber Ethernet Services between the two UNIs, fall into Performance Tier *PT2* for both directions. Similarly, Subscriber Layer 1 Services between the two UNIs fall into *PT2* for both directions.

The value of the Class of Service Name List item (Section 8.1) is {*M*, *Ultimate Quality*}. *M* is a Class of Service Label while *Ultimate Quality* is a Class of Service Name agreed to by the Subscriber and the Service Provider.

The value of the Common Parameter Bounds Table item (Section 8.5) is shown in Table 36.

Subscriber Connectivity Service	Common Parameters	Class of Service Names and/or Labels	
		<i>M</i>	<i>Ultimate Quality</i>
Layer 1	<i>T</i>	≤ 1 Month	≤ 1 Month
Ethernet	<i>T</i>	≤ 1 Month	≤ 1 Month
	<i>C</i>	≤ 0.1	≤ 0.1
	Δt	≤ 10 Seconds	≤ 10 Seconds
	<i>n</i>	≤ 10	≤ 5

Table 36 – Common Parameter Bounds Table Item Value for the Example

Note that the bounds for *M* conform to [R11]. Also note that the bound on the width of the sliding window for Ethernet, *n*, is ≤ 5 for *Ultimate Quality* versus ≤ 10 for *M*. This implies fewer consecutive periods of high loss will cause a transition to Unavailable Time for *Ultimate Quality* than it will for *M*. Note also that IP VPN is not included in Table 36 because it is not in the value of the Supported Service Types Attribute.

In this example, the Subscriber instantiates two Connectivity Services:

- A Subscriber Ethernet Service with a Point-to-Point EVC between *UNI a* and *UNI b* and
- A Subscriber Layer 1 Service between *UNI a* and *UNI b*.

The value of the EVC List of Class of Service Names Service Attribute (Section 8.7 of MEF 10.4 [5]) for this EVC is {*M*, *Ultimate Quality*}. Only the portions of the value of the Performance Objective Bounds Tables item that are relevant are shown in Table 37 and Table 38.

<i><M, PT2></i>		
Subscriber Connectivity Service	Performance Metric	Point-to-Point
Layer 1	D (ms)	$\leq 8 [P_d \geq 99.9\%]$
Ethernet	FD (ms)	$\leq 20 [P_d \geq 99\%]$
	MFD (ms)	≤ 13
	IFDV (ms)	$\leq (8) \left[\begin{matrix} P_v \geq (99\%) \\ \Delta\tau \geq (1 \text{ sec}) \end{matrix} \right]$
	FDR (ms)	$\leq (10) [P_r \geq (99\%)]$
	FLR (%)	$\leq .01$

Table 37 – Relevant Portion of the Value of the *<M, PT2>* Performance Objective Bounds Table

<i><Ultimate Quality, PT2></i>		
Subscriber Connectivity Service	Performance Metric	Point-to-Point
Layer 1	D (ms)	$\leq 4 [P_d \geq 99.95\%]$
Ethernet	FD (ms)	$\leq 6 [P_d \geq 99.95\%]$
	MFD (ms)	≤ 10
	IFDV (ms)	$\leq 6 \left[\begin{matrix} P_v \geq (99.95\%) \\ \Delta\tau \geq 1 \text{ sec} \end{matrix} \right]$
	FDR (ms)	$\leq 8 [P_r \geq (99.95\%)]$
	FLR (%)	$\leq .005$

Table 38 – Relevant Portion of the Value of the *<Ultimate Quality, PT2>* Performance Objective Bounds Table

Note that the bounds in Table 37 conform to [R12]. Note also that bounds in Table 38 are more stringent than the bounds in the *<H, PT2>* table (Table 10) as might be expected for the Class of Service Name *Ultimate Quality*.

The value of the SLS Service Attribute for each Connectivity Service is within the Connectivity Service Performance Objective bounds in the Network Service agreement.

The value of the SLS Service Attribute for the EVC is shown in Figure 6 using the structure of Figure 10 in MEF 10.4 [5].

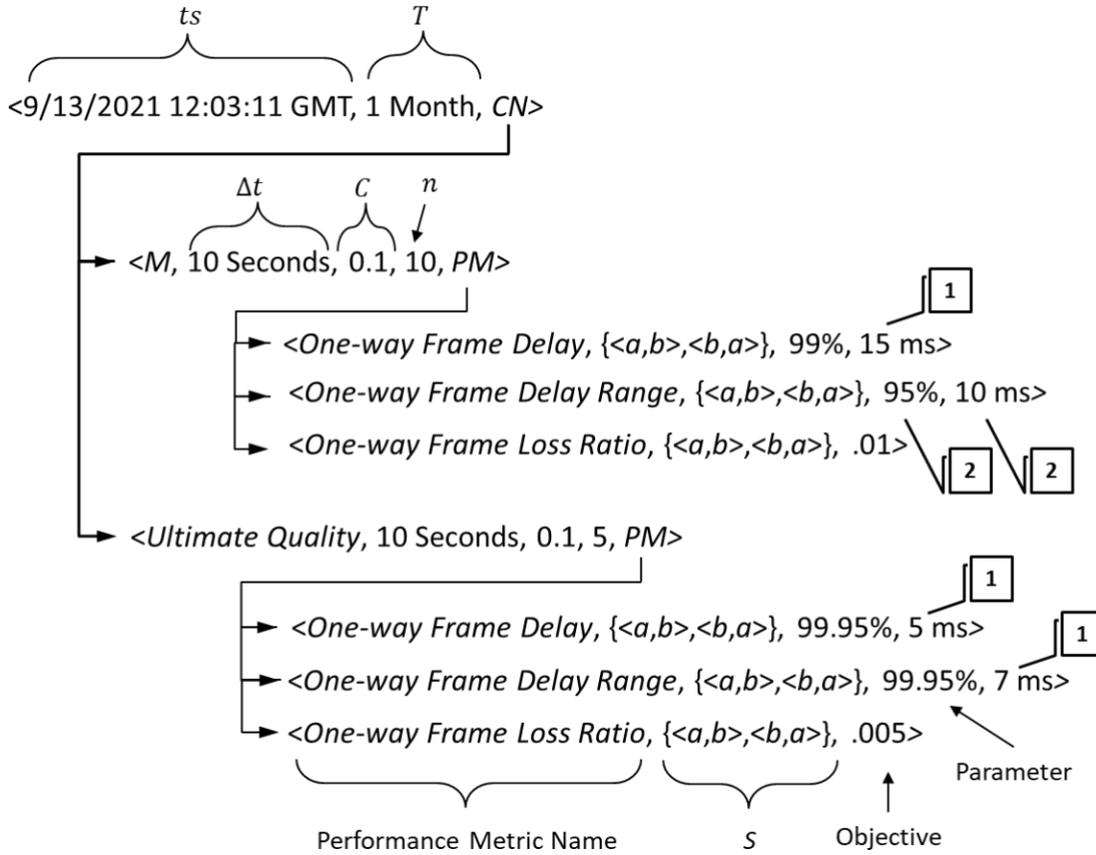


Figure 6 – Value of the Service Level Specification for the EVC

The agreed values for the Network Service for the common parameters, i.e., T , C , Δt , and n in Figure 6 are equal to the values of the upper bounds in Table 36. Thus, this part of the value of the SLS meets [R14].

The agreed values for the Network Service for the Performance Objectives and associated parameters in Figure 6, with the exception of those values with callouts 1 and 2, are equal to the values of the bounds in Table 37 and Table 38. The agreed values with callout 1 are more stringent than the mandated values in Table 37 and Table 38. For example, the Performance Objective for One-way Frame Delay for the Class of Service Label M is 15ms compared to 20ms in Table 37. Thus this part of the value of this SLS meets [R14].

The agreed values with callout 2 are less stringent than the recommended values in Table 37. In particular $P_r = 95\%$ compared to the recommend value of 99% in Table 37 and the One-way Frame Delay Range objective is 10ms compared to the recommended value of 8ms in Table 37. Thus, this part of the value of the SLS does not meet [D1].

The value of the SLS Service Attribute for the Subscriber L1VC is shown in Figure 7 using a structure similar to that used in Figure 6.

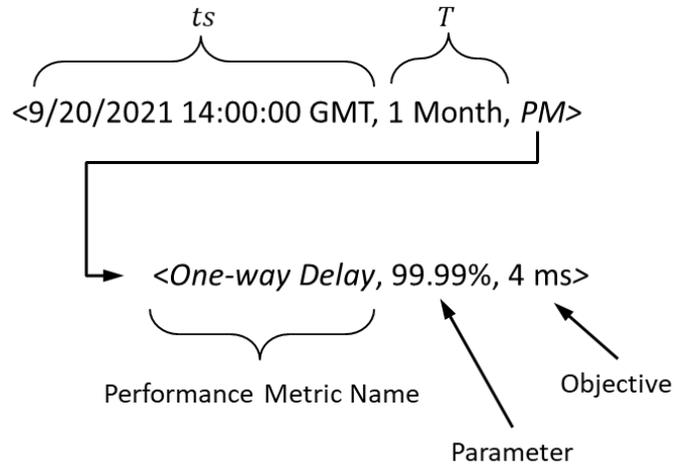


Figure 7 – Value of the Service Level Specification for the Subscriber L1VC

During the instantiation of the Subscriber Layer 1 Service, the Subscriber and the Service Provider agree to base the value of the SLS on the Class of Service Name *Ultimate Quality*. The procedure used to reach this agreement is beyond the scope of this document.

The agreed values for the Network Service for the common parameter *T* in Figure 7 are equal to the upper bounds in Table 36 for the Class of Service Name *Ultimate Quality*. In addition, the agreed values for the Network Service for the Performance Objectives and associated parameter in Figure 7 meet the bounds in in Table 38 for the Class of Service Name *Ultimate Quality*. Thus, this value of the SLS meets [R13].

Note that the Layer 1 Characteristic Information carried on a Subscriber L1VC does not contain information about a Class of Service Name. But the Class of Service Name can still be used to determine the value of the SLS for the L1VC as illustrated by this example.

Appendix D Acknowledgements (Informative)

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