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NICC Document

Ethernet ALA Service Definition

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Foreword

This NICC Document (ND) has been produced by NICC Ethernet Working Group.

Introduction

This document contains the Service Definition for Ethernet ALA. The document is based on the ALA Architecture defined in ND1644 [2]. It should be read in conjunction with the ALA UNI and NNI definitions in ND1031 [i.3] and ND1036 [i.4].

1 Scope

This document is part of a suite of documents that define Ethernet ALA:

- ND1644 Ethernet ALA Architecture
- ND1030 Ethernet ALA Service definition (this document)
- ND1031 Ethernet ALA UNI
- ND1036 Ethernet ALA NNI

ND1644 describes the concepts of ALA, the architecture and reference points and it also provides some examples of ALA solutions.

This document provides the definition of the ALA Service and its associated attributes. There are separate descriptions of a point-to-point ALA User Connection and a Multicast ALA User Connection. This document covers:

- Forwarding behaviour
- Service frame tagging
- Protocol transparency
- Policing / shaping behaviour
- OAM protocol functions
- Higher layer functionality (e.g. IGMP snooping)

The main objective of this issue of the document is to meet the requirements of residential end-users.

ND1031 and ND1036 describe the aspects of the UNI and NNI that depend on the technology used at the physical interfaces.

2 References

For the particular version of a document applicable to this release see ND1610 [1].

NOTE: While any hyperlinks included in this clause were valid at the time of publication NICC cannot guarantee their long term validity.

2.1 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

[1] ND1610 Next Generation Networks, Release Definition

[2] NICC ND1644: "Architecture for Ethernet Interconnect and Ethernet ALA". December 2010.

[3] MEF 10.2: "Ethernet Services Attributes Phase 2". October 2009. http://www.metroethernetforum.org/MSWord_Documents/MEF10.2.doc

[4] MEF 23: "Class of Service Phase 1 Implementation Agreement". June 2009. http://www.metroethernetforum.org/PDF_Documents/technical-specifications/MEF23.pdf

[5] MEF 26: "External Network Network Interface (ENNI) – Phase 1. January 2010. http://www.metroethernetforum.org/MSWord_Documents/MEF26.doc

[6] Broadband Forum TR-101: "Migration to Ethernet-Based DSL Aggregation". April 2006. http://www.broadband-forum.org/technical/download/TR-101.pdf

2.2 Informative references

[i.1] ETSI Directives: "ETSI drafting rules Clause 14a:- Verbal Forms For The Expression Of Provisions". Version 26, July 2009. http://portal.etsi.org/Directives/26_directives_july_2009.pdf

[i.2] NICC ND1642: "Requirements for Ethernet Interconnect and Ethernet ALA". February 2010.

[i.3] NICC ND1031: "Ethernet ALA UNI". December 2010.

[i.4] NICC ND1036: "Ethernet ALA NNI". Work in Progress.

[i.5] MEF 6.1: "Ethernet Services Definitions – Phase 2". April 2008. http://www.metroethernetforum.org/PDF_Documents/MEF6-1.pdf

[i.6] IEEE 802.3™-2005: "IEEE Standard for Information technology-Telecommunications and information exchange between systems-Local and metropolitan area networks--Specific requirements Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications." http://standards.ieee.org/getieee802/802.3.html

[i.7] IEEE Std 802.1Q™-2005: "IEEE Standard for Local and Metropolitan Area Networks—Virtual Bridged Local Area Networks". http://standards.ieee.org/getieee802/download/802.1Q-2005.pdf

[i.8] IEEE Std 802.1ad™-2005: "IEEE Standard for Local and Metropolitan Area Networks—Virtual Bridged Local Area Networks—Revision—Amendment 4: Provider Bridges". http://standards.ieee.org/getieee802/download/802.1ad-2005.pdf [i.9] IEEE Std 802.1ag™-2007: "IEEE Standard for Local and Metropolitan Area Networks Virtual Bridged Local Area Networks Amendment 5: Connectivity Fault Management". http://standards.ieee.org/getieee802/download/802.1ag-2007.pdf

[i.10] ITU-T Rec. Y.1731: "OAM functions and mechanisms for Ethernet based networks". http://www.itu.int/rec/T-REC-Y.1731

[i.11] IETF RFC 3376: "Internet Group Management Protocol, Version 3". http://www.ietf.org/rfc/rfc3376.txt

[i.12] IETF RFC 3569: "An Overview of Source-Specific Multicast (SSM)", section 7. http://www.ietf.org/rfc/rfc3569.txt

[i.13] IETF RFC 4541: "Considerations for Internet Group Management Protocol (IGMP) and Multicast Listener Discovery (MLD) Snooping Switches". http://www.ietf.org/rfc/rfc4541.txt

[i.14] IETF RFC 4604: "Using Internet Group Management Protocol Version 3 (IGMPv3) and Multicast Listener Discovery Protocol Version 2 (MLDv2) for Source-Specific Multicast. http://www.ietf.org/rfc/rfc4604.txt

3 Key Words, Definitions and Abbreviations

3.1 Key Words

The key words “shall”, “shall not”, “must”, “must not”, “should”, “should not”, “may”, “need not”, “can” and “cannot” in this document are to be interpreted as defined in the ETSI Drafting Rules [i.1].

3.2 Definitions

For the purposes of the present document, the following terms and definitions apply:

ALA domain: span of control of the ALA-provider

ALA-provider: Operator of the access network segment supporting Ethernet ALA

ALA-user: Direct user of Ethernet ALA

ALA-user connection: connection between the UNI and NNI supported by Ethernet ALA for each ALA-user

Customer Premises Equipment: equipment provided and operated by the ALA-user or end-user at the end-user’s premises.

NOTE: The terms ‘ALA-user CPE’ and ‘end-user CPE’ are used within the text where it is necessary to distinguish between the two.

Egress: the direction from the ALA Provider to the ALA User at an interface

End-user: Ultimate recipient of services provided over ALA

NOTE: End-users can include both residential consumers and business users.

Ethernet ALA: Ethernet service between the Point of Interconnect at the NNI and the customer premises provided by the ALA-provider to the ALA-user

NOTE: The term Ethernet ALA is overloaded since it is used both in the Ofcom Technical Requirements and by this document. Within this document, the term Ethernet ALA (or just ALA) is used to describe the service defined by NICC.

Ingress: the direction from the ALA User to the ALA Provider at an interface

NOTE: a frame travelling upstream will be an ingress frame at the UNI and an egress frame at the NNI.

Multicast Channel: IP Multicast flow that is forwarded by the ALA provider network identified by either IP multicast group address in ASM operation or IP source address and IP multicast group address in SSM operation.

NNI Frame: Ethernet frame transmitted across the NNI

Service Frame: Ethernet frame carried by the ALA User Connection

Network Termination Unit: device provided and operated by the ALA provider at the customer premises that terminates the network of the ALA provider and provides the UNI

User-Network Interface: interface between the ALA-provider and the ALA-user at the customer premises

UNI Frame: Ethernet frame transmitted across the UNI

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AIS	Alarm Indication Signal	(Y.1731)
ALA	Active Line Access	(Ofcom)
ADSL	Asymmetric Digital Subscriber Line	(G.992)
ASM	Any-Source Multicast	(IETF RFC3569)
AUC	ALA User Connection	(ND1644)
CBS	Committed Burst Size	(MEF 10)
CIR	Committed Information Rate	(MEF 10)
CPE	Customer Premises Equipment	(ND1644)
DHCP	Dynamic Host Configuration Protocol	(IETF RFC 2131)
EBS	Excess Burst Size	(MEF 10)
EIR	Excess Information Rate	(MEF 10)
ENNI	External Network-Network Interface	(MEF 10)
EPL	Ethernet Private Line	(MEF 6.1)
IGMP	Internet Group Management Protocol	(IETF RFC 3376)
L2CP	Layer 2 Control Protocol	(MEF 10)
MEG	Maintenance Entity Group	(ITU-T Y.1731)
MEP	MEG End Point	(ITU-T Y.1731)
MIP	MEG Intermediate Point	(ITU-T Y.1731)
NNI	Network-Network Interface	(ND1644)
NTU	Network Termination Unit	(ND1644)
OAM	Operation, Administration and Maintenance	(ITU-T Y.1731)
PPPoE	Point-to-Point Protocol over Ethernet	(IETF RFC 2516)
QoS	Quality of Service	
S-Tag	Service VLAN Tag	(IEEE 802.1Q)
SSM	Source-Specific Multicast	(IETF RFC3569)
TPID	Tag Protocol Identifier	(IEEE 802.1Q)
UNI	User-Network Interface	(ND1644)
VDSL2	Very high speed Digital Subscriber Line 2	(ITU-T G.993)
VLAN	Virtual Local Area Network	(IEEE 802.1Q)

4 Overview

ND1644 [2] describes the ALA architecture. Two ALA service types are defined:

- Point-to-point ALA service
- Multicast ALA service

The ALA service transports Service Frames across an ALA User Connection (AUC) between an ALA UNI and an ALA NNI. The ALA User Connection isolates the traffic of different ALA Users within the ALA Provider network. Each Service Frame is an Ethernet MAC frame [i.6].

The ALA service is defined by the characteristics of the ALA-User Connection (AUC), AUC End Points, UNI and NNI objects that are specified in this document. Figure 1 shows the how these objects are combined to define an ALA Service. In this diagram, the cardinality of a given object in relation to another is indicated using a multiplicity where 1 means 'one' and N means 'many' e.g. each AUC group may be associated with many AUC endpoints. These objects are based on those defined in MEF26 [5].

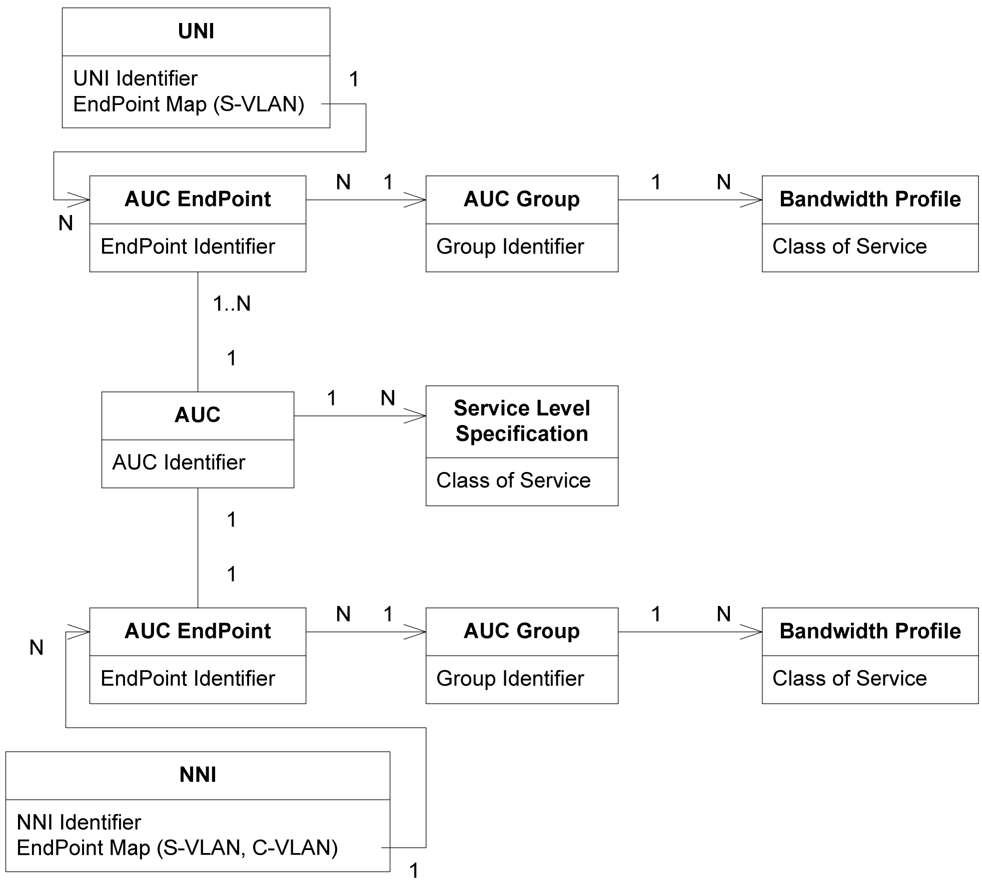

Figure 1: Overview of ALA service model

The ALA UNI and NNI support multiple AUCs. The ALA UNI object contains an AUC Endpoint Map that controls mapping between an AUC and a VLAN at the UNI. The ALA NNI object is similar, but the AUC Endpoint Map supports using either one or two VLAN tags.

Each AUC has one AUC Endpoint at the NNI. A Point-to-Point AUC has one AUC Endpoint at a UNI. A Multicast AUC is likely to have AUC Endpoints at multiple UNIs. Each AUC supports multiple classes of service. The AUC has a service level specification that defines the performance and availability attributes that apply to the ALA service delivered using that AUC for each class of service.

Each AUC Endpoint at the UNI and NNI is a member of an AUC Group. This AUC Group has an associated bandwidth profile for each class of service. At the NNI this allows the bandwidth profile to be shared between multiple point-to-point AUCs for aggregation purposes. At the UNI, this allows the bandwidth profile to be shared between Point-to-Point and Multicast AUCs.

Clause 5 contains requirements for each of the entities shown in Figure 1. Clause 6 defines the service attributes associated with each of these objects.

5 Requirements

5.1 MEF to ALA Terminology Mapping

This clause contains requirements from MEF 26 [5]. Conformance of an ALA service to MEF NNI requirements shall be in accordance with the mapping from MEF terms to ALA terms shown in Table 1.

Table 1: Mapping from MEF to ALA terminology

MEF Term	ALA Term
OVC	AUC
ENNI	NNI, UNI
ENNI Frame	UNI Frame, NNI Frame

5.2 ALA UNI

This subclause profiles requirements from section 7.1 (ENNI Service Attributes) of MEF 26 [5].

5.2.1 UNI Identifier

The UNI Identifier shall be conformant to the ENNI Identifier requirements [R3] and [R4] in section 7.1.1 of MEF 26 [5].

5.2.2 UNI Types

The ALA UNI shall support the S-Tagged service interface, and may support the Port-based and/or Customer Edge Port (C-Tagged) service interfaces defined by Clause 15 of IEEE 802.1ad [i.8].

The S-Tagged service interface supports multiple AUCs per UNI. The AUC of UNI frames is identified using an IEEE 802.1Q VLAN tag. One AUC can be supported using the untagged VLAN on the port. All untagged and priority-tagged UNI frames received at a UNI are mapped to the AUC End Point configured for this untagged S-VLAN. This mode supports all 4 ALA Classes of service.

The Port-based service interface supports one AUC per UNI. All upstream frames in this AUC are mapped to a default Class of Service. The Port-based service interface allows the ALA UNI to directly support the UNI for an MEF EPL service.

The Customer Edge Port service interface supports one point to point and one point to multipoint AUC per UNI. One defined VID value maps upstream frames to the multipoint AUC. All other frames are mapped to the point to point AUC, regardless of any tagging. This mode supports all 4 ALA Classes of service.

Note 1: The Port-based service interface is not supported by MEF 26.

Note 3: For all UNI types, some L2CP frames may be peered or filtered at the UNI according to the L2CP requirements in clause 5.7.

5.2.3 Frame Format

5.2.3.1 S-Tag TPID

An ALA UNI shall support S-Tag TPID values of 0x8100 and 0x88a8.

NOTE: Supporting TPID of 0x88a8 allows support of an IEEE 802.1ad compliant provider edge bridge as the CPE device and allows use of the DEI field. Supporting TPID of 0x8100 allows backward compatibility with TR-101 implementations.

5.2.3.2 UNI Frame Format

This clause specifies whether each UNI frame is treated as untagged, priority tagged or VLAN-tagged for the purpose of clauses 5.2.4 and 5.2.5. Addition and removal of VLAN tags by an AUC is discussed in clause 5.5.5.

All UNI Frames arriving at a port-based UNI shall be treated as untagged.

NOTE: The 802.1ad port-based service interface supports priority-tagged frames but the Port-based UNI type in this document does not. This divergence is required to allow the case that S-Tag TPID=0x8100.

If a UNI frame at an S-Tagged UNI has an outer-VLAN tag with a TPID that matches the interface TPID then that UNI frame is VLAN-tagged with the VLAN ID in the VLAN tag; otherwise it is treated as untagged. A VLAN-tagged frame with a VLAN-ID of 0 is treated as priority tagged.

All UNI Frames arriving at a Customer Edge Port Based UNI with no tag shall be treated as untagged.

All UNI Frames arriving at a Customer Edge Port Based UNI with a VLAN-ID of 0 shall be treated as priority tagged. All UNI Frames arriving at a Customer Edge Port Based UNI with a VLAN-ID matching the configured multicast VLAN-ID shall be treated as priority tagged.

All UNI Frames arriving at a Customer Edge Port Based UNI with a non-zero VLAN-ID which does not match the configured multicast VLAN-ID shall be treated as untagged.

5.2.3.3 L2CP Frame Format

Layer 2 Control Protocol (L2CP) frames crossing an ALA UNI may be untagged or VLAN-tagged (as appropriate to each L2CP).

5.2.4 AUC End Point Map

The UNI AUC End Point Map specifies the association between UNI frames and AUC End Points at that UNI.

5.2.4.1 Entries for a Port Based UNI

At a Port-based UNI, the AUC End Point Map shall contain a single entry for the AUC End Point that all service frames map to.

5.2.4.2 Entries for an S-Tagged UNI

At an S-Tagged UNI, the AUC shall be determined by the S-VLAN ID of the UNI frame. The AUC End Point Map shall contain a row for each S-VLAN-ID and AUC configured on the UNI.

5.2.4.3 Entries for an Customer Edge-Port Based UNI

At a Customer Edge Port Based UNI, the AUC shall be determined by the C-VLAN ID of the UNI frame. The AUC End Point Map shall contain a row for the C-VLAN ID pertaining to the multicast AUC (if) configured on the UNI and a row for the point to point AUC. All other frames shall be mapped to the point to point AUC.

5.2.4.4 VLAN Bundling

No more than one S-VLAN-ID shall map to each AUC end-point.

5.2.4.5 Discard of unknown VLANs

An ingress UNI frame that is not mapped to an AUC End Point shall not be forwarded.

Note: For the Customer Edge Port based UNI, there is a implicit mapping of all frames that are not mapped to the multicast AUC End Point to the configured point to point AUC End Point.

5.2.4.6 VLAN ID range

The AUC End Point Map at the UNI shall support all S-VLAN IDs in the range 1-4094.

5.2.5 Untagged S-VLAN

At an S-Tagged UNI, one S-VLAN on the interface may be configured as untagged. All untagged and priority-tagged UNI frames received at a UNI shall be mapped to the AUC End Point configured for this untagged S-VLAN together with any frames that are received tagged with that S-VLAN ID. All service frames transmitted from this AUC End Point shall be untagged.

5.2.6 Number of AUCs per UNI

The ALA UNI shall support at least 4 AUCs and should support at least 8 AUCs.

The ALA UNI shall support at least 2 Multicast AUCs.

5.2.7 Maximum Number of AUC End Points Per AUC

An ALA UNI shall support one AUC End Point per AUC.

5.3 ALA NNI

This subclause profiles requirements from section 7.1 (ENNI Service Attributes) of MEF 26 [5] with extensions to add support for a double tagged NNI.

5.3.1 NNI Identifier

The NNI Identifier shall be conformant to the ENNI Identifier requirements [R3] and [R4] in section 7.1.1 of MEF 26 [5].

5.3.2 NNI Frame Format

5.3.2.1 NNI Frame Tagging

Service Frames crossing an ALA NNI shall be VLAN tagged with one of the formats shown in Figure 2. Untagged and priority-tagged service frames are not supported at the NNI.

DA(6) : SA(6) : S-Tag (4) : Ethertype (2) : payload and FCS	
DA(6) : SA(6) : S-Tag (4) : C-Tag (4) : Ethertype (2) : payload and FCS	

Figure 2: ALA NNI Frame Formats

5.3.2.2 NNI Frame Format

S-VLAN and C-VLAN tags at an NNI shall use the formats defined in clauses 9.6 and 9.7 of IEEE 802.1ad [i.8].

5.3.2.3 L2CP Frame Format

Layer 2 Control Protocol (L2CP) frames crossing an ALA NNI may be untagged or VLAN-tagged (as appropriate to each L2CP).

5.3.2.4 S-Tag TPID

An ALA NNI shall support S-Tag TPID values of 0x8100 and 0x88a8.

5.3.2.5 C-Tag TPID

The C-Tag TPID at the ALA NNI shall be 0x8100.

5.3.3 VLAN architectures

An ALA NNI shall support Point-to-Point AUCs using the 1:1 VLAN architecture or shall support the N:1 VLAN architecture or may support both.

5.3.4 AUC End Point Map

The NNI AUC End Point Map specifies how ingress NNI frames are mapped to an AUC End Point and how egress NNI frames are tagged according to their AUC End Point.

5.3.4.1 Single-Tagged AUC Identification

For Point-to-Point AUCs supported by the 1:1 VLAN architecture and Multicast AUCs, a Single-Tagged AUC End Point shall be identified by the S-VLAN ID configured in the AUC End Point Map.

For Point-to-Point AUCs supported by the N:1 VLAN architecture, each AUC still has an AUC End-Point at the NNI. The AUC End-Point for each NNI Frame can be identified by the combination of the S-VLAN ID and MAC address (source MAC address in upstream traffic, destination MAC address in downstream traffic). However, it is only necessary to configure the association of S-VLANs to AUC End-Points. The ALA provider network will use dynamic MAC address learning and might not identify the AUC which the service frame belongs to until the service frame reaches the UNI.

5.3.4.2 Double-Tagged AUC Identification

A Double-Tagged Point-to-Point AUC End Point shall be identified by the combination of the S-VLAN ID and C-VLAN ID.

5.3.4.3 Number of AUC End Points per S-VLAN

For an NNI supporting only the 1:1 VLAN architecture, each S-VLAN ID in the AUC End Point Map may be used to identify:

- One Single-Tagged AUC End Point; or
- One Multicast AUC End-Point; or

- Many Double-Tagged AUC End Points

For an NNI supporting the N:1 VLAN architecture, each S-VLAN ID in the AUC End Point Map may be used to identify:

- Many Single-Tagged AUC End Points; and
- One Multicast AUC End-Point.

5.3.4.4 VLAN Bundling

No more than one S-VLAN-ID or S&C-VLAN-ID shall map to each AUC end-point.

5.3.4.5 Discard of unmapped frames

An ingress NNI frame that is not mapped to an AUC End Point shall not be delivered across any UNI (see also clause 5.10.2).

5.3.4.6 Mixing double and single-tagged AUCs

An ALA NNI shall support both Single-Tagged AUC End Points and Double-Tagged AUC End Points.

5.3.4.7 VLAN ID range

An ALA NNI shall support all S-VLAN IDs and C-VLAN IDs in the range 1-4094.

5.3.5 Number of AUCs per NNI

At reference point A-3 in the ALA architecture [2], an ALA provider shall be able to provide aggregated access to AUCs through one or more physical interfaces.

5.3.6 Maximum Number of AUC End Points Per AUC

An ALA NNI shall support at most one AUC End Point per AUC.

5.4 AUC End Point

The AUC End Point object controls the Class of Service mapping for service frames at the UNI and NNI using class of service mapping tables. Traffic management of service frames is specified based on this Class of Service.

This subclause profiles requirements from section 7.3 (OVC End Point per ENNI Service Attributes) of MEF 26 [5].

5.4.1 AUC End Point Identifier

The AUC End Point Identifier shall be conformant to the OVC End Point Identifier requirements [R50] and [R51] in section 7.3.1 of MEF 26 [5].

5.4.2 Class of Service Mapping

ND1644 [2] introduces four classes of service supported by ALA. Each Class of Service is referenced by a Class of Service Label (A-D). The AUC end-point supports a map from the PCP value of the UNI Frame or NNI Frame to a Class of Service.

The MEF bandwidth profile algorithm used by ALA can be configured to be color-aware. The Color of a Service Frame is identified either using the VLAN PCP field or the DEI field of an S-VLAN tag.

5.4.2.1 CoS at a Single-Tagged AUC End-Point

A Single-Tagged AUC End-Point shall use the PCP value of the S-Tag to identify the Class of Service of each ingress frame as specified in requirements [R52] and [D3] of MEF 26.

5.4.2.2 CoS at a Double-Tagged AUC End-Point

At a double tagged AUC end-point, the Class of Service shall be marked in the PCP of both the S-VLAN and C-VLAN tags of both ingress and egress frames.

Note: This is to support equipment that is only aware of the outer VLAN tag on a frame, while also ensuring that the inner-VLAN tag is marked as expected by IEEE 802.1ad implementations.

A Double-Tagged AUC End-Point may use the PCP value of the S-Tag or C-Tag to identify the Class of Service of each ingress frame as specified in requirements [R52] and [D3] of MEF 26.

5.4.2.3 Class of Service Decoding for Ingress Frames

For a C-VLAN Tag or when the S-Tag TPID is configured as 0x8100, the mapping from ingress PCP to CoS and Drop Eligibility is given in Table 2.

Table 2: Class of Service Decoding for C-Tag or S-Tag with TPID=0x8100

PCP	Class
4	A
3	B
2	C
1	C drop eligible
0	D

When the S-Tag TPID is configured as 0x88a8, the mapping in Table 3 applies:

Table 3: Class of Service Decoding for S-Tag TPID=0x88a8

PCP	DEI	Class
4	X	A
3	X	B
2	0	C
2	1	C drop eligible
1	X (note 1)	C drop eligible
0	X	D

Note 1: This is defined so as to specify which marking takes precedence in the event of the PCP bit and DEI bit having opposite settings.

ALA User packets which do not have a defined PCP marking, i.e. PCP = 5, 6 or 7, shall be treated as Class C, Drop Eligible or dropped.

5.4.2.4 Class of Service Support

An ALA Provider shall provide support for Class A and Class C, and should provide support for all 4 Classes of Service.

Note: An ALA Provider might not offer all classes on every AUC due to network constraints.

Where a given ALA Provider does not support one (or more) of the defined Classes, packets with an unsupported marking shall either be treated as Class C (Drop Eligible) or dropped.

5.4.2.5 Class of Service Encoding for Egress Frames

For the C-Tag or when the S-Tag TPID is configured as 0x8100, the mapping from Class of Service and Drop Eligibility to egress PCP is given in Table 4.

Table 4: Class of Service Encoding for C-Tag or S-Tag with TPID=0x8100

Class	PCP
A	4
B	3
C	2
C drop eligible	1
D	0

When the S-Tag TPID is configured as 0x88a8, the mapping in Table 5 applies:

Table 5: Class of Service Encoding for S-Tag with TPID=0x88a8

Class	PCP	DEI
A	4	0
B	3	0
C	2	0
C drop eligible	2	1
D	0	0

5.4.2.6 Color Indication at an AUC End-Point

Color indication for each ingress and egress frames shall conform to requirements [R3] and [R4] of MEF 23.

5.4.3 AUC Groups

AUC Groups are described in ND1644 and are used as a way to apply ALA bandwidth profiles to a group of one or more AUC End-Points at a UNI and NNI.

5.4.3.1 AUC Group Identifier

The AUC End-Point uses the AUC Group Identifier to identify the AUC Group it belongs to. The AUC Group Identifier shall be unique among all such identifiers for AUC Groups supported by the ALA Provider. The AUC Group Identifier shall contain no more than 45 bytes.

5.4.3.2 AUC Group membership at the NNI

An AUC Group shall not contain AUCs from different ALA Users. The AUCs in an AUC Group shall all use the same S-VID at the NNI.

5.4.3.3 Number of AUC End-Points per AUC Group

An AUC Group shall support a maximum of 4095 AUC End-Points at the NNI.

5.4.3.4 AUC bandwidth overbooking

The CIR and EIR bandwidth aggregates for the different classes at the NNI shall be able to be less than the sum of the ingress bandwidth profiles for the individual AUCs in a given AUC Group.

5.4.3.5 AUC Group membership at the UNI contention point

An AUC group at the UNI shall contain no more than 1 AUC End-Point belonging to a Point-to-Point AUC and no more than 1 AUC End-Point belonging to a Multicast AUC.

5.4.4 AUC Group Bandwidth Profiles

5.4.4.1 Bandwidth Profiles per Class of Service

The AUC Group shall support bandwidth profiles for each service class within an AUC Group.

5.4.4.2 Ingress / Egress Bandwidth Profiles

The AUC Group shall support asymmetric separate upstream and downstream bandwidth profiles i.e. the ingress and egress bandwidth profiles do not have to match.

5.4.4.3 Bandwidth Profile Algorithm

The AUC Group bandwidth profiles shall implement the MEF bandwidth profile algorithm according to section 7.6 of MEF 26 (as corrected by MEF26.0.1).

The behaviour of the MEF bandwidth profile algorithm appropriate to ALA is summarised in Annex A.

5.4.4.4 Frame length

The frame length used by the MEF ENNI bandwidth profile algorithm shall be the length of the UNI or NNI frame (including all VLAN tags).

Note: The frame length used for the bandwidth profile algorithm can be different at the NNI and UNI. The configuration of the bandwidth profile parameters will need to allow for the overhead of different numbers of VLAN tags.

5.4.4.5 Applicable Frames

All frames mapped to the AUC Group and Class of Service, including any control or IGMP frames, are counted in the bandwidth profile.

5.4.4.6 Coupling Flag

The AUC Group bandwidth profiles shall have the coupling flag (CF) set to 1. This means that excess committed bandwidth can be used by ingress frames marked drop eligible (yellow).

5.4.4.7 Color Mode

The AUC Group bandwidth profile should support the Color Mode parameter for Class C as defined in section 7.6.1 of MEF26. Where not specified for a class, the Color Mode attribute is set to Color Blind.

Note: When Color Mode is Color Blind, the ingress bandwidth profile treats all frames as drop ineligible (green).

5.4.4.8 Weighted Scheduling at the UNI

In the case of upstream contention between classes C and D at the UNI, the weight parameter defines the maximum percentage of ingress bandwidth (committed and excess), available to class C & D, that will be allocated to class D.

5.4.4.9 Bandwidth Profile Attributes

The AUC Group bandwidth profiles shall support the Committed Information Rate (CIR), Committed Burst Size (CBS), Excess Information Rate (EIR), and Excess Burst Size (EBS) attributes defined by requirements [R82], [R83], [R84], and [R85] in MEF 26[5]. The applicable bandwidth profile parameters for each Class of Service are given in Table 6.

Table 6: Bandwidth Profile Attributes

Class	CIR	CBS	EIR	EBS
A	C1	CB1	-	-
B	C2	CB2	-	-
C + D	C3	CB3	E3	EB3

Classes 3 and 4 share the same bandwidth profile. Where Class C and Class D packets are both queued in the upstream direction at the UNI they shall be forwarded with a relative weight as specified in clause 5.4.4.8.

5.5 Point-to-Point AUC Requirements

This subclause profiles requirements from section 7.2 (OVC Service Attributes) of MEF 26 [5].

5.5.1 AUC Identifier

The AUC Identifier shall be conformant to the OVC End Point Identifier requirements [R30] and [R31] in section 7.2.4 of MEF 26 [5].

5.5.2 AUC End Points

A Point-to-Point AUC shall have one AUC End Point at a UNI and one AUC End Point at an NNI.

5.5.3 Service Frame Length

The length of an ALA Service Frame shall be calculated from the first bit of the Destination MAC Address through the last bit of the Frame Check Sequence and includes the S-VLAN tag that is present at the ALA UNI. Frame overhead that is added by the ALA provider (including additional VLAN tags at the NNI) shall not be included in the service frame length for the purpose of AUC MTU policing.

5.5.4 AUC Maximum Transmission Unit Size

5.5.4.1 MTU behaviour

When the length of a Service Frame is larger than the AUC MTU Size, it shall be dropped at the ingress UNI or NNI. The operation of a Bandwidth Profile that applies to this Service Frame is not defined.

5.5.4.2 Minimum AUC MTU

An ALA provider shall support an AUC Maximum Transmission Unit Size of at least 1600 bytes.

5.5.4.3 Relationship to UNI / NNI MTU

The AUC Maximum Transmission Unit Size shall be less than or equal to the smaller of the MTU Sizes of the associated UNI and NNI.

5.5.5 VLAN Transparency

The modification of the VLAN headers of each frame between the UNI and NNI shall depend on the combination of AUC endpoint types as shown in Table 7.

Table 7: AUC VLAN Modification

UNI AUC Endpoint	NNI AUC Endpoint	Upstream AUC action	Downstream AUC action
Untagged	S-Tagged	Push NNI S-Tag	Pop NNI S-Tag
	S&C-Tagged	Push NNI S&C-Tag	Pop NNI S&C-Tag
Priority Tagged (with TPID of the UNI)	S-Tagged	Pop UNI S-Tag Push NNI S-Tag	Pop NNI S-Tag Push UNI S-Tag
	S&C-Tagged	Pop UNI S-Tag Push NNI S&C-Tag	Pop NNI S&C-Tag Push UNI S-Tag
VLAN Tagged (with TPID of the UNI)	S-Tagged	Pop UNI S-Tag Push NNI S-Tag	Pop NNI S-Tag Push UNI S-Tag
	S&C-Tagged	Pop UNI S-Tag Push NNI S&C-Tag	Pop NNI S&C-Tag Push UNI S-Tag

The AUC shall transparently carry any VLAN tags that may be present in the payload of the Ethernet frame that are not used for classification in the AUC End Point Map (see clauses 5.2.4, 5.3.4).

5.5.6 Color Forwarding

The AUC shall support Color forwarding as specified in [R43] of MEF 26 [5].

5.5.7 Frame Delivery

A point-to-point AUC shall support unconditional unicast, multicast and broadcast frame delivery as specified in requirements [R44], [R46] and [R48] of MEF 26 [5].

5.5.8 Service Level Specification

The AUC Service Level Specification specifies the frame delivery performance objectives between the ALA UNI and NNI. This section defines the performance attributes that are part of the Service Level Specification for the Point-to-Point AUC. This sub-clause references the definition of these attributes in MEF 10.2. For each of these attributes the MEF requires a set of ordered pairs of network interfaces to be defined, between which these attributes can be measured. For the Unicast AUC, these performance attributes are measured in the upstream direction from the UNI to the NNI and in the downstream direction from the NNI to the UNI.

In order to meet a Service Level Specification defined by these attributes, it is expected that the ALA Provider will need to implement strict priority scheduling at any congestion points in their network to prioritise transmission of Class A traffic over Class B traffic, which in turn would be prioritised over Class C & D traffic. Starvation of the lower priority queues can be avoided by the use of per Class Policers. Example implementations are described in ND1644.

5.5.8.1 Service Level Specification Applicability

The performance attributes described in this section shall only apply to “Qualified” Service Frames as defined by section 6.9 of MEF 10.2. The Service Level Specification is not defined for frames marked as drop-eligible by either the ALA User or a Bandwidth Profile.

Note: It is expected that the ALA Provider will implement a queue management algorithm such as RED to improve the frame loss performance for frames marked drop-ineligible (green).

5.5.8.2 One-way Frame Delay

MEF 10.2 section 6.9.2 defines three performance attributes for delay: 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 Point-to-Point AUC SLS shall support the One-way Frame Delay performance objective corresponding to a percentile of the distribution.

5.5.8.3 Inter-Frame Delay Variation

The Point-to-Point AUC SLS shall support the Inter-frame delay variation performance objective as defined in MEF10.2 section 6.9.4.

5.5.8.4 Frame Loss Ratio

The Point-to-Point AUC SLS shall support the One-way Frame Loss Ratio performance objective as defined in MEF10.2 section 6.9.6.

5.5.8.5 Availability

The Point-to-Point AUC SLS shall support the Availability performance objective as defined in MEF 10.2 section 6.9.7.

5.5.8.6 Required SLS Attributes by Class

The Service Level Specification shall define separate performance objectives for each supported class in an AUC in accordance with Table 8:

Table 8: Required SLS attributes by class

Class	One-way Frame Delay	Inter-Frame Delay Variation	Frame Loss Ratio	Availability
A	M	M	M	M
B	O	M	M	M
C + D	O	O	M	O

M = Required
O = Optional

5.5.9 Relationship Between AUCs on the same interface

Where Class A traffic is present from more than one AUC on the same access line, there needs to be a mechanism for each AUC to deterministically limit the jitter produced by Class A traffic in the other AUCs on that line. Two different ways in which this might be done are described in ND1644 along with the possible nodal implications.

Where Class C and/or D traffic is present from more than one AUC on the same access line, the sum of this traffic for each AUC needs to be able to be transmitted with a relative, defined weight set by the ALA provider, based on their product definition. This weighting shall be equal in the case where ALA Users on the same access line take an AUC with the same bandwidth attributes for Class C and Class D. A way in which this might be done is described in ND1644 along with the possible nodal implications.

Any Class C/D packet dropping at the NNI shall be done without regard to the individual AUC identity.

5.6 Multicast AUC Requirements

5.6.1 AUC Identifier

See clause 5.5.1.

5.6.2 AUC End Points

A Multicast AUC shall have one or more AUC End Points at UNIs and one AUC End Point at an NNI.

5.6.3 Service Frame Length

See clause 5.5.3.

5.6.4 AUC Maximum Transmission Unit Size

See clause 5.5.4.

5.6.5 VLAN Transparency

A multicast AUC does not support VLAN transparency. Service Frames received with additional C-VLAN tags at the UNI or the NNI shall be discarded.

5.6.6 Color Forwarding

See clause 5.5.6.

5.6.7 Frame Delivery

5.6.7.1 Unconditional forwarding

When the Frame Delivery is configured as "Unconditional", all properly formatted ingress frames mapped to an AUC End Point at an NNI with a multicast or broadcast destination MAC address shall be delivered to all of the other End Points associated by the AUC as described in [R46] and [R48] of MEF 26 [5].

5.6.7.2 Conditional forwarding

When the Frame Delivery is configured as "IGMP", delivery of properly formatted ingress frames mapped to a Multicast AUC End Point at an NNI with a multicast destination MAC address is controlled by IGMP.

5.6.7.3 Upstream frames

The only frames mapped to a Multicast AUC at a UNI shall be IGMP control messages.

5.6.7.4 Discarding unicast frames

Unicast frames mapped to a Multicast AUC shall be discarded.

5.6.7.5 Subscriber Isolation

Upstream IGMP frames received by an AUC End-Point at a UNI shall not be delivered to another UNI.

5.6.8 IGMP Support

The flooding of Ethernet multicast frames within the Multicast AUC is controlled by the use of an IGMP control plane. The IGMP control plane uses IGMP proxy and snooping functions to monitor IGMP traffic and adjust replication filters in the ALA provider network and the ALA NTU so that packets are replicated only to those AUC End Points that have specifically requested a multicast group.

5.6.8.1 IGMP Transport

All downstream and upstream IGMP messages used to control membership of groups in a Multicast AUC shall be transported within the VLAN that transports the Multicast AUC.

5.6.8.2 IGMP Classification

The Multicast AUC shall support the identification and processing of ALA User initiated IGMP messages.

5.6.8.3 IGMP Proxy Reporting

The Multicast AUC shall support IGMPv3 snooping with proxy-reporting as defined in section 1.6 of TR-101 [6] which additionally references RFC4541 [i.13]. This feature shall be configurable on a per Multicast AUC basis.

5.6.8.4 IGMP Query Suppression

When IGMP Proxy Reporting is enabled, the Multicast AUC shall only forward IGMP general queries to those UNIs receiving at least one multicast stream and shall not forward IGMP group specific queries from the NNI to UNIs.

5.6.8.5 Transparent Snooping

The Multicast AUC may support IGMPv3 transparent snooping as defined in section 1.6 of TR-101 [6] which additionally references RFC4541 [i.13]. Where IGMP transparent snooping is available to the ALA user, it shall be in addition to the option for proxy reporting.

5.6.8.6 Priority Marking

The Multicast AUC shall support marking, in the upstream direction, user-initiated IGMP traffic with an Ethernet priority.

5.6.8.7 Previous IGMP versions

IGMPv3 includes support for IGMPv2 by allowing an IGMP aware network element to drop into compatibility mode on a per group basis when it detects the presence of a host using an older version of IGMP.

The ALA User should use IGMPv3 to support the ALA multicast service. The ALA User may use IGMPv2 to support the ALA multicast service. The ALA User shall not use IGMPv1; the Multicast AUC may ignore IGMPv1 IGMP messages as required by [6].

5.6.8.8 Multicast Forwarding

TR-101 [6] assumes that multicast support is provided using a layer 3 control plane but a layer 2 forwarding plane. The implications of a layer 2 forwarding plane are described in section 6.2 of [6] but can be summarised as follows:

- In order to prevent incorrect forwarding of traffic in the data plane channels with IP multicast group addresses that map to the same layer 2 multicast MAC address must not be forwarded over the same VLAN at the same time.
- In order to support source specific multicast channels with identical IP multicast group addresses but different IP source addresses must not be forwarded over the same VLAN at the same.

The Multicast AUC should support layer-3 forwarding of multicast traffic. If it supports layer-2 forwarding only then this shall be explicitly stated in the service definition and the ALA User must ensure that the IP addressing chosen is such that the channels are uniquely defined at the Ethernet layer.

5.6.8.9 Any Source Multicast

The Multicast AUC shall support Any Source Multicast (forwarding based only on destination IP address).

If an IGMP source specific join is received (S,G) for a multicast group in the defined any source multicast range, the Multicast AUC should discard such a request.

The ALA provider may extend the ASM range.

The ALA Provider may restrict the group IP addresses that an ALA User can use for their ASM multicast channels.

5.6.8.10 Source Specific Multicast

For multicast groups within the source specific multicast range the Multicast AUC shall support forwarding of multicast traffic based on source and destination IP address (Source Specific Multicast).

If an IGMP any source join (*,G) is received for a multicast group in the defined source specific multicast range it shall be discarded as required by RFC4604.

The ALA Provider may extend the SSM range.

The ALA Provider may restrict the group and source IP addresses that an ALA User can use for their SSM multicast channels.

5.6.8.11 Source Filtered Multicast

Source filtered multicast (using IGMPv3 exclude messages with a non-null source list) is not supported by ALA. If such an exclude message is received by the Multicast AUC it shall be silently discarded.

5.6.8.12 Group 0.0.0.0

For security purposes, the ALA-provider shall discard any user-initiated IGMP Leave messages for group ‘0.0.0.0’.

5.6.8.13 Static Replication

The Multicast AUC shall support the capability for the ALA user to mandate certain defined multicast groups as being always available at the closest access node to the ALA end user. Effectively these multicast groups shall be available at the replication point regardless of IGMP messages from the end users. For ASM the multicast group is identified by Multicast AUC and destination multicast group IP address. For SSM the multicast group is identified by multicast AUC source IP address and destination multicast group IP address.

5.6.8.14 IGMP messages per second

The ALA provider shall define the maximum number of IGMP messages per second that will be accepted for a given multicast AUC over a single UNI. The ALA provider may ignore subsequent messages (as a DoS protection mechanism). A Multicast AUC shall support at least 10 IGMP messages per second at the UNI.

5.6.8.15 Number of channels per UNI and NNI

The ALA provider shall define the maximum number of channels that may be simultaneously joined at an individual UNI and NNI for a given multicast AUC. A Multicast AUC shall be able to support forwarding state for at least 10 simultaneous multicast groups per UNI.

5.6.8.16 Multicast Bandwidth Control

The ALA User is responsible for managing the number of multicast channels and their bandwidth at the ALA UNI and NNI, in particular they need to ensure that:

- An individual end user joining a multicast channel does not violate the number of channels or the bandwidth available to a Multicast AUC or AUC Group at the ALA UNI; and
- A channel join request received at the ALA NNI does not result in the number of channels or the total bandwidth available at the NNI for the multicast AUC being exceeded.

In each case the ALA user is responsible for ensuring that they ignore the request for the channel. At the UNI this means filtering the IGMP messages and at the NNI this means ignoring the channel join request.

If the ALA user exceeds the limits on number of channels or bandwidth at the ALA UNI or NNI for a multicast AUC then the ALA provider may ignore channel requests, police or otherwise drop excess traffic. If this results in channel or service outage this will not be counted towards service unavailability in any SLS.

The ALA provider shall drop excess traffic to ensure that a single ALA user cannot disrupt other ALA users by sending excess multicast traffic/groups.

5.6.8.17 AUC Provisioning

An ALA provider may define a total limit for simultaneous channels and IGMP message handling on a given UNI or NNI and may deny a request for the provision of a new Multicast AUC if accepting it would violate these limits.

5.6.8.18 AUC Modification

The ALA-provider shall support the addition and removal of ALA end users to an ALA Multicast AUC without impacting other end users connected via the Multicast AUC.

5.6.8.19 AUC Statistics

The ALA provider shall provide summary statistics for the Multicast AUC at each UNI as follows:

1. Total number of successful joins
2. Total number of unsuccessful joins
3. Total number of leave messages
4. Total number of general queries sent to users
5. Total number of specific queries sent to users
6. Total number of invalid IGMP messages received

A successful join is an IGMP Membership Report that causes the forwarding tables in the ALA provider network to be updated such that a new channel is sent across the UNI (as long as it is being received at the NNI).

The mechanism for reporting these statistics to an ALA User is beyond the scope of this specification.

5.6.8.20 ALA User CPE requirements

The ALA multicast AUC requires the ALA user to deploy CPE that supports the functionality in section 6.2.1 of TR-101 [6]. In particular the following TR-101 requirements shall be supported by the ALA User CPE: R-191, R-192, R-193, R-200.

The TR-101 requirement R-196 shall be modified as follows in order to use ALA terminology:

When the ~~RG~~ ALA User CPE receives an IGMP membership query on a ~~given WAN-facing IP interface~~ logical interface assigned to the multicast AUC, the IGMP Proxy-Routing function MUST only send a corresponding membership report on this specific interface.

The TR-101 requirement R-201 shall be modified as follows in order to use ALA terminology:

The ~~RG~~ALA User CPE MUST NOT forward UPNP multicast messages to ~~its WAN interface~~ a multicast AUC.

Note: Other requirements in section 6.2.1 of TR-101 may be valid for a given service provided by the ALA user, however the definition of such services are beyond the scope of ALA.

5.6.9 Service Level Specification

This section defines the performance attributes that are part of the Service Level Specification for the Multicast AUC.

The MEF 10.2 performance attributes [10] have been adapted to apply to a multicast service because of the presence of IGMP snooping. For each of these attributes the MEF requires a set of ordered pairs of network interfaces to be defined, between which the one way delay is monitored. For the Multicast AUC, this is the set of ordered pairs of the NNI paired with each UNI interface in the AUC. The Frame Delay performance objectives then define the worst case delay performance between the NNI and any UNI in the AUC.

In addition, the Multicast AUC requires a definition of new performance attributes to specify the performance of multicast channel changes.

Mechanisms for reporting Multicast AUC performance to the ALA User are out of scope of this document.

5.6.9.1 Channel Change Latency

The Channel Change Latency (CCL) is the maximum time interval between when:

- An IGMP membership report is sent across the UNI by an ALA User; and when
- The first packet of a requested multicast channel is received by the ALA User across the UNI.

Any part of this time interval outside of the control of the ALA Provider Network is excluded from the Multicast AUC Channel Change Latency i.e. any interval between an IGMP join being sent across the NNI by the ALA provider and the Multicast channel being sent across the NNI by the ALA User.

Within a specified time period, the Channel Change Latency performance objective $\hat{C}$ shall be defined as met if and only if $CCL \leq \hat{C}$.

5.6.9.2 One-way Frame Delay

MEF 10.2 section 6.9.2 defines three performance attributes for delay: 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 Multicast AUC SLS shall support the One-way Frame Delay performance objective corresponding to a percentile of the distribution.

5.6.9.3 Inter-Frame Delay Variation

The Multicast AUC SLS shall support the Inter-frame delay variation performance objective as defined in MEF10.2 section 6.9.4.

5.6.9.4 Frame Loss

The Frame Loss Ratio (FLR) is the maximum percentage of frames for any multicast channel continuously joined over the monitored time period, *T* by the ALA User at any UNI that are:

- Received by the ALA provider at the NNI;
- Not delivered by the ALA provider at that UNI; where
- Those frames are not marked out-of-profile by either an ingress bandwidth profile at the NNI or an egress bandwidth profile at the UNI.

If a channel change occurs at a UNI within the time period *T,* the Frame Loss Ratio for that channel at that UNI is undefined.

Within the time period, *T*, the Frame Loss Ratio Performance objective $\hat{L}$ shall be defined as met if and only if $FLR \leq \hat{L}$.

5.6.9.5 Availability

In addition to network availability, capacity constraints within an ALA Provider Network could mean that an ALA Provider will not guarantee 100% availability of all multicast channels to every end-user, even if there is available capacity at both the NNI and UNI. The Availability performance attribute has therefore been enhanced to reflect channel changes that are rejected by the ALA Provider when the ALA provider network is otherwise available.

The Multicast AUC SLS shall support Availability performance objective as defined in MEF10.2 section 6.9.8, except that:

1) The Frame Loss Ratio used shall be the one defined in clause 5.6.9.4;

2) The AUC shall also be unavailable during the time interval Δt where the ALA User has requested a multicast channel and did not receive it within the Channel Change Latency objective.

Condition 2) for unavailability does not apply if:

- The ALA User exceeds the maximum number of IGMP requests at a UNI during the time interval Δt ; or
- The additional channel requested would be marked out-of-profile by either an ingress bandwidth profile at the NNI or an egress bandwidth profile at the UNI.

5.7 Layer 2 Control Protocol Processing

The Point-to-Point AUC shall support filtering reserved addresses as described in R-95 of TR-101.

The Point-to-Point AUC should support forwarding the addresses in the range 01-80-C2-00-00-00 to 01-80-C2-00-00-0F that are not reserved by the S-VLAN component as defined by Table 8-2 of IEEE 802.1ad-2005.

5.8 Access Loop Identification and Characterisation

The functions listed in this sub-clause are derived from Broadband Forum TR-101 [6]. They are included to ease compatibility of an ALA service with TR-101 based operational support systems already deployed by ALA-Users.

5.8.1 PPPoE Intermediate Agent

A point-to-point AUC shall support a PPPoE Intermediate agent as specified in requirements [R-115] to [R-121] of TR-101 [6].

The ALA User shall be able to configure whether or not the PPPoE Intermediate Agent is enabled on each AUC. When the PPPoE Intermediate Agent is disabled, PPPoE packets shall be forwarded transparently by the AUC.

5.8.2 L2 DHCP Relay Agent

A point-to-point AUC shall support a L2 DHCP relay agent as specified in requirements [R-96] to [R-105] and [R112] to [R-114] of TR-101 [6].

The ALA User shall be able to configure whether or not the L2 DHCP Relay Agent is enabled on each AUC. When the L2 DHCP Relay Agent is disabled, DHCP packets shall be forwarded transparently by the AUC.

5.8.3 Access Loop Identification

This information allows the ALA-user to dynamically learn which end-user is associated with which AUC, as an alternative to a priori knowledge of these associations. This information can be logged by the ALA User DHCP and PPP servers and used for end user authentication and geo-localization purposes.

5.8.3.1 Circuit-ID

The PPPoE Intermediate Agent and L2 DHCP Relay Agent shall insert the Circuit-ID field. The value of the Circuit-ID for an AUC may vary if there are reconfigurations in the ALA provider’s network.

5.8.3.2 Remote-ID

The PPPoE Intermediate Agent and L2 DHCP Relay Agent shall insert the Remote-ID field. The value of the Remote-ID for an AUC shall be configurable by the ALA-User.

5.8.4 Access Loop Characteristics

When an ADSL or VDSL2 Access Loop is used, the PPPoE Intermediate Agent and L2 DHCP Relay Agent should insert the Access Loop Characteristics sub-options as specified in requirements [R-129] to [R-131] of TR-101.

5.9 Ethernet OAM

The requirements in this subclause reference functions defined in IEEE 802.1ag [i.9] and ITU-T Y.1731 [i.10]. Figure 3 shows the Ethernet OAM architecture for ALA using the conventions from IEEE 802.1ag.

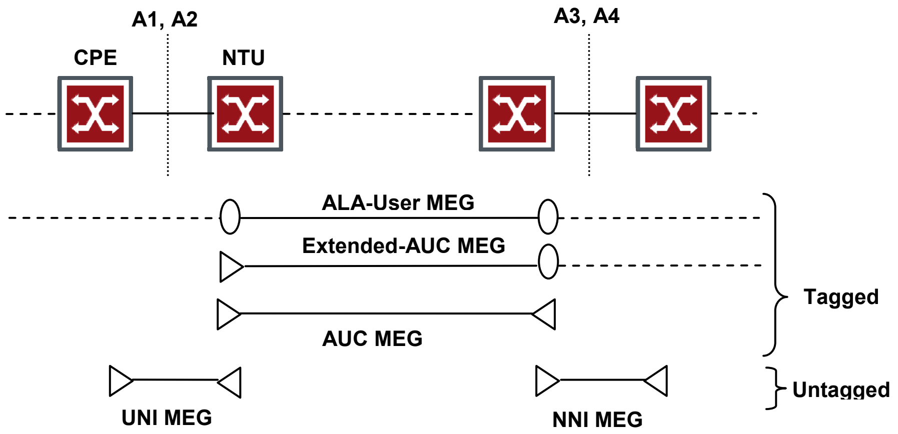

Figure 3: Ethernet OAM Architecture

5.9.1 ALA User MEG

5.9.1.1 AUC MEG Support

The AUC should support the ALA User MEG on a Point-to-Point AUC in the 1:1 VLAN architecture.

5.9.1.2 AUC MEG VLAN Tagging

If ALA-User MEG is supported, it shall be configured on the VLAN that supports the AUC.

5.9.1.3 AUC MEG-level

If ALA-User MEG is supported, it shall be configured at MEG-level 3.

5.9.1.4 AUC MIPs

If ALA-User MEG is supported, it shall support a MIP at the UNI.

If ALA-User MEG is supported, it should support a MIP at the NNI.

5.9.1.5 AUC Diagnostics

MIPs on the ALA User MEG shall support Loopback and Linktrace.

5.9.1.6 AIS

If ALA-User MEG is supported, the ALA-Provider should support sending AIS towards the UNI and NNI at an interval of 60 seconds on the ALA User MEG based on the state of the AUC.

If ALA-User MEG is supported, the ALA-Provider may support the generation of AIS at an interval of 1 second towards both the UNI and NNI.

5.9.2 Extended-AUC MEG

The Extended-AUC MEG allows an ALA User to monitor the Frame Delay and Frame Loss performance of an AUC without deploying ALA User CPE.

5.9.2.1 Extended-AUC MEG support

An Extended-AUC MEG shall be supported on the VLAN carrying a Point-to-Point AUC in the 1:1 VLAN architecture.

The use of the Extended-AUC MEG in N:1 VLANs is left open for future study.

5.9.2.2 Extended-AUC MEG level

The Extended-AUC MEG shall be configured at MEG-level 2

5.9.2.3 Extended-AUC MEG MAID

The Extended-AUC MEG shall use MD-Name Format 1 (not present) and Short MA-Name Format 4 (character string). The Short MA-Name shall be the AUC identifier.

5.9.2.4 UNI MEP

A MEP shall be configured on the Extended-AUC MEG at the UNI with MEPID 2.

5.9.2.5 AUC MIPs

The ALA Provider should support a MIP on the Extended-AUC MEG at the NNI interface.

5.9.2.6 Extended-AUC MEG diagnostics

The Extended-AUC UNI MEP shall support Loopback and linktrace
MIPs on the Extended-AUC MEG shall support loopback and linktrace

The Extended-AUC UNI MEP shall support the generation of Y.1731 LMR Messages in response to a Y.1731 LMM message from the remote MEP for the support of Single Ended Frame Loss Measurement.

The Extended-AUC UNI shall support the counter requirements for Y.1731 Single Ended Frame Loss measurements for at least the duration of any test initiated by the remote MEP.

The Extended-AUC UNI MEP shall support the generation of Y.1731 DMR Messages in response to a Y.1731 DMM message from the remote MEP for the support of Two-Way Frame Delay Measurement.

5.9.2.7 UNI MEP Continuity Check

The Extended-AUC UNI MEP may support Continuity Check with a configurable interval.
The Extended-AUC UNI MEP Continuity check shall be disabled by default.
The Extended-AUC UNI MEP Continuity Check shall support generation of the interface status TLV.

5.9.2.8 AIS

The ALA-Provider may support sending AIS at an interval of 60 seconds on the Extended-AUC MEG based on the state of the AUC.

The ALA-Provider may support sending AIS at an interval of 1 second on the Extended-AUC MEG based on the state of the AUC.

5.9.3 AUC MEG

The ALA provider may operate Maintenance Associations on the VLAN carrying the AUC at MEG-levels 0-1.

5.9.4 UNI MEG

5.9.4.1 UNI MEG support

The ALA UNI should support the UNI MEG.

5.9.4.2 UNI MEG-level

The UNI MEG shall be configured at MEG-level 1.

5.9.4.3 UNI MAID

The UNI MEG shall use MD-Name Format 1 (not present) and Short MA-Name Format 4 (character string). The Short MA-Name shall be the UNI identifier.

5.9.4.4 UNI MEP

The ALA Provider shall configure a MEP with MEPID 1.

5.9.4.5 UNI Continuity Check

The UNI MEG shall enable Continuity Check with an interval of 1 second.

5.9.4.6 UNI Diagnostics

The UNI MEG shall support Loopback and Linktrace.

5.9.5 NNI MEG

5.9.5.1 NNI MEG support

The ALA NNI should support the NNI MEG.

5.9.5.2 NNI MEG-level

The NNI MEG shall be configured at MEG-level 1.

5.9.5.3 NNI MAID

The UNI MEG shall use MD-Name Format 1 (not present) and Short MA-Name Format 4 (character string). The Short MA-Name shall be the NNI identifier.

5.9.5.4 NNI MEP

The ALA Provider shall configure a MEP with MEPID 1.

5.9.5.5 NNI Continuity Check

The NNI MEG shall enable Continuity Check with an interval of 1 second.

5.9.5.6 NNI Diagnostics

The NNI MEG shall support Loopback and Linktrace.

5.10 Security in N:1 VLANs

The requirements in this sub-clause only apply where a Point-to-Point AUC is implemented using N:1 VLAN transport. This is because in this architecture, the end-user MAC address is processed by the ALA Provider network.

5.10.1 Isolation Between ALA User Connections

The AUC shall prevent forwarding traffic between UNIs. Traffic received from a UNI shall only be forwarded to a NNI.

5.10.2 Broadcast Handling

5.10.2.1 Upstream Broadcast Storms

The AUC shall protect the ALA user from broadcast storms, by limiting the rate of upstream broadcast frames per UNI. This limit shall be configurable.

5.10.2.2 Downstream DHCP Broadcast

The AUC shall forward a downstream DHCP broadcast message only to the UNI for which it is intended as specified in [R-100] of TR-101 [6].

5.10.2.3 Downstream ARP Broadcast

The AUC shall ensure that downstream broadcast ARP requests are only sent to a UNI with the associated requested IP address as specified in [R-106] and [R-107] of TR-101 [6].

5.10.3 MAC Address Translation

MAC address translation (MAT) uses a symmetric one to one mapping table per UNI that maps between each end-user MAC address and a Virtual-MAC address (VMAC). The VMAC is a unique ALA Provider administered MAC addresses per end-user MAC address. This function provides protection against denial of service in the case where multiple CPE use the same MAC address and satisfies R-89 of TR-101 [6].

5.10.3.1 MAT Support

The AUC shall support per S-VLAN activation / deactivation of the AUC MAT function.

5.10.3.2 MAC Address Mapping

The AUC MAT function shall translate the source address of Ethernet frames in upstream traffic from the end-user MAC to the VMAC. The AUC shall translate the destination address of Ethernet frames in downstream traffic from the VMAC to the end-user MAC address.

5.10.3.3 MAT Helper Functions

The AUC MAT function shall support symmetric, one to one translation between each end-user MAC and a VMAC in the payload of the following messages : ARP, DHCP v4, IEEE 802.1ag LTM and LTR.

5.10.4 MAC Address Flooding

The ALA provider shall support limiting the number of end-user MAC addresses per UNI. This limit shall be configurable.

6 Service Attributes

This section describes the service attributes that must be agreed between the ALA provider and ALA User in order to provision the ALA Service. The service attributes are grouped into objects by UNI, NNI, AUC End-Point and AUC. The index fields for each object are shaded in grey. Attributes are Mandatory (M) or Optional (O). Each attribute is described with reference to the conformance requirements in clause 5.

6.1 ALA UNI

Table 9 lists the ALA UNI Attributes. There is one set of UNI attributes per ALA UNI.

Table 9 – UNI Attributes

Attribute Name	Description	Possible Values	Required	Clause
UNI Identifier	Identifier for the UNI	String (up to 45 chars)	M	5.2.1
UNI Type	Whether the interface supports multiple AUCs (S-Tagged) or an EPL service (Port-based), or a single AUC and a single multicast AUC (Customer Edge Port Based)	S-Tagged , Port-based or Customer Edge Port Based	M	5.2.2
UNI TPID	TPID of VLAN tags at the UNI	0x8100, 0x88a8	M	5.2.3.1
AUC End-Point Map	A table with rows associating VLAN IDs with AUC End-Point Identifiers at the UNI	See Table 10	M	5.2.4
Untagged S-VLAN	The S-VLAN configured as the untagged S-VLAN at this UNI	1-4094	M	5.2.5
UNI MEG exists	A Boolean value indicating whether the UNI MEG has been configured	Boolean (Yes or No)	M	5.9.4.1

Table 10 lists the attributes in the UNI AUC End Point Map.

Table 10 – UNI AUC End Point Map Attributes

Attribute Name	Description	Possible Values	Required
VLAN ID	VLAN-ID at the UNI	1-4094	M
AUC End Point	AUC End Point Identifier for the associated AUC End Point object	String (up to 45 chars). See clause 5.4.1.	M

6.2 ALA NNI

Table 11 lists the ALA NNI Attributes. There is one set of these attributes per ALA NNI.

Table 11 – NNI Attributes

Attribute Name	Description	Possible Values	Required	Clause
NNI Identifier	Identifier for the NNI	String (up to 45 chars)	M	5.3.1
VLAN architectures	The VLAN architectures supported by this NNI	1:1, N:1, Both	M	5.3.3
NNI TPID	TPID of S-VLAN tags at the NNI	0x8100, 0x88a8	M	5.3.2.4
AUC End-Point Map	A table with rows associating VLAN IDs with AUC End-Point Identifiers at the UNI	See Table 12	M	5.3.4
AUCs Supported	The number of AUCs this NNI can support	Integer	M	5.3.5
NNI MEG exists	A Boolean value indicating whether the NNI MEG has been configured	Boolean (Yes or No)	M	5.9.5.1

Table 12 lists the attributes in the NNI AUC End Point Map.

Table 12 – NNI AUC End Point Map Attributes

Attribute Name	Description	Possible Values	Required
S-VLAN ID	S-VLAN-ID at the NNI	1-4094	M
C-VLAN ID	C-VLAN ID at the NNI	1-4094	O (see 1)
AUC End Point	AUC End Point Identifier for the associated AUC End Point object	String (up to 45 chars). See clause 5.4.1.	M

Notes:

(1) The C-VLAN ID is only required at the NNI for a double-tagged AUC End-Point.

6.3 AUC End-Point

Table 13 lists the AUC End-Point Attributes. There is one set of these attributes per AUC End-Point.

Table 13 – AUC End Point Service Attributes

Attribute Name	Description	Possible Values	Required	Clause
EndPoint Identifer	AUC End Point Identifier	String (up to 45 chars)	M	5.4.1
AUCGroup	AUC Group Identifier	String (up to 45 chars)	M	5.4.3.1
ClassB_SUP	Support for Class B traffic	Boolean (Yes or No)	M	5.4.2.4
ClassD_SUP	Support for Class D traffic	Boolean (Yes or No)	M	5.4.2.4

6.4 AUC Group Bandwidth Profiles

Table 14 lists the Bandwidth profile attributes for each AUC Group. There is one set of these attributes for each Class of Service for each direction supported by the AUC Group.

Table 14 – AUC Group Service Attributes

Attribute Name	Description	Possible Values	Required	Clause
AUCGroup	AUC Group Identifier	String (up to 45 chars)	M	5.4.3.1
CoS	Class of Service	A,B,C (see note 1)	M	5.4.4.1
Direction	Egress or ingress profile	0 (Egress)/ 1 (Ingress)	M	5.4.4.2
CIR	Committed Information Rate (bps)	Integer	M	5.4.4.9
CBS	Committed Burst Size (bytes)	Integer	M	5.4.4.9
EIR	Excess Information Rate (bps)	Integer	M	5.4.4.9
EBS	Excess Burst Size (bytes)	Integer	M	5.4.4.9
CM	Color Mode	“Color Blind” or “Color Aware”	M	5.4.4.7
Weight	The weighting between Class C and Class D	Integer in the range 1-99	O (see 3)	5.4.4.8

Notes:

(1) There is no bandwidth profile for Class D; it is a fraction of the Class C profile
(2) EIR = 0 for Class A and Class B
(3) Weight is only applicable to the entry in the table for Class C, Ingress at the UNI.

6.5 Point-to-Point AUC

Table 15 lists the Point-to-Point AUC Attributes. There is one set of these attributes per Point-to-Point AUC.

Table 15 – Point to Point AUC Service Attributes

Attribute Name	Description	Possible Values	Required	Clause
AUC Identifier	Identifier for the AUC	String (up to 45 chars)	M	5.5.1
AUC End Point List	A list of AUC End Points	A list of AUC End Point Identifiers	M	5.5.2
MTU	Maximum Transmission Unit in bytes	Integer	M	5.5.4
Color Forwarding	Color Forwarding	Boolean (Yes or No)	M	5.5.6
SLS	Service Level Specification	See Table 16	M	5.5.8
PPPoE Intermediate Agent	Controls whether the PPPoE Intermediate Agent is enabled	Boolean (Yes or No)	M	5.8.1
L2 DHCP Relay Agent	Controls whether the L2 DHCP Relay Agent is enabled	Boolean (Yes or No)	M	5.8.2
Circuit ID	Circuit ID field inserted into DHCP and PPPoE packets	String (up to 63 chars)	O	5.8.3.1

Remote ID	Remote ID field inserted into DHCP and PPPoE packets	String (up to 63 chars) - see (1).	O	5.8.3.2
ALA User MEG exists	A Boolean value indicating whether the ALA User MEG has been configured	Boolean (Yes or No)	M	5.9.1.1
ALA User MEG NNI MIP Exists	A Boolean value indicating whether the ALA User MEG has a MIP configured at the NNI	Boolean (Yes or No)	M	5.9.1.4
ALA User MEG AIS	A Boolean value indicating whether the ALA Provider will generate AIS on the ALA user MEG	Boolean (Yes or No)	M	5.9.1.6
ALA User MEG AIS interval	The transmission interval for AIS on the ALA User MEG	1 second or 60 seconds	M	5.9.1.6
Extended-AUC MEG NNI MIP Exists	A Boolean value indicating whether the ALA Provider has configured a level 3 MIP on a double-tagged NNI	Boolean (Yes or No)	M	5.9.2.5
Extended-AUC MEG CC transmission Interval	A value indicating the transmission interval for continuity check on the Extended-AUC MEG. A value of 0 indicates that CC is disabled.	1s, 10s, 1min, 10 min	M	5.9.2.7
Extended-AUC MEG AIS support	A Boolean value indicating whether the ALA Provider supports the generation of AIS on the Extended-AUC MEG	Boolean (Yes or No)	M	5.9.2.8
Broadcast Max	Maximum number of broadcast frames per second	Integer	O	5.10.2.1
MAT	Controls whether MAC address translation is activated on the AUC	Boolean (Yes or No) (see note 3)	M	5.10.3.1
VMAC range	Range of Virtual MAC addresses associated with the AUC	Base MAC – Upper MAC e.g. 00:00:00:00:00:00–FF:FF:FF:FF:FF:FF	O	5.10.3.2
MAC Max	Maximum number of end-user MAC addresses	Integer	O (see 2)	5.10.4

Notes:

(1) An operator may wish to use the same value for the AUC Identifier and the Remote ID. In this case the length of the Remote ID should be restricted to 45 characters.
(2) MAC Max is mandatory where an N:1 VLAN architecture is used.
(3) for an AUC that does not support MAT the value of this attribute should be set to ‘No’.

Table 16 – Point to Point AUC SLS Attributes

Attribute Name	Description	Possible Values	Required	Clause
AUC Identifier	Identifier for the AUC	String (up to 45 chars)	M	5.5.1
CoS	Class of Service	A,B,C (see note 1)	M	5.5.8.6
Direction	Upstream or Downstream SLS	Upstream / Downstream	M	5.5.8
Time interval	The time interval over which SLS attributes are measured (seconds). This is the MEF performance attribute T.	Integer	M	5.5.8
One-way Frame Delay Percentile	Percentile for Frame Delay Performance	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.2
One-way Frame Delay Performance Objective	Frame Delay Performance Objective corresponding to the defined percentile	Integer (milliseconds)	M	5.5.8.2
Inter-Frame Delay Variation Percentile	Percentile for Inter-Frame Delay Variation Performance	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.3
Inter-Frame Delay Variation Performance Objective	Frame Delay Performance Objective corresponding to the defined percentile	Integer (milliseconds)	M	5.5.8.3
Frame Loss Ratio	The performance objective for the frame loss ratio	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.4
Availability Interval	This is the MEF 10.2 performance attribute Δt.	Integer (milliseonds)	M	5.5.8.5
Availability Intervals	Number of consecutive small time intervals for assessing availability. This is the MEF 10.2 performance attribute n.	Integer	M	5.5.8.5
Unavailability frame loss ratio threshold	This is the MEF 10.2 performance attribute C_u.	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.5
Availability frame loss ratio threshold	This is the MEF 10.2 performance attribute C_a	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.5
AUC Availability Performance objective	AUC Availability Performance objective. This is the MEF 10.2 performance attribute $\hat{A}$.	Decimal Percentage (accuracy of 3 decimal places)	M	5.5.8.5

Notes:

(1) The required performance attributes by class are given in clause 5.5.8.6.

6.6 Multicast AUC

Table 17 lists the Multicast AUC Attributes. There is one set of these attributes per Multicast AUC.

Table 17 – Multicast AUC Service Attributes

Attribute Name	Description	Possible Values	Required	Clause
AUC Identifier	Identifier for the AUC	String (up to 45 chars)	M	5.6.1
AUC End Point List	A list of AUC End Points	A list of AUC End Point Identifiers	M	5.6.2
MTU	Maximum Transmission Unit in bytes	Integer	M	5.6.4
Frame delivery	Whether IGMP snooping is enabled	Unconditional / IGMP	M	5.6.7
IGMP Transparent Snooping	Whether IGMP proxy reporting or Transparent Snooping is used	Proxy Reporting / Transparent Snooping	M	5.6.8.5
Forwarding Mode	Whether Ethernet or IP based forwarding is used for IP Multicast groups	Ethernet or IP	M	5.6.8.8
ASM address range extension	List of multicast addresses outside of the normal ASM range that the ALA provider will treat as ASM. If omitted the defaults apply.	List of multicast IP addresses	O	5.6.8.9
SSM address range extension	List of multicast addresses outside of the normal SSM range that the ALA provider will treat as SSM. If omitted the defaults apply.	List of multicast IP addresses	O	5.6.8.10
Permitted multicast IP addresses	List of valid IP multicast addresses for traffic within the multicast AUC. If omitted any address is valid.	List of IP multicast group addresses	O	5.6.8.9, 5.6.8.10
Permitted source IP addresses	List of valid source IP addresses for traffic within the Multicast AUC. If SSM is not supported by the ALA provider then this parameter is absent.	List of IP addresses	O	5.6.8.10
Static Replication List	A table with rows listing the Multicast Channels that are statically replicated to the Access Node	See Table 18	M	5.6.8.13
IGMP messages per second	The maximum number of IGMP messages per second permitted at the UNI	Integer	M	5.6.8.14
Max Channels per UNI	The maximum number of IP multicast channels per UNI	Integer	M	5.6.8.15
Max Channels per NNI	The maximum number of IP multicast channels per NNI	Integer	M	5.6.8.15

Time interval	The time interval over which SLS attributes are measured (seconds). This is the MEF performance attribute T.	Integer	M	5.6.9
Channel Change Latency	The performance objective for channel change latency in milliseconds	Integer	M	5.6.9.1
One-way Frame Delay Percentile	Percentile for Frame Delay Performance	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.2
One-way Frame Delay Performance Objective	Frame Delay Performance Objective corresponding to the defined percentile	Integer (milliseconds)	M	5.6.9.2
Inter-Frame Delay Variation Percentile	Percentile for Inter-Frame Delay Variation Performance	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.3
Inter-Frame Delay Variation Performance Objective	Frame Delay Performance Objective corresponding to the defined percentile	Integer (milliseconds)	M	5.6.9.3
Frame Loss Ratio	The performance objective for the frame loss ratio	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.4
Availability Interval	This is the MEF 10.2 performance attribute Δt.	Integer (milliseonds)	M	5.6.9.5
Availability Intervals	Number of consecutive small time intervals for assessing availability. This is the MEF 10.2 performance attribute n.	Integer	M	5.6.9.5
Unavailability frame loss ratio threshold	This is the MEF 10.2 performance attribute C_u.	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.5
Availability frame loss ratio threshold	This is the MEF 10.2 performance attribute C_a	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.5
AUC Availability Performance objective	AUC Availability Performance objective. This is the MEF 10.2 performance attribute $\hat{A}$.	Decimal Percentage (accuracy of 3 decimal places)	M	5.6.9.5

Table 18 lists the attributes in the Multicast AUC Static Replication List.

Table 18 – Static Replication List

Attribute Name	Description	Possible Values	Required
Group address	Group address of the IP Multicast Group	IP address	M
Source address	Source address of the IP Multicast Group	IP address	O

7 Mandatory Configurations

Where there is no capability to provide baseband voice, an ALA provider shall offer a Point-to-Point AUC capable of carrying voice communications.

The bandwidth profiles and SLS parameters that would define such an AUC are for further study within NICC.

Annex A (informative): MEF Bandwidth profile behaviour

This Annex describes the behaviour of the MEF bandwidth profile for each of the classes of service supported by ALA.

ALA supports the MEF color concept, but Yellow is only applicable to Classes C and D.
Ingress color marking is only applicable to Classes C & D.

Ingress color marking is done via the DEI bit or a PCP value of 2 for S-tagged frames, and a PCP value of 2 only for non S-tagged frames.

The packet treatment is as follows:

All Green packets are forwarded.
Yellow packets can be dropped, but if forwarded, have the defined performance parameters, except for frame loss ratio
All Red packets are dropped.

Classes A and B

Any ingress coloring is ignored and may be overwritten on egress
If the equivalent packet rate is =< CIR + burst size, then the packet is Green
If the equivalent packet rate is > CIR + burst size, then the packet is Red

Classes C and D

Any ingress coloring will be used but may be overwritten on egress

Ingress Green marked packets
If the equivalent packet rate is =< (CIR + burst size), then the packet remains Green
If the equivalent packet rate is > (CIR + burst size) but <(CIR+the burst size + EIR) the packet is remarked yellow
If the equivalent packet rate is > (CIR + burst size + EIR), then the packet is Red

Ingress Yellow marked packets
The packet marking is unchanged unless the equivalent packet rate is > (CIR + burst size +EIR), then the packet is Red

Notes:
With the color coupling flag set, ingress yellow traffic can use any unused CIR bandwidth
Ingress yellow traffic will be limited to (CIR+EIR – any Green traffic)

History

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