Technical Specification

MEF 10.1.1

Amendment to Ethernet Services Attributes Phase 2

July 2010

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Foreword

This Amendment to MEF 10.1 is intended to replace parts of section 6.9 (6.9, and 6.9.1 through 6.9.6) and revise related material in sections 2 and 8.4.

The amendment makes changes as follows:

- Update the Frame Delay attribute to:
  - Add the definition of Frame Delay Range parameter
  - Add the definition of Mean Frame Delay parameter
- Clarify for Point-to-Point EVCs that objectives apply to one direction of transmission at a time
  - Makes point-to-point and multipoint treatment consistent
- Rename FDV as Inter-Frame Delay Variation for clarity

Updates to other technical content of MEF 10.1 are out of scope.

One key difference is in the treatment of Point-to-Point EVC Performance as a special case of Multipoint EVC, where separate populations of Service Frames delivered between each ordered pair of UNIs are evaluated against the performance objective.

Another difference is the treatment of the case where no qualified Service Frames are delivered between one or more ordered pairs of UNIs during the evaluation interval. The performance is designated "Undefined", but also designated as compliant with the associated objective.

Introduction

This Amendment is divided in three parts:

1. This amendment makes changes to the terminology list (Section 2 of MEF 10.1) as indicated by the strikeouts to delete text and the underlines to insert new text.

2. This amendment replaces the introduction to sub-section 6.9 and sub-sections 6.9.1 through 6.9.6 of MEF 10.1 with the following text.

3. This amendment makes changes to Table 16 (section 8.4) of MEF 10.1 as indicated by the strikeouts to delete text and the underlines to insert new text.

Part 1

FD	Frame Delay
FLR	Frame Loss Ratio
Frame	Short for Ethernet frame.
Frame Delay	The time required to transmit a Service Frame from ingress UNI to egress UNI.
Frame Delay Performance	A measure of the delays experienced by different Service Frames belonging to the same CoS instance.
Frame Delay Range	The difference between the Frame Delay Performance values corresponding to two different percentiles.
Frame Delay Range Performance	A measure of the extent of delay variability experienced by different Service Frames belonging to the same CoS instance.
Frame Loss Ratio Performance	Frame Loss Ratio is a measure of the number of lost frames between the ingress UNI and the egress UNI. Frame Loss Ratio is expressed as a percentage.
IFDV	Inter-Frame Delay Variation
Inter-Frame Delay Variation	The difference in delay of two Service Frames belonging the same CoS instance.
Inter-Frame Delay Variation Performance	A measure of the variation in the delays experienced by different Service Frames belonging to the same CoS instance.
Mean Frame Delay Performance	The arithmetic mean, or average of delays experienced by different Service Frames belonging to the same CoS instance.
Ordered Pair of UNIs	A directional UNI pair of the form <Ingress UNI, Egress UNI>, selected from the UNI list for the EVC of interest.
Point-to-Point EVC	An EVC with exactly 2 UNIs.
Qualified Set of Service Frames	The set of frames that comply with specific criteria, such as the arrival time at the Ingress UNI and Bandwidth Profile compliance, on which a performance attribute is based.
User Network Interface	The physical demarcation point between the responsibility of the Service Provider and the responsibility of the Subscriber.

Part 2

6.9 EVC Related Performance Service Attributes

The EVC Related Performance Service Attributes specify the Service Frame delivery performance. Four performance attributes are considered in this specification. These are Frame Delay Performance, Inter-Frame Delay Variation Performance, Frame Loss Ratio Performance, and Availability Performance.

Performance Attributes apply to “Qualified” Service Frames, which are frames that meet the following criteria for a given ordered pair of UNIs and a given Class of Service:

- Each Service Frame **MUST** be the first egress Service Frame at the same UNI *j* resulting from an ingress Service Frame at the other UNI *i* of the ordered pair. The Service Frame MAY be a Unicast (see Section 6.5.1.1), Multicast (see Section 6.5.1.2), Broadcast (see Section 6.5.1.3), or Layer 2 Control Protocol (see Section 6.5.1.4) Service Frame. Note that a single ingress Service Frame can result in multiple egress Service Frames, e.g., a Multicast Service Frame.

- The first bit of each Service Frame **MUST** arrive at the ingress UNI within the time interval *T*,

- Each Service Frame **MUST** have the Class of Service Identifier for the Class of Service instance in question, and

- Each ingress Service Frame **MUST** have an Ingress Bandwidth Profile compliance of Green.

Such Service Frames are elements of the set of **Qualified Service Frames** for an Ordered Pair of UNIs and a given Class of Service on an EVC.

Performance Attributes **MUST NOT** apply to Service Frames with the level of conformance determined to be Yellow or Red. Typically, the Frame Loss Ratio Performance will be degraded for Service Frames determined to be Yellow. Service Frames determined to be Red will be discarded. (See Section 7.11.2.5.)

For a given EVC and Class of Service instance, Performance Objectives **MAY** be specified over any given subset of the Ordered Pairs of UNIs (describing transmission direction) on the EVC. Once a subset of UNI pairs is defined, then all attributes in this section **SHALL** have performance objectives applying to that subset. Section 10.4 provides examples on how to structure these metrics to be UNI-oriented and EVC-oriented.

Values of the Service Frame delay, delay variation, and loss performance during periods of unavailable time **MUST NOT** be used to determine Service Frame delivery compliance. A process **MUST** be established to exclude all performance during unavailable periods from comparison with Service Frame performance objectives.

The assessment of all performance attributes **SHOULD** account for unexpected arrival phenomena, such as frame duplication, or frames arriving in a different order from that observed on ingress, and the presence of these phenomena alone do not necessarily exclude a Service Frame from the set of Qualified Service Frames.

6.9.1 Frame Delay Performance for a Point-to-Point EVC

NOTE – The contents of this section have been deleted, and the scope of Section 6.9.2 has been broadened to cover the Point-to-Point EVC case.

6.9.2 One-way Frame Delay Performance for an EVC

This section defines three performance attributes: the One-way Frame Delay Performance corresponding to a percentile of the distribution, the One-way Mean Frame Delay, and the One-way Frame Delay Range.

The One-way Frame Delay for an egress Service Frame at a given UNI in the EVC is defined as the time elapsed from the reception at the ingress UNI of the first bit of the corresponding ingress Service Frame until the transmission of the last bit of the Service Frame at the given UNI. This delay definition is illustrated in Figure 5.

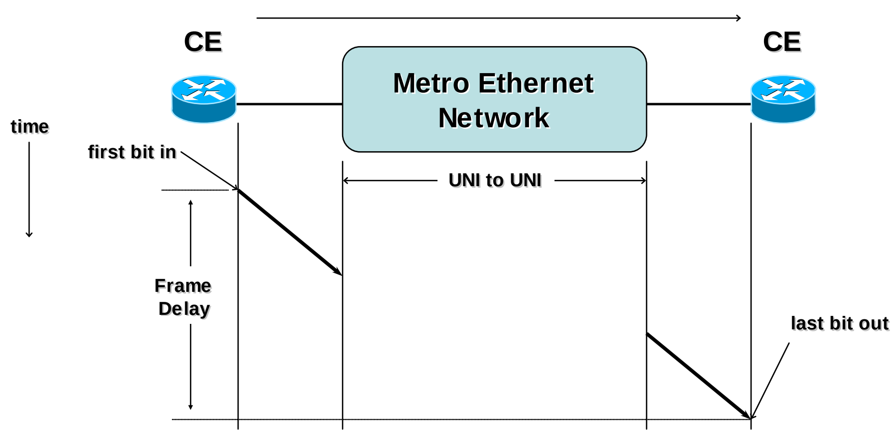

Figure 5 – Frame Delay for Service Frame

Note that this definition of Frame Delay for a Service Frame is the one-way[1] delay that includes the delays encountered as a result of transmission across the ingress and egress UNIs as well as that introduced by the MEN.

There **MAY** be multiple Frame Delay Performance Objectives defined for a particular Class of Service instance on an EVC. Each such metric is based on a subset of the ordered pairs of UNIs

[1] One-way delay is difficult to measure and therefore one way delay may be approximated from two way measurements. However these techniques are beyond the scope of this document.

in the EVC for a time interval *T*. Each Frame Delay Performance metric **SHALL** be defined as follows:

- Let the UNIs in the EVC be numbered from 1 to *m*. And let *S* be a subset of the ordered UNI pairs in the EVC. That is $S \subseteq \{\langle i, j \rangle \mid i = 1,...,m, j = 1,...,m, i \neq j\}$.

- Let $\bar{d}_T^{\langle i,j \rangle}$ represent the P-Percentile of one-way delay for all Qualified Service Frames delivered to UNI *j* resulting from an ingress Service Frame at UNI *i*. If there are no such egress Service Frames at UNI *j* resulting from ingress Service Frames at UNI *i*, then $\bar{d}_T^{\langle i,j \rangle} = \text{Undefined}$.

- Then the One-way Frame Delay Performance metric **SHALL** be defined as the maximum value of all of the values $\bar{d}_T^{\langle i,j \rangle}$ for $\langle i, j \rangle \in S$, unless all $\bar{d}_T^{\langle i,j \rangle}$ are Undefined in which case the performance is Undefined.

- Let $\bar{d}_{Tyx}^{\langle i,j \rangle} = \bar{d}_{Ty}^{\langle i,j \rangle} - \bar{d}_{Tx}^{\langle i,j \rangle}$ represent the difference between Percentiles P_y and P_x (where $P_y > P_x$ and *i* and *j* are the same pair in each term) of one-way delay for all Qualified Service Frames delivered to UNI *j* resulting from an ingress Service Frame at UNI *i*. If there are no such egress Service Frames at UNI *j* resulting from ingress Service Frames at UNI *i*, then $\bar{d}_{Txy}^{\langle i,j \rangle} =$ Undefined.

- Then the One-way Frame Delay Range Performance metric **SHALL** be defined as the maximum value of all of the values of the difference $\bar{d}_{Tyx}^{\langle i,j \rangle} = \bar{d}_{Ty}^{\langle i,j \rangle} - \bar{d}_{Tx}^{\langle i,j \rangle}$ for $\langle i, j \rangle \in S$, unless all $\bar{d}_{Txy}^{\langle i,j \rangle}$ are Undefined in which case the performance is Undefined.

- Let $\bar{m}_T^{\langle i,j \rangle}$ represent the arithmetic mean of one-way delay for all Qualified Service Frames delivered to UNI *j* resulting from an ingress Service Frame at UNI *i*. If there are no such egress Service Frames at UNI *j* resulting from ingress Service Frames at UNI *i*, then $\bar{m}_T^{\langle i,j \rangle} =$ Undefined.

- Then the One-way Mean Frame Delay Performance metric **SHALL** be defined as the maximum value of all of the values $\bar{m}_T^{\langle i,j \rangle}$ for $\langle i, j \rangle \in S$, unless all $\bar{m}_T^{\langle i,j \rangle}$ are Undefined in which case the performance is Undefined.

To restate the Frame Delay definition mathematically, let the UNIs in the EVC be numbered from 1 to *m* and let $D_T^{\langle i,j \rangle}$ be the set of one-way Frame Delay values for all Qualified Service Frames at UNI *j* resulting from an ingress Service Frame at UNI *i*. $D_T^{\langle i,j \rangle}$ can be expressed as

$D_T^{\langle i,j\rangle} = \left\{ d_1^{\langle i,j\rangle}, d_2^{\langle i,j\rangle}, \ldots, d_{N_{\langle i,j\rangle}}^{\langle i,j\rangle} \right\}$, where $d_k^{\langle i,j\rangle}$ is the one-way Frame Delay of the k[th] Service Frame. Define $\bar{d}_T^{\langle i,j\rangle}$ for $P > 0$ as

$$\bar{d}_T^{\langle i,j\rangle} = \begin{cases} \min\left\{ d \mid P \le \dfrac{100}{N_{\langle i,j\rangle}} \displaystyle\sum_{k=1}^{N_{\langle i,j\rangle}} I\left(d, d_k^{\langle i,j\rangle}\right) \right\} & \text{if } N_{\langle i,j\rangle} \ge 1 \\ \textit{Undefined} & \text{otherwise} \end{cases}$$

where,

$$I(d, d_k) = \begin{cases} 1 & \text{if } d \ge d_k \\ 0 & \text{otherwise} \end{cases}.$$

$\bar{d}_T^{\langle i,j\rangle}$ is the minimal delay during the time internal T that P percent of the frames do not exceed. Note that when P>0, only values of d within $D_T^{\langle i,j\rangle}$ will satisfy $P \le (100/N_{<i,k>})\sum I(d,d_k)$.

Then a one-way Frame Delay Performance metric for an EVC can be expressed as

$$\bar{d}_{T,S} = \begin{cases} \max\left\{ \bar{d}_T^{\langle i,j\rangle} \mid \langle i,j\rangle \in S \text{ and where } N_{\langle i,j\rangle} > 0 \right\} \\ \textit{Undefined} \text{ when all } N_{\langle i,j\rangle} = 0 \mid \langle i,j\rangle \in S \end{cases}.$$

The One-way Frame Delay attribute permits specification of multiple values for P, (P_0, P_1, P_2, …) and corresponding objectives ($\hat{d}_0^{\langle i,j\rangle}$, $\hat{d}_1^{\langle i,j\rangle}$, $\hat{d}_2^{\langle i,j\rangle}$, …). Another parameter is the objective for the difference between the delay performance of two selected percentiles, P_x and P_y , expressed as

$$\bar{d}_{Tyx}^{\langle i,j\rangle} = \begin{cases} (\bar{d}_{Ty}^{\langle i,j\rangle} - \bar{d}_{Tx}^{\langle i,j\rangle}) \text{ if } N_{\langle i,j\rangle} > 0 \\ \textit{Undefined} \text{ if } N_{\langle i,j\rangle} = 0 \end{cases}$$

Then a one-way Frame Delay Range Performance metric for an EVC can be expressed as

$$\bar{d}_{TyxS} = \begin{cases} \max\left\{ \bar{d}_{Tyx}^{\langle i,j\rangle} \mid \langle i,j\rangle \in S \text{ and where } N_{\langle i,j\rangle} > 0 \right\} \\ \textit{Undefined} \text{ when all } N_{\langle i,j\rangle} = 0 \mid \langle i,j\rangle \in S \end{cases}.$$

The **minimum one-way delay** is an element of $D_T^{\langle i,j\rangle}$, where $d_{\min}^{\langle i,j\rangle} \le d_k^{\langle i,j\rangle}$ (for all $k = 1,2,\ldots,N_{\langle i,j\rangle}$), and is a possible selection as one of the percentiles. The minimum delay represents the $N_{<i,j>}^{-1}$th percentile and all lower values of P as $P \to 0$.

Another One-way Frame Delay attribute is the arithmetic mean of $D_T^{\langle i,j \rangle}$, which can be expressed as

$$\bar{\mu}_T^{\langle i,j \rangle} = \begin{cases} \frac{1}{N_{\langle i,j \rangle}} \sum_{k=1}^{N_{\langle i,j \rangle}} \left(d_k^{\langle i,j \rangle} \right) & \text{if } N_{\langle i,j \rangle} > 0 \\ \mathit{Undefined} & \text{if } N_{\langle i,j \rangle} = 0 \end{cases}$$

Then a One-way Mean Frame Delay Performance metric for an EVC can be expressed as

$$\bar{\mu}_{TS} = \begin{cases} \max\left\{ \bar{\mu}_T^{\langle i,j \rangle} \mid \langle i,j \rangle \in S \text{ and } \bar{\mu}_T^{\langle i,j \rangle} \text{ where } N_{\langle i,j \rangle} > 0 \right\} \\ \mathit{Undefined} \text{ when all } N_{\langle i,j \rangle} = 0 \mid \langle i,j \rangle \in S \end{cases}.$$

The parameters of a One-way Frame Delay Performance metric are given in Table 5.

Parameter	Description
T	The time interval
S	Subset of the ordered UNI pairs of the EVC
P_x	A specific percentile of the Frame Delay Performance, $P_x > 0$
P_y	Another specific percentile of the Frame Delay Performance, where $P_y > P_x$
$\hat{d}_x$	One-way Frame Delay Performance Objective corresponding to P_x
$\hat{d}_y$	One-way Frame Delay Performance Objective corresponding to P_y
$\hat{d}_{yx}$	One-way Frame Delay Range Objective corresponding to the Frame Delay Performance at P_x and P_y $\bar{d}_{Tyx}^{\langle i,j \rangle} = (\bar{d}_{Ty}^{\langle i,j \rangle} - \bar{d}_{Tx}^{\langle i,j \rangle})$ where $P_y > P_x$
$\hat{\mu}$	One-way Mean Frame Delay Performance Objective

Table 5 – One-way Frame Delay Performance Parameters

Given T, S, P_x, and a one-way Frame Delay Performance objective $\hat{d}_x$, expressed in time units, the one-way Frame Delay Performance **SHALL** be defined as met over the time interval T for the subset S if and only if $\bar{d}_{T,S} \le \hat{d}_x$. Further, given P_y and a One-way Frame Delay Performance objective $\hat{d}_y$, expressed in time units, the objective for one-way Frame Delay Range between P_x and P_y **SHALL** be defined as met over the time interval T for the subset S if and only if $\bar{d}_{TyxS} \le \hat{d}_{yx}$. Finally, given a One-way Mean Frame Delay Performance objective $\hat{\mu}$, expressed in time units, the Frame Delay Performance **SHALL** be defined as met over the time interval T if and only if $\bar{\mu}_{TS} \le \hat{\mu}$.

Recall that if any of the above Service Frame Performance attributes are Undefined for time interval *T* and ordered pair $\langle i, j \rangle$, then the performance for that ordered pair **SHALL** be excluded from calculations on the performance of pairs in *S*. For a given set *S*, if the Service Performance is Undefined for *all* ordered pairs, then the performance for *S* **SHALL** be defined as compliant.

For a Point-to-Point EVC, *S* **MAY** include one or both of the ordered pairs of UNIs in the EVC.

For a Multipoint-to-Multipoint EVC, *S* **MAY** be any subset of the ordered pairs of UNIs in the EVC.

For a Rooted-Multipoint EVC, *S* **MUST** be such that all ordered pairs in *S* contain at least one UNI that is designated as a Root.

6.9.3 Inter-Frame Delay Variation Performance for a Point-to-Point EVC

NOTE – The contents of this section have been deleted, and the scope of Section 6.9.4 has been broadened to cover the Point-to-Point EVC case.

6.9.4 Inter-Frame Delay Variation Performance for an EVC

Inter-Frame Delay Variation (IFDV) is the difference between the one-way delays of a pair of selected Service Frames. This definition is borrowed from RFC3393 [6] where IP packet delay variation is defined. For a particular Class of Service Identifier and an ordered pair of UNIs in the EVC, IFDV Performance is applicable to Qualified Service Frames.

NOTE – Earlier documents refer to Inter-Frame Delay Variation as “Frame Delay Variation”.

The Inter-Frame Delay Variation Performance **SHALL** be defined as the P-percentile of the absolute values of the difference between the Frame delays of all Qualified Service Frame pairs that satisfy the following conditions:

- The difference in the arrival times of the first bit of each Service Frame at the ingress UNI was exactly D*t*.

This definition is in agreement with the IP packet delay variation definition given in [6] where the delay variation is defined as the difference between the one-way delay of two packets selected according to some selection function and are within a given interval [T_1, T_2].

Inter-Frame Delay Variation Performance depends on the choice of the value for D*t*. Values for both Dt and *T* typically should be chosen to achieve a reasonable level of statistical accuracy.

The choice of the value for Δt can be related to the application timing information. As an example for voice applications where voice frames are generated at regular intervals, Δt may be chosen to be few multiples of the inter-frame time.

Let a_i be the time of the arrival of the first bit of the i[th] Service Frame at the ingress UNI, then the two frames i and j are selected according to the selection criterion:

$$\{a_j - a_i = \Delta t \quad and \quad j > i\}$$

Let r_i be the time frame *i* is successfully received (last bit of the frame) at the egress UNI, then the difference in the delays encountered by frame *i* and frame *j* is given by $d_i - d_j$. Define

$$\Delta d_{ij} = |d_i - d_j| = |(r_i - a_i) - (r_j - a_j)| = |(a_j - a_i) - (r_j - r_i)|$$

With d_j being the delay of the j[th] frame, a positive value for $d_i - d_j$ implies that the two frames are closer together at the egress UNI while a negative value implies that the two frames are further apart at the egress UNI. If either or both frames are lost or not delivered due to, for example, FCS violation, then the value Δd_{ij} is not defined and does not contribute to the evaluation of the Inter-Frame Delay Variation.

Figure 6 shows a depiction of the different times that are related to Inter-Frame Delay Variation Performance.

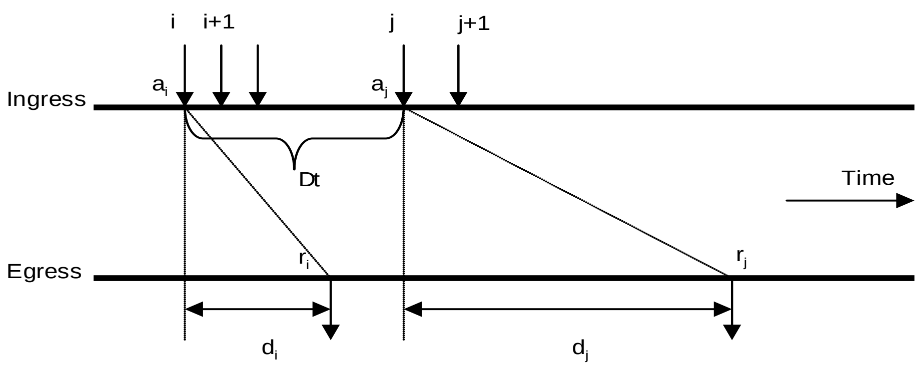

Figure 6 – Inter-Frame Delay Variation Definition

For a particular Class of Service instance, Inter-Frame Delay Variation Performance metrics **MAY** be specified over any given subset of two or more UNIs on an EVC. Each such metric is based on a subset of the ordered pairs of UNIs in the EVC for a time interval *T*. Each Inter-Frame Delay Variation Performance metric **SHALL** be defined as follows:

- Let the UNIs in the EVC be numbered from 1 to m. And let S be a subset of the ordered UNI pairs in the EVC. That is $S \in \{\langle i, j \rangle \mid i = 1,...,m, j = 1,...,m, i \neq j\}$.

- Let $\Delta\tilde{d}_T^{\langle i,j\rangle}$ be the P-percentile of the absolute value of the difference between the Frame Delays of all Qualified Service Frame pairs whose difference in the arrival times of the first bit of each Service Frame in the pair at UNI *i* was exactly Δt.
- If there are no such pairs of Service Frames for UNI *i* and UNI *j*, then $\Delta\tilde{d}_T^{\langle i,j\rangle} = Undefined$.
- Then the Inter-Frame Delay Variation Performance metric **SHALL** be the maximum of the values $\Delta\tilde{d}_T^{\langle i,j\rangle}$ for $\langle i,j\rangle \in S$, unless all $\Delta\tilde{d}_T^{\langle i,j\rangle}$ are Undefined in which case the performance is Undefined.

To restate the definition mathematically, let the UNIs in the EVC be numbered from 1 to *m*. And let *S* be a subset of the ordered UNI pairs in the EVC. That is

$$S \subseteq \{\langle i,j\rangle \mid i = 1,...,m,\ j = 1,...,m, i \neq j\}.$$

Let

$$V_T^{\langle i,j\rangle} = \{\Delta d_1^{\langle i,j\rangle}, \Delta d_2^{\langle i,j\rangle}, ..., \Delta d_{N_{\langle i,j\rangle}}^{\langle i,j\rangle}\}$$

be the set of all absolute value of delay variations for all eligible pairs of Qualified Service Frames from UNI *i* to UNI *j* where the difference in the arrival times of the first bit of each Service Frame at the ingress UNI was exactly Δt. Define

$$\Delta\tilde{d}_T^{\langle i,j\rangle} = \begin{cases} \min\left\{ d \mid P \le \frac{100}{N_{\langle i,j\rangle}} \sum_{k=1}^{N_{\langle i,j\rangle}} I(d, \Delta d_k^{\langle i,j\rangle}) \right\} \text{if } N_{\langle i,j\rangle} \ge 1 \\ Undefined \text{ otherwise} \end{cases}$$

where;

$$I(d, \Delta d) = \begin{cases} 1 \text{ if } d \ge \Delta d \\ 0 \text{ otherwise} \end{cases}.$$

Then an Inter-Frame Delay Variation Performance metric for an EVC can be expressed as

$$\Delta\tilde{d}_{T,S} = \begin{cases} \max\left\{\Delta\tilde{d}_T^{\langle i,j\rangle} \mid \langle i,j\rangle \in S \text{ and where } N_{\langle i,j\rangle} \ge 1\right\} \\ Undefined \text{ when all } N_{\langle i,j\rangle} = 0 \mid \langle i,j\rangle \in S \end{cases}.$$

For the SLS, an Inter-Frame Delay Variation metric **MUST** specify a set of parameters and an objective.

The parameters and objective for an Inter-Frame Delay Variation Performance metric are given in Table 7.

Parameter	Description
T	The interval
S	Subset of the ordered UNI pairs of the EVC
P	Inter-Frame Delay Variation Performance percentile
Δt	The separation between frame pairs for which Inter-Frame Delay Variation Performance is defined
$\breve{d}$	Inter-Frame Delay Variation Performance Objective

Table 7 – Inter-Frame Delay Variation Parameters

Given T, S, P, Δt, and $\breve{d}$, the Inter-Frame Delay Variation Performance **SHALL** be defined as met over the time interval T for the subset S if and only if $\Delta\tilde{d}_{T,S} \le \breve{d}$.

Recall that if the Inter-Frame Delay Variation is Undefined for time interval T and ordered pair $\langle i, j \rangle$, then the performance for that ordered pair **SHALL** be excluded from calculations on the performance of pairs in S. For a given set S, if the Service Performance is Undefined for *all* ordered pairs, then the performance for S **SHALL** be defined as compliant.

For a Point-to-Point EVC, S **MAY** be include one or both of the ordered pairs of UNIs in the EVC.

For a Multipoint-to-Multipoint EVC, S **MAY** be any subset of the ordered pairs of UNIs in the EVC.

For a Rooted-Multipoint EVC, S **MUST** be such that all ordered pairs in S contain at least one UNI that is designated as a Root.

6.9.5 One-way Frame Loss Ratio Performance for a Point-to-Point EVC

NOTE – Section 6.9.7 refers to this section for the definition of the frame loss ratio $flr(\Delta t_i)$ of a Point-to-Point EVC. For the purposes of the Availability Performance, the Frame Loss Ratio Performance (defined in detail in section 6.9.6) **SHALL** be defined as follows:

$$flr(\Delta t_i) = FLR_{\Delta t_i,S} = \begin{cases} \max\left\{FLR_{\Delta t_i}^{\langle i,j\rangle} \mid \langle i, j\rangle \in S \text{ and where } I_{\Delta t_i}^{\langle i,j\rangle} \ge 1\right\} \\ 0 \text{ when all } I_{\Delta t_i}^{\langle i,j\rangle} = 0 \mid \langle i, j\rangle \in S \end{cases}$$

where the set of ordered pairs, S, contains both ordered pairs of UNIs in the Point-to-Point EVC.

NOTE – The contents of this section have been deleted, and the scope of Section 6.9.6 has been broadened to cover the Point-to-Point EVC case.

6.9.6 One-way Frame Loss Ratio Performance for an EVC

There **MAY** be multiple One-way Frame Loss Ratio Performance metrics defined for a particular Class of Service instance on an EVC. Each such metric is based on a subset of the ordered pairs of UNIs in the EVC for a time interval *T*. Each One-way Frame Loss Ratio Performance metric **SHALL** be defined as follows:

- Let the UNIs in the EVC be numbered from 1 to *m*. And let *S* be a subset of the ordered UNI pairs in the EVC. That is $S \subseteq \{\langle i,j\rangle \mid i = 1,\ldots,m,\ j = 1,\ldots,m, i \neq j\}$.

- Let $I_T^{\langle i,j\rangle}$ denote the number of ingress Service Frames at UNI *i* whose first bit arrived at UNI *i* during the time interval *T*, whose Ingress Bandwidth Profile compliance was Green, and that should have been delivered to UNI *j* according to the Service Frame Delivery service attributes (see Sections 6.5.2, 6.7, and 7.13). Each Service Frame can be a Unicast (see Section 6.5.1.1), Multicast (see Section 6.5.1.2), Broadcast (see Section 6.5.1.3), or Layer 2 Control Protocol (see Section 6.5.1.4) Service Frame.

- Let $E_T^{\langle i,j\rangle}$ denote the number of such Service Frames delivered to UNI *j*.

- Define $FLR_T^{\langle i,j\rangle} = \begin{cases} \left(\dfrac{I_T^{\langle i,j\rangle} - E_T^{\langle i,j\rangle}}{I_T^{i,j}}\right) \times 100 \text{ if } I_T^{\langle i,j\rangle} \geq 1 \\ \mathit{Undefined} \text{ otherwise} \end{cases}$.

- Then the One-way Frame Loss Ratio Performance metric **SHALL** be defined as $FLR_{T,S} = \begin{cases} \max\left\{FLR_T^{\langle i,j\rangle} \mid \langle i,j\rangle \in S \text{ and where } I_T^{\langle i,j\rangle} \geq 1\right\} \\ \mathit{Undefined} \text{ when all } I_T^{\langle i,j\rangle} = 0 \mid \langle i,j\rangle \in S \end{cases}$.

For the SLS, a One-way Frame Loss Ratio Performance metric entry **MUST** specify a set of parameters and an objective. The parameters and objective of a One-way Frame Loss Ratio Performance metric are given in Table 9.

Parameter	Description
T	The time interval
S	Subset of the ordered UNI pairs
$\hat{L}$	One-way Frame Loss Ratio Performance objective

Table 9 – One-way Frame Loss Ratio Performance Parameters

Given *T*, S, and a One-way Frame Loss Ratio Performance objective, the One-way Frame Loss Performance **SHALL** be defined as met over the time interval *T* for the subset S if and only if $FLR_{T,S} \leq \hat{L}$.

Recall that if the One-way Frame Loss Ratio Performance is Undefined for time interval T and ordered pair $\langle i, j \rangle$, then the performance for that ordered pair **SHALL** be excluded from calculations on the performance of pairs in S. For a given set S, if the Service Performance is Undefined for *all* ordered pairs, then the performance for S **SHALL** be defined as compliant.

For a Point-to-Point EVC, S **MAY** include one or both of the ordered pairs of UNIs in the EVC.

For a Multipoint-to-Multipoint EVC, S **MAY** be any subset of the ordered pairs of UNIs in the EVC.

For a Rooted-Multipoint EVC, S **MUST** be such that all ordered pairs in S contain at least one UNI that is designated as a Root.

Part 3

The EVC Service Attributes are listed in Table 16 along with the type of parameter value for the attribute. For a given instance of a service, a table like that of Table 16 **MUST** be specified for the EVC associated with the service.

Attribute	Type of Parameter Value
EVC Type (Section 6.1)	Point-to-Point, Multipoint-to-Multipoint, or Rooted-Multipoint
EVC ID (Section 6.1.2.2)	An arbitrary string, unique across the MEN, for the EVC supporting the service instance
UNI List (Section 6.3)	A list of <UNI Identifier, UNI Type> pairs
Maximum Number of UNIs (Section 6.4)	Integer. **MUST** be 2 if EVC Type is Point-to-Point. **MUST** be greater than or equal to 2 otherwise.
EVC Maximum Transmission Unit Size (Section 6.10)	Integer ³ 1522.
CE-VLAN ID Preservation (6.6.1)	Yes or No
CE-VLAN CoS Preservation (Section 6.6.2)	Yes or No
Unicast Service Frame Delivery (6.5.1.1)	Discard, Deliver Unconditionally, or Deliver Conditionally. If Deliver Conditionally is used, then the conditions **MUST** be specified.
Multicast Service Frame Delivery (Section 6.5.1.2)	Discard, Deliver Unconditionally, or Deliver Conditionally. If Deliver Conditionally is used, then the conditions **MUST** be specified.
Broadcast Service Frame Delivery (Section 6.5.1.3)	Discard, Deliver Unconditionally, or Deliver Conditionally. If Deliver Conditionally is used, then the conditions **MUST** be specified.
Layer 2 Control Protocols Processing (Section 6.7)	A list of Layer 2 Control Protocols labeled Tunnel or Discard.
EVC Performance (Sections 6.8 and 6.9)	Performance objectives for One-way Frame Delay Performance, One-way Frame Delay Range Performance, One-way Mean Frame Delay Performance, Inter-Frame Delay Variation Performance, One-way Frame Loss Ratio Performance, and Availability Performance and associated Class of Service Identifier(s) as defined in Section 6.8.

Table 16 – EVC Service Attributes