TCF Ultra-Fast Broadband

Ethernet Access Service Description

Version Number and Status: **Final**
Version date: **19 January 2011**

This document sets out the minimum standards that the TCF Working Party recommends an LFC should meet if it is delivering the UFB Ethernet Access Service. The Working Party gives its support to this document but recognises that changes may be required following negotiation with the CFH to take account of matters such as interoperability considerations, technical feasibility, and service capability/cost trade-off decisions. This TCF UFB Ethernet Access Service Description has been approved by the following parties: Crown Fibre Holdings; InternetNZ; Kordia; Northpower; Orcon; Telecom; TelstraClear; Vector; Vodafone.

The following parties have given their support to Section 7. Multicast Services: Freeview; MediaWorks; SKYTV; and TVNZ.

Contents

1 Introduction

This Ethernet Access Services Description provides the framework for Ethernet Access Services, the Layer 2 services to be provided to Access Seekers under the Government's Ultra Fast Broadband (UFB) initiative.

The baseline Service Descriptions or Service Profiles are defined in separate annexes for End-user segments with distinctively different needs in terms of service characteristics, SLAs and price. The Service Profiles will describe which parameters/options are valid for each End-user segment for each particular service offering. Initially Service Profiles will be defined for Mass Market, Business and Business Premium market segments.

This document includes point-to-point Ethernet Line Access (ELA) services and point-to-multipoint Ethernet Multicast Access (EMA) services.

1.1 Purpose

This Service Description will give potential Access Seekers interface and interoperability details of the L2 connectivity services that Access Providers will make available. For Access Providers, these Service Descriptions will be major guidelines for the development of their network architecture and network functionality, capability and reliability.

1.2 High Level Principles

The following principles have been agreed as the basis for the development of these standards. These principles may be revised as the standards progress.

- Transparency of service
- Future proof and end-user freedom
- MEF terminology and service templates will be used where appropriate
- Desirability for multi-access the customer's site
- Alignment to, but not restricted by, the ITP and revised ITP requirements
- Interoperability and common interfaces

1.3 Assumptions

The working group has assumed the following:

- These standards will be mandatory for all Access Providers.
- These standards will not be mandatory for access seekers who purchase dark fibre from the Access Provider.
- Each end-to-end service must be secure from other Access Seekers. That is, no one service should be able to affect the SLA of another Access Seeker. Initial focus on interoperability to provide Access Seekers with a level of confidence that:
    - They can use the same equipment to consume layer 2 services from different Access Providers
    - They can offer similar services nationally via different Access Providers. This should included end-to-end service interoperability for items such as transparency, MTU size, CoS support etc.

2 References

[1]	OFCOM Ethernet Active Line Access: Updated Technical Requirements, 3rd March 2009
[2]	NICC ND 1642 Requirements for Ethernet Interconnect and Ethernet ALA, 2009-06
[3]	Communications Alliance, Wholesale Service Definition Framework – Ethernet, Release 1, Dec. 2009
[4]	MEF 6.1 Ethernet Services Definitions – Phase 2, April 2008
[5]	MEF 10.2 Ethernet Services Attributes Phase 2, October 2009
[6]	MEF 23 Class of Service Phase 1,
[7]	MEF 26 External Network Interface (ENNI) – Phase 1, January 2010
[8]	TCF UFB Working Party Discussion Paper on Option 82 – Dec 2010
[9]	Broadband Forum TR101 Migration to Ethernet-based DSL aggregation

3 Key words, Abbreviations and Definitions

3.1 Key words and abbreviations

CBS	Committed Burst Size
CIR	Committed Information Rate
CO	Central Office
CoS	Class of Service
CPE	Customer (End-user) Premises Equipment
EAS	Ethernet Aggregation Switch
EBS	Excess Burst Size
EIR	Excess Information Rate
ELA	Ethernet Line Access
EMA	Ethernet Multicast Access
HG	Home Gateway
IGMP	Internet Group Management Protocol
LFC	Local Fibre Company
MEF	Metro Ethernet Forum
E-NNI	External Network-Network Interface
NID	Network Interface Device
OLT	Optical Line Terminal
ONT	Optical Network Terminal
OVC	Operator Virtual Circuit
POI	Point of Interconnect
QoS	Quality of Service
UNI	User-Network Interface

3.2 Definitions

Please refer to Annex 5 - FTTP Terminology for definitions of the terms used in this Service Description. A brief overview of the Ethernet service concepts and service types (and their attributes) as defined by the Metro Ethernet Forum (MEF).

4 Scope

This Ethernet Access Services Description covers both point-to-point Ethernet Line Access (ELA) services and point-to-multipoint Ethernet Multicast Access (EMA) services.

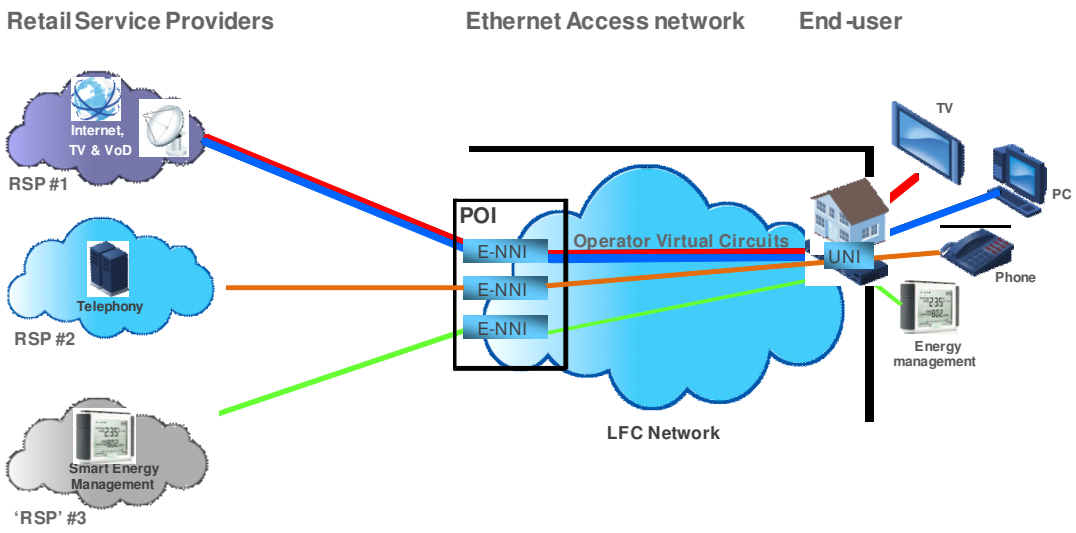
4.1 Any Service Provider to any End-user capability

The products specified in this document are designed to offer a NGN model. The ITU defines NGN as follows:

> *A Next Generation Network (NGN) is a packet-based network able to provide services including Telecommunication Services and able to make use of multiple broadband, QoS-enabled transport technologies and in which service-related functions are independent from underlying transport-related technologies. It offers unrestricted access by users to different Service Providers. It supports generalised mobility which will allow consistent and ubiquitous provision of services to users*

The diagram below visualizes the any-to-any model: any End-user is able to receive multiple services from multiple Service Providers simultaneously. Please note that the any-to-any capability still allows End-users to receive all their services from a single Service Provider if they wish.

Figure 1: Any-to-any Model



Note: A Virtual Circuit is an association between a UNI and an E-NNI and does not imply a particular build or design.

4.2 Build on MEF, OFCOM and Communications Alliance work

OFCOM in the UK has, through industry consultation, developed a comprehensive set of requirements for wholesale, open-access Ethernet connectivity products, in their terminology "Ethernet Active Line Access" or "Ethernet ALA". NICC (the UK Network Interoperability Consultative Committee) have further developed these requirements into "Requirements for

Ethernet Interconnect and Ethernet ALA. The OFCOM and NICC documents reflect the requirements of a wide range of UK Service Providers.

In Australia, the Communications Alliance, a group comprising of most Australian network operators and service providers, have drafted an Ethernet Wholesale Service Definition framework, which has been used as a basis for NBNCo's Fibre Access Service.

Both OFCOM and the Communications Alliance's work relied heavily on Ethernet service descriptions and templates developed by the Metro Ethernet Forum and other international standardisation bodies. These standards are expected to continue to be updated over time and this framework allows for new standards to be supported seamlessly as they are introduced.

The TCF Working Party has agreed to take MEF, OFCOM and NBNCo's product and service specifications as the basis for this service description.

4.3 Minimum set of Ethernet Access products

This document provides specification of a framework for a *minimum* set of Ethernet access products that shall be available. However, Access Providers have the option to offer Access Seekers a wider choice of products.

This Ethernet Access Service Description focuses on the technical service parameters, and does not address the parameters and service levels terms applying to supporting operational processes, or to service availability. These are subject to commercial agreements being negotiated between Crown Fibre Holdings and respondents to the ITP. The definition of the supporting operational construct together with service level terms would normally be included in Operations Manuals and Service Level Terms separate to the Service Description. However because of the critical nature of the traffic SLA and its relevance to technical service performance this has been included in this document.

5 Service Definition Framework

This section describes the network architecture, service demarcation points and service components to be offered.

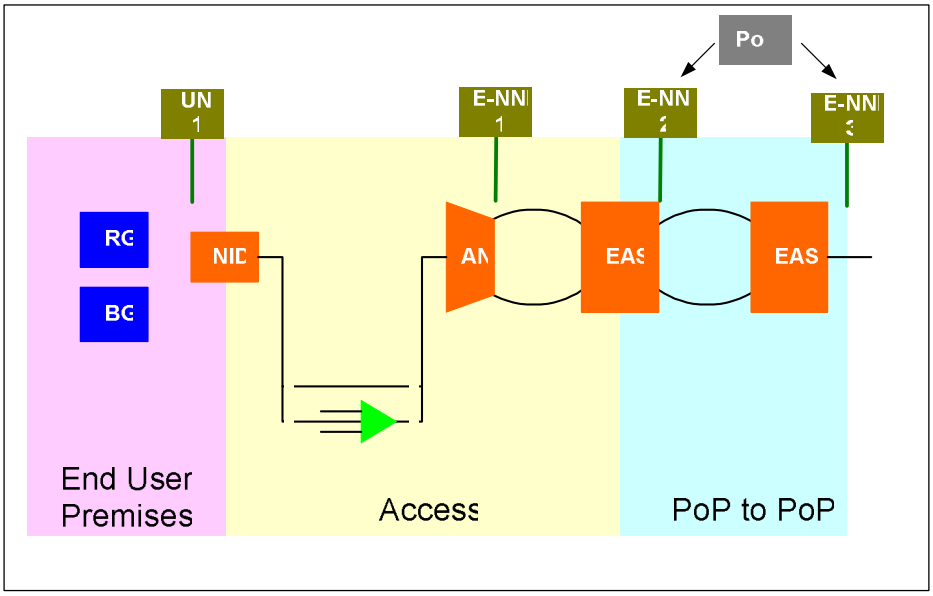
This document uses:

- Metro-Ethernet Forum (MEF) standards and terminology to describe Ethernet services layer. Note this does not imply a physical design and solution.
- Broadband Forum (BBF) standards to describe the access architecture. Note that this does not imply a particular physical architecture or design, simply the functions that occur in an access network.

5.1 Architecture and Demarcation Points

The diagram below shows the general architecture of an Access Provider network and potential interface points for Access Seekers to connect their service elements to.

Figure 2: Access Provider Network Architecture Per LFC Candidate Area



5.1.1 Network Interface Device (NID)

The Network Interface Device (NID) is provided by the Access Provider and is located in the End-user premises. The NID terminates the physical access fibre and implements the User Network Interface (UNI) which is the physical and logical demarcation point for the service. The NID may be a PON ONT, active Ethernet Demarcation Device or something similar.

5.1.2 Physical Access

Physical access provides the connection between the End-user premises and the Access Provider network. The access fibre terminates on the NID at the End-user premises and on

the AN in the Access Provider network. The access bandwidth determines the maximum capacity available for all services together provided to the premises.

Physical access shall be provided over the UFB Network.

The amount of dedicated bandwidth for each End-user is determined by the CIR bandwidth purchased by Service Providers for each OVC to each End-user (see next section).

Bandwidth management should assure that between the End-user UNI and each Service Provider's E-NNI the CIR bandwidth commitments are honoured at all times.

5.1.3 Access Node (AN)

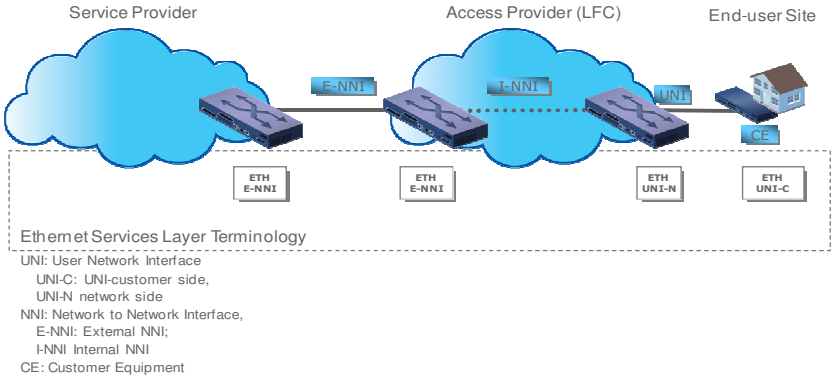
The Access Node (AN) terminates the physical access fibre in the Access Provider network. The AN lights the fibre and implements that layer 2 functional aspects of the service.

5.1.4 Ethernet Aggregation Switch (EAS)

The Ethernet Aggregation Switch performs the TR-101/156 aggregation functions and will combine and manage traffic from a number of Access Nodes. There may be one or more layers of aggregation in an Access Provider network depending on the individual geographic and network topology requirements.

The EAS implements the External-Network Network Interface (E-NNI see diagram below) which is the physical and logical demarcation point for the service. The E-NNI will be one or more physical 1 Gbit/s or 10 Gbit/s Ethernet interfaces, carrying multiplexed traffic streams from End-users.

Figure 3: External-Network Network Interface



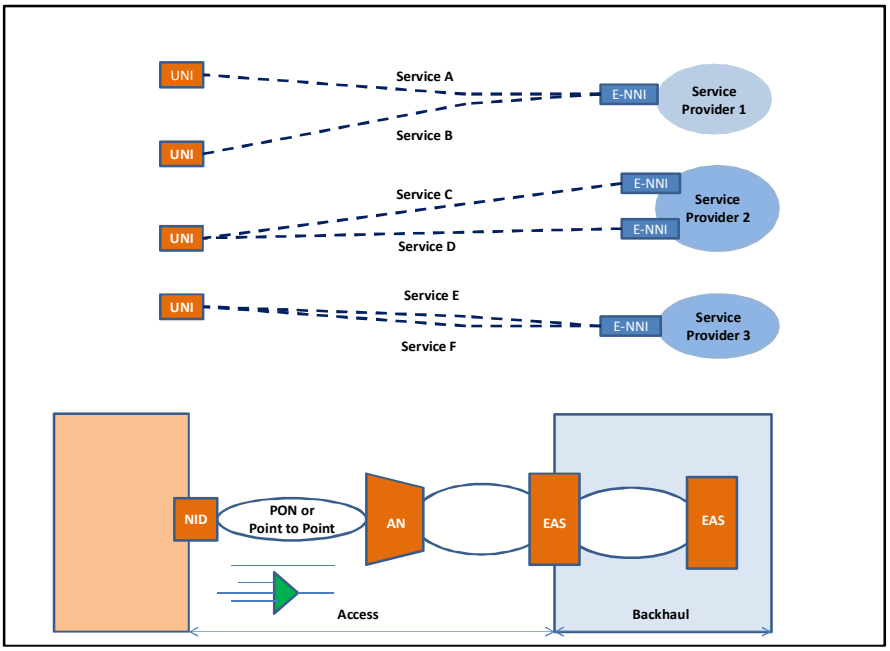
5.1.5 Backhaul

Backhaul provides an extension of the Ethernet Service and is required between EAS nodes and POIs when they are not Co-located. In this respect it is not a separate product but simply delivers the Ethernet Service to the POI with the service performance parameters defined in clause 6.6.

5.2 Discrete Products

The following diagram shows how the different service components are connected to provide a complete Layer 2 Service that Access Seekers can use to deliver end-to-end services to End Users.

Figure 4: Layer 2 Service



In a multi-service solution an End User can have one or more UNIs, and subscribe to one or more services supplied by the same or different Access Seekers.

5.2.1 User to Network Interface (UNI)

A UNI is the boundary between the User and the Network.

Access Seekers will require exclusive use of the UNI.

5.2.2 Handover Connection

The Handover Connection includes the following items:

- E-NNI
- Bandwidth (1 Gbit/s, 10 Gbit/s etc.)
- Fibre from EAS to OFDF

5.2.3 Operator Virtual Circuit (OVC)

The OVC is an association between a UNI and an E-NNI. The term OVC originates from MEF26 (ENNI) and is similar to an Ethernet Virtual Circuit (EVC) in MEF 6.2, which is an association between two UNI's.

The OVC service attributes and parameters (e.g. CoS, VLAN, bandwidth profile etc) are described in section 6.

The OVC for point-to-point Ethernet Line Access (ELA) Services supports unicast delivery of Ethernet service frames.

A point-to-multipoint OVC for Ethernet Multicast Access (EMA) services is described in section 7.

Services can be demarcated as follows:

- One OVC service per UNI
- One OVC service per VLAN on an UNI

5.3 Monitoring and Service Integrity

Monitoring uses Ethernet OAM features and is an optional (commercial) service that could provide services at the following levels:

1. Fault investigation, i.e. interface for proactive fault detection and resolution. For example this could be embedded in a service to reduce costs from 'faults not found' or speed up resolution.

2. Reporting, i.e. provide ongoing monitoring and reporting both for premium SLAs and customer information.

3. Integration, i.e. allow Access Seekers to integrate their own OAM systems to allow them to use their own tools for reporting and monitoring.

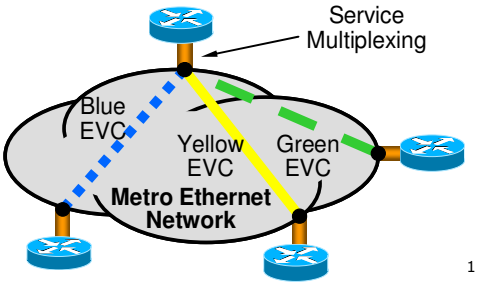
Refer to section 9 for details.

6 Service Types and Attributes

6.1 Ethernet Access Virtual Private Line (E-AVPL)

The E-AVPL service type is a virtual point-to-point service between an E-NNI and a UNI. The UNI can be shared by multiple E-AVPL services. Each End-user has its own E-AVPL services.

Figure 5: E-AVPL Service Type



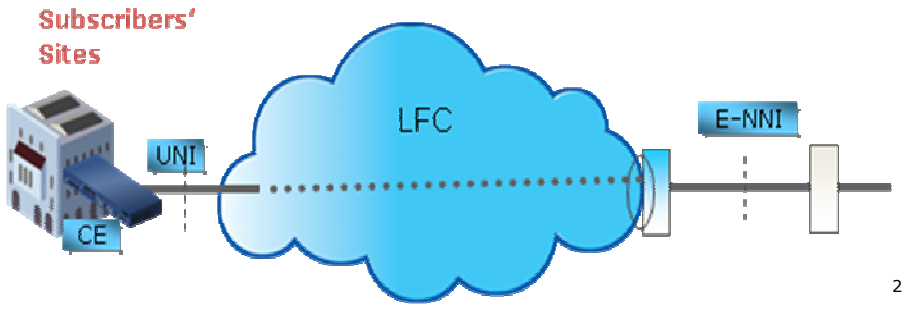
[1]

The mass market service profile in Annex 2 is based on an E-AVPL service type. The ranges of attribute values required to be offered by LFCs for defined End-user segments can be found in the Service Profiles in Annex 1-4.

6.2 Ethernet Access Private Line (E-APL)

The E-APL service type provides a transparent circuit between the UNI and an E-NNI. It is useful for any connection that requires a high degree of transparency in terms of either layer 2 control protocols, broadcast MAC addresses, VLANs or Ethertypes. Example of where E-APLs are commonly used include: Data Centre connections, Retail Service Provider connections to Multi-Dwelling-Units and services where Ethernet fail-over mechanisms are required.

Figure 6: Ethernet Access Private Line



[2]

The Business Service Profiles in Annex 3 and 4 are based on an E-APL service type. The ranges of attribute values required to be offered by LFCs for defined End-user segments can be found in the Service Profiles in Annex 1-4.

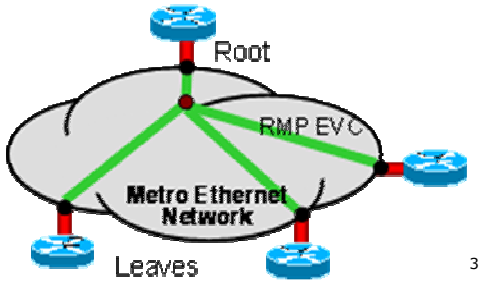
[1] Used with the permission of the Metro Ethernet Forum
[2] Used with the permission of the Metro Ethernet Forum.

6.3 Ethernet Virtual Private Tree (EVP-Tree)

The EVP-Tree service type is a rooted multi-point service, allowing all End-users to exchange traffic with the 'root' (the E-NNI) but not with each other.

The EMA service described in section 7 uses a constrained version of an EVP-Tree service construct. Whereas a MEF EVP-Tree service support Unicast, Multicast and Broadcast service frames, the EMA service only supports Multicast service frames between root and leaf and only IGMP control messages between leaf and root. Chapter 6 of the Broadband Forum's TR-101 describes the requirements.

Figure 7: Ethernet Virtual Private Tree (EVP-Tree)



[3]

6.4 Traffic Separation at the UNI and E-NNI

Access providers will offer both 802.1ad and QinQ at the E-NNI. Tag assignments are done by the Access Provider.

Business E-APL services are identified at the E-NNI using only the S-tag (outer or only tag), the C-tag is transparent to the Access Provider Network. Mass market E-AVPL services may be identified at the E-NNI by a combination of S-tag and C-tag to provide greater scalability.

Three UNI addressing modes are possible – tagged, untagged or CE-VLAN transparent:

- Tagged - by default, mass market E-AVPL services will be configured as a dot1q tagged interface. Traffic separation uses C-tags only. Each C-VLAN is mapped to a separate E-AVPL or Multicast service instance.
- Untagged - if an Access Seeker reserves a UNI for their exclusive use they may request that it be untagged. An untagged UNI can support one E-AVPL service instance and/or one multicast services instance.
- CE-VLAN transparent – Business and Business Premium E-APL services are configured with a CE-VLAN transparent UNI. This means that C-tags are transparent to the Access Provider network.

6.5 Class of Service

Class of Service defines how traffic is treated when there is overbooking for resources. Examples of techniques used are:

[3] Used with the permission of the Metro Ethernet Forum

- Strict prioritisation, where any higher priority packets/frames are forwarded before any lower priority ones.
- Weighted, where higher priority packets/frames are routed more frequently (at a specified rate, such as 3:1) than lower priority ones.

It is possible to define CIR/EIR for a particular Class of Service.

Note that there are no standards for allocating CoS budgets within a partial network and it would be difficult to define an appropriate performance for the L2 Service. The Australian Communications Alliance INDUSTRY GUIDELINE G632:2007 "Quality of Service parameters for networks using the Internet Protocol" is a relevant reference document.

The approach taken for the ELA service is to consider all frames to be of one of two types:

- High Priority i.e. drop ineligible ('Green'), or
- Low Priority i.e. drop eligible ('Yellow')

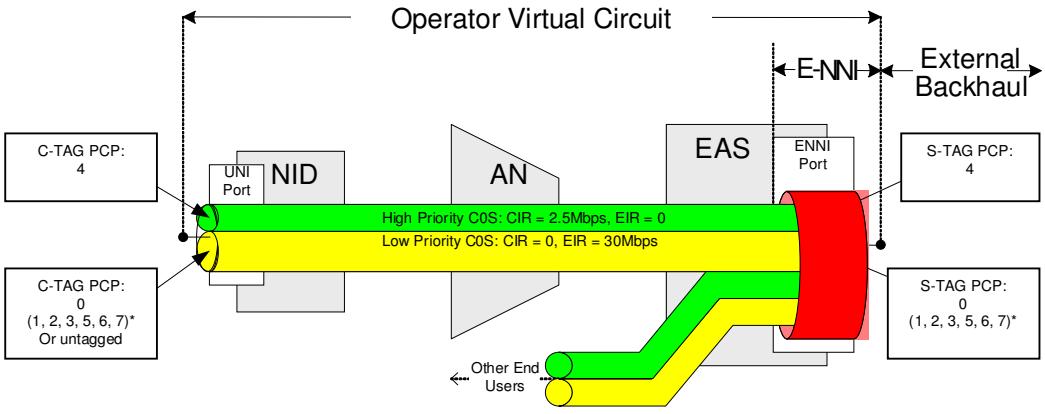
6.6 Bandwidth Profile

The bandwidth profile for individual EAS instances is summarised in the following table and diagram.

Table 1: Bandwidth Profiles

Class of Service	Bandwidth	PCP Mapping	Colour	Discard Eligible	Performance Attributes
High Priority	CIR > 0 EIR = 0	4	Green	No	FD <= 5ms FDV <= 1ms FLR <= 0.1%
Low Priority	CIR = 0 EIR > 0	0 (1,2,3,5,6,7)*	Yellow	Yes	FLR <= 2%

*PCP marking 1, 2, 3, 5, 6 and 7 are reserved for future expansion of the CoS model. They are temporarily mapped to the Low Priority CoS.



**PCP marking 1, 2, 3, 5, 6 and 7 are reserved for future expansion of the CoS model. They are temporarily mapped to the Low Priority CoS.*

Note: the CIR and EIR values in the above diagram are for illustrative purposes only.

6.7 Bandwidth and Colour marking

High Priority traffic will be policed up to a Committed Information Rate (CIR) and Committed burst Size (CBS) of the Ethernet Access service and classified as GREEN (Refer to MEF 23 for information on colour information). The Access Provider will deliver all GREEN traffic within the specified performance metrics. Any traffic that the Access Seeker marks as high priority but is above CIR will be classified as RED and discarded.

Low priority traffic will be policed up to the Excess Information Rate (EIR) and Excess Burst Size (EBS) of the ELA service and marked YELLOW. The Access Provider should deliver YELLOW traffic if there is sufficient capacity in the network. Any traffic that the Access Seeker marks as low priority but is above EIR will be marked RED and discarded.

6.8 PCP mapping and Discard Eligibility

Discard Eligible Identifier (DEI) is bit contained with an 802.1ad frame header and can be used to indicate whether a frame is in-profile or out-of-profile. DEI will not be used in the EAS as it will not be present on the UNI (which is a single tagged 802.1q interface) and is not supported by all networking equipment.

PCP (the p-bits in the VLAN header) can be used to indicate CoS and/or used to indicate whether traffic is in-profile or out-of profile.

The recommendation is to use PCP = 4 to indicate that traffic is high priority i.e. discard in-eligible (GREEN), and PCP = 0 to indicate that traffic is low priority i.e. discard eligible (YELLOW). Other PCP values are reserved for future use but will be mapped to the Low Priority traffic class in the interim.

For the mass market Ethernet Access service this PCP marking scheme is only mandatory for the S-tag on ingress at the E-NNI and on the C-tag on ingress at the UNI i.e. its only purpose is to indicate to the Access Provider what priority the frame should receive.

For a business and business premium ELA service, which must support 802.1p transparency and should allow Access Seekers complete freedom to use PCP bits however they want, a slightly different approach is needed. It is recommended that the UNI supporting a business premium service should ignore the C-tag PCP bit and by default classify all ingress traffic as GREEN i.e. EIR = 0.

6.9 Overbooking at the E-NNI

The Access Seeker may choose to overbook the E-NNI. For Traffic to be considered to be within contract (i.e. subject to SLA) it must be both within CIR at the individual service level and within aggregate E-NNI bandwidth.

Low Priority traffic (≤EIR) can be oversubscribed at the E-NNI.

6.10 Guaranteed bandwidth (High Priority CoS)

It is possible, and even advantageous, to overbook CIR, both implicitly by the Access Seeker (to achieve the availability figure) and explicitly by the Access Provider to minimise costs. This is more advantageous the more aggregation nodes and the further the distance travelled. However, the performance requirements (see section 6.6) for properly marked frames within a contracted CIR bandwidth shall be met at all times.

6.11 Shared Bandwidth (Low Priority CoS)

Shared bandwidth provides a common pool of bandwidth to a number of users. There is no guarantee that at any time any spare bandwidth is available to a user, but it is expected that scheduling and other fair management techniques will ensure all users get fair access to this pool over relatively short periods.

The Ethernet Access Service specifies EIR bandwidth only in terms of a maximum Frame Loss Ratio (FLR).

7 Ethernet Multicast Access (EMA) Services

7.1 Introduction

Multicast functionality is desirable to make efficient use of network resources when delivering broadcast content. The Ethernet Multicast Access (EMA) service provides a multicast enabled layer 2 service. It is a separate service type to the ELA (Ethernet Line Access) service. Both ELA and EMA services can co-exist on the same network and on the same physical UNI and NNI.

The service should be based on the end-user experience to ensure that the viewer has a good television experience.

Multicast Use Cases: Mass Market TV Services

The EMA service is intended to be used for mass market TV, and is based on the MEF EVP-Tree service construct and the BBF Multicast requirements in chapter 6 of TR-101. It is designed to be used by Access Seekers as a Multicast delivery mechanism for Broadcast TV services.

The EMA service is a Layer 2 service that includes some Layer 3 inspection.

7.2 Exclusions

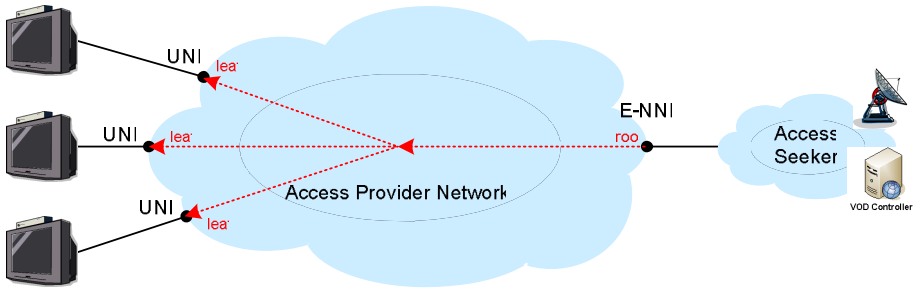
- It is assumed that Layer 3 multicast mechanisms (e.g. PIM/SM) are not part of the LFC network functionality.
- IGMP Control Plane Interoperability.
- Multicast Listener Discovery (MLD).

7.3 EMA for Mass Market TV services

The EMA service provides point-to-multipoint connectivity between one NNI and one or more UNI as shown in the diagram below. The NNI is known as the "root" and ingress service frames can be forwarded to some or all UNIs. The UNI is known as a "leaf" and ingress service frames can only be forwarded to the root i.e. there will be no connectivity between UNIs.

The EMA service is implemented as a separate service instance to the point-to-point ELA (Ethernet Line Access) service although it can share the same physical UNI and NNI interfaces as ELA services.

Figure 8: EMA for Mass Market TV Services



7.4 VLAN Model

The EMA service will use a dedicated N:1 multicast VLAN model as described in section 6.2 of TR-101. The EMA service will be identified at the NNI with a VLAN_ID. The EMA service can share a UNI with other services using VLAN_ID to identify each individual service instance. Provided a Retail Service Provider requests it an EMA and an ELA service should be combined onto the same VLAN_ID at the UNI to simplify VLAN requirements in the customer equipment.

7.5 Frame Delivery

7.5.1 Downstream Direction:

Frame delivery for multicast traffic in the downstream direction is controlled by a Layer 3 control plane e.g. IGMP or MLD. At the NNI, all properly formatted ingress frames with a multicast destination MAC address are flooded to the UNIs which have requested membership of that specific Multicast group.

At the NNI, Unicast ingress frames are discarded.

7.5.2 Upstream Direction:

At the UNI, the only ingress frames that are mapped to the EMA service are Layer 3 control messages.

Ingress frames received at a UNI are not delivered to another UNI.

7.6 IGMP and MLD Support

The EMA service will support IGMP v2 (RFC2236) and v3 (RFC3376) for IPv4 through the implementation of IGMP snooping.

The EMA service will support MLD v2 for IPV6 (RFC3810) through the implementation of MLD snooping.

The EMA service should implement the recommendations in "Considerations for Internet Group Management Protocol (IGMP) and MLD Snooping Switches" (RFC4541).

IGMP and MLD include "source filtering", which enables a network to use the source IP address of a multicast frame to determine frame forwarding.

The flooding of Ethernet Multicast Frames within an EMA service instance is controlled by the use of an IGMP/MLD control plane. The IGMP/MLD control plane uses the snooping function to monitor IGMP and MLD traffic and adjust replication filters so that frames are only delivered to those UNI that have specifically requested membership to that multicast group.

IGMP is an IPv4 specific protocol. MLD is an IPv6 specific protocol. The EMA service must ensure that the IGMP snooping function does not disable IPv6 multicast functionality and that the MLD snooping function does not disable IPv4 Multicast functionality.

All downstream and upstream IGMP and MLD messages used to control membership of groups within an EMA service instance are transported within the VLAN associated with that EMA service instance.

7.7 Bandwidth Profile and CoS for EMA

As the EMA service is intended for use as a mass market TV service, the bandwidth requirements are highly asymmetric. The downstream bandwidth profile at the NNI needs to support the total number of TV channels an Access Seeker in offering. The upstream bandwidth at the UNI can be very small as it only needs to allow for IGMP control messages.

The EMA service will support high priority Class of Service only.

7.8 Optimising the TV User Experience

It is recommended that fast release technology is adopted, although it is acknowledged there is no technical standard established for this technology.

The service should be based on the end-user experience to ensure that the viewer has a rapid and smooth channel change experience.

8 Traffic Management and Security

8.1 General principles

All traffic in the Access Provider network flows either from UNI to E-NNI or from E-NNI to UNI. Direct UNI to UNI traffic is outside the scope of this document as is E-NNI to E-NNI traffic (i.e. between one Access Seeker and another Access Seeker).

The Access Provider must, as far as possible, be entirely neutral with respect to the traffic it carries, i.e. the Access Provider, as a Layer 2 carrier shall not inspect the contents of the Access Seekers' End-users' unless it is necessary to do so to deliver IGMP snooping, and Lawful Intercept.

All invalid traffic must be silently dropped as soon as it is detected. Invalid traffic refers to frames with invalid FCS, destination or source address, short frames or long frames.

Class of Service marking on all packets received from Access Seeker by an Access Provider must be preserved across the Access Provider network.

8.2 E-NNI Redundancy

As the E-NNI is the interface between the Access Provider and Access Seeker it may be appropriate to specify minimum standards for redundancy. A single physical E-NNI link may support a large numbers of services and therefore could significantly contribute to availability.

Therefore the Access Providers must be able to support E-NNI link redundancy if requested by an Access Seeker.

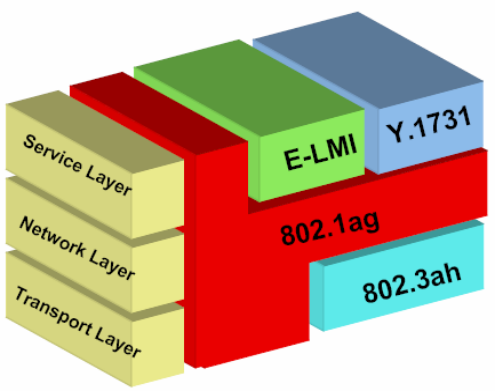
The typical mechanism for implementing Ethernet link redundancy is known as link aggregation, or LAG, which is based on the Link Aggregation Control Protocol (LACP). Link aggregation is typically used to aggregate together one or more physical links into a LAG group.

9 Operations, Administration and Maintenance (OAM)

The MEF specifies a number of OAM protocols with various applications. The figure below illustrates these protocols. The key protocols of interest for layer 2 services are:

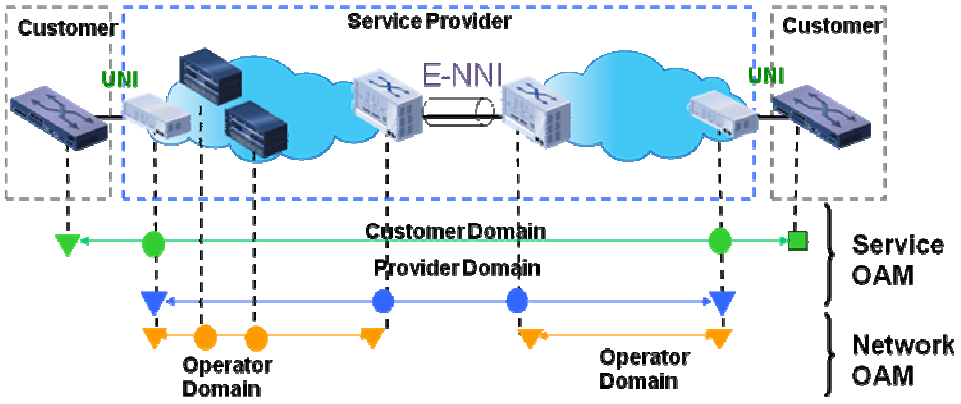
- 802.3ah – a link (network) layer protocol which is typically less used in wholesale networks.
- 802.1ag – an end-to-end (service) protocol used as a keep-alive to monitor circuits between UNIs.
- Y.1731 – an end-to-end protocol similar to 802.1ag that allows performance monitoring reporting, including frame delay (latency), inter-frame delay variation (jitter) and frame loss.

Figure 9: MEF OAM structure[4]



The diagram below shows how 802.1ag and Y.1731 work across a wholesale network to provide end-to-end Service OAM for fault management and performance reporting:

Figure 10: End-to-end OAM with at the service layer (802.1ag/Y.1731) and network layer (802.3ah)[5]



[4]Used by the permission of the MEF
Used by permission of the MEF

All Access Providers should provide transparency to 802.1ag and Y.1731 on all services. Participation in 802.1ag and Y.1731 domains, as well as 802.3ah transparency should be optional.

ANNEX 1 – Service Profiles

1.1 Introduction

This Annex provides the service description options for different end-user segments. End-user segments differ in terms of their needs with respect to Service characteristics, SLAs and price. In order to optimise underlying cost for the segments, currently the following End-user segments have been identified:

- Mass market (Annex 2)
- Business (Annex 3)
- Business Premium (Annex 4)

A service includes one or more instances of the following components:

- The External Network-to-Network Interface (E-NNI), the set of policies and rules at the physical interface between the Access Provider network and the Access Seeker or Service Provider network
- The User-to-Network Interface (UNI), the physical properties of and policies and rules at a physical interface that performs the boundary between the End-user premises between the access network and Service Provider or End-user equipment on site. Note that it is possible for multiple UNIs to exist at a specific customer's site.
- Operator Virtual Circuits (OVCs), the association between E-NNI and the UNI.

1.2 External Network to Network Interface

The E-NNI is a generic component for all End-user segments. The table below shows the minimum service attributes for the E-NNI with all valid attribute value ranges:

Service attribute	Valid attribute values
UNI Identifier	OSS/BSS
Physical Medium	1000BASE-LX, 10GBASE-LR
Speed	1 Gbit/s or 10 Gbit/s
Mode	Auto-negotiate
MAC Layer	IEEE 802.3-2005
ENNI MTU Size	9100 bytes
Service Multiplexing	Yes
Bundling	Yes
All to One Bundling	No
CE-VLAN ID for untagged and priority tagged Service Frames	NA
Maximum number of OVCs	No maximum
Ingress Bandwidth Profile Per OVC	See OVC section for options
Egress Bandwidth Profile Per OVC	See OVC section for options
L2CP Processing	Peer aggregation control frames

Attribute Notes

- Ingress profile per OVC is defined by the specific OVCs.

- Both QinQ and 802.1ad will be supported on the E-NNI.
- The Ethernet MTU includes: MAC header, the Ethertype or Length field, any VLAN tags, the payload and FCS.
- The Ethernet MTU excludes: Preamble and Inter-Frame-Gap.

ANNEX 2 – Service Profiles –Mass market

2.1 Introduction

The tables below show the minimum service attributes and valid attribute value ranges for the Mass market segment for the following valid service types.

- E-AVPL
- EVP-TREE

2.2 UNI – E-AVPL and E-Tree

Valid UNI attribute options for an E-AVPL or E-Tree are shown in the table below:

Service attribute	Valid attribute values
UNI Identifier	OSS/BSS
Physical Medium	100/1000Base-T
Speed	1000 Mbit/s
Mode	FDX
MAC Layer	IEEE 802.3-2005
UNI MTU Size	2000 bytes
Service Multiplexing	Yes
Bundling	No
All to One Bundling	No
CE-VLAN ID for untagged and priority tagged Service Frames	Yes, by negotiation
Maximum number of OVCs	10
Ingress Bandwidth Profile Per UNI	Not Allowed
Egress Bandwidth Profile Per UNI	Not Allowed
L2CP Processing	See OVC detail.

Attribute Notes

- Ingress bandwidth profiles only allowed on a per OVC or per CoS basis, not per UNI.
- Bundling is not allowed on the Mass Market service, but multiple single VLAN OVCs can be provided.

2.3 OVC

2.3.1 OVC per UNI & OVC Attributes - E-AVPL

Service attribute	Valid attribute values
UNI OVC ID	OSS/BSS
CE-VLAN ID/OVC Map	Yes. LFC specified
Access bandwidth	Subject to commercial arrangements
Maximum number of MAC addresses	16
OVC Type	Point-to-Point
OVC ID	E-AVPL-[Access Seeker ID]-123 OSS/BSS
UNI List	OSS/BSS
Maximum Number of UNIs	1
Maximum Number of OVCs at each NNI	802.1ad (4095 x 4095)
OVC MTU size	2000 bytes
CE-VLAN ID Preservation	No. However there must be a 1:1 mapping between UNI VID and NNI CVID
CE-VLAN CoS Preservation	Low priority is rewritten to PCP 0, and all high priority traffic will be preserved.
Unicast Service Frame Delivery	Unconditional * [to within the service CIR]. EIR traffic undefined except for Frame Loss Ratio. Refer to clause 6.6
Multicast Service Frame Delivery	Unconditional * [to within the service CIR]. EIR traffic undefined except for Frame Loss. Refer to clause 6.6
Broadcast Service Frame Delivery	Unconditional * [to within the service CIR]. EIR traffic undefined except for Frame Loss. Refer to clause 6.6
Layer 2 Control Protocols Processing	Peer IEEE 802.3x Mac Control Frames (PAUSE)
	Discard Link Aggregation Control Frames
	Discard IEEE 802.1x Port Authentication
	Discard Generic Attribute Registration Protocol (GARP)
	Discard Spanning Tree Protocol (STP)
	Discard a protocol multicast to all bridges in a bridged LAN
	Discard Link OAM
	Discard E-LMI frames
OVC Performance	See Service level agreement

Attribute Notes

- MEF 6.1 stipulates that all L2CPs for an E-AVPL service should be either peer or discard. Tunnelling is not a valid option.

- CE-VLAN ID preservation: This attributes means that CE-VLAN ID translation can occur, but a 1:1 VLAN mapping must still be maintained between the translated VLAN and the VLAN handed over at the ENNI.

2.4 Other Attributes

Service attribute	Valid attribute values
UNI Ethernet	
Ethernet Protocols	Ethernet II, 802.3, 802.1q
Untagged Frames	Sent to default OVC
Default OVC	Service Provider defined
Fibre Network Resiliency	No
Diverse Ring/Single Lead-in	No
Layer 2 Resiliency	No
Number of UNIs at premises	4
Number of VLANs per OVC	1
Additional Parameters	MAC should not be corrupted or modified, except when otherwise specified in this document.
	No MAC address range filtering
	LFC selects UNI VLAN IDs
	LFC selects NNI SVID/CVID mapping

2.5 EVP-TREE

Service attribute	Valid attribute values
UNI OVC ID	OSS/BSS
CE-VLAN ID/OVC Map	Yes. LFC specified
Access bandwidth	Subject to commercial arrangements
Maximum number of MAC addresses per UNI	16
OVC Type	Rooted-Multipoint
OVC ID	EVP-Tree-[Access Seeker ID]-123 OSS/BSS
UNI List	OSS/BSS
Maximum Number of UNIs	Unspecified
Maximum Number of OVCs at each NNI	4094
OVC MTU size	2000 bytes
CE-VLAN ID Preservation	N/A
CE-VLAN CoS Preservation	N/A
Unicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6

Multicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6
Broadcast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6
Layer 2 Control Protocols Processing	Discard all
	See Service level agreement
OVC Performance	

ANNEX 3 – Service Profiles –Business

3.1 Introduction

The tables below show the minimum service attributes and valid attribute value ranges for the Business market segment for the following valid service types:

Valid service types:

- E-APL

3.2 UNI –E-APL

Valid UNI attribute options for an E-AVPL or E-Tree are shown in the table below:

Service attribute	Valid attribute values
UNI Identifier	OSS/BSS
Physical Medium	1000Base-T
Speed	1000 Mbit/s
Mode	FDX
MAC Layer	IEEE 802.3-2005
UNI MTU Size	2000 bytes
Service Multiplexing	No
Bundling	No
All to One Bundling	Yes
CE-VLAN ID for untagged and priority tagged Service Frames	Transparent. All service frames mapped to one OVC
Maximum number of OVCs	1
Ingress Bandwidth Profile Per UNI	Not Allowed
Egress Bandwidth Profile Per UNI	Not Allowed
L2CP Processing	Not Allowed

3.3 OVC per UNI & OVC attributes- E-APL

Service attribute	Valid attribute values
UNI OVC ID	OSS/BSS
CE-VLAN ID/OVC Map	Transparent. All service frames at the UNI mapped to one OVC
Access bandwidth	To be specified, need to be granular enough yet practical
Ingress Bandwidth Profile Per OVC	To be specified, need to be granular enough yet practical
Ingress Bandwidth Profile per CoS Identifier	To be specified, need to be granular enough yet practical

Maximum number of MAC addresses	64
OVC Type	Point-to-Point
OVC ID	E-APL-[Access Seeker ID]-123 OSS/BSS
UNI List	OSS/BSS
Maximum Number of UNIs	1
Maximum Number of OVCs at each NNI	4095
OVC MTU size	2000 byte
CE-VLAN ID Preservation	Yes
CE-VLAN CoS Preservation	Yes
Unicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6.
Multicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6.
Broadcast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6
Layer 2 Control Protocols Processing	Peer IEEE 802.3x Mac Control Frames (PAUSE)
	Discard Link Aggregation Control Frames
	Discard IEEE 802.1x Port Authentication
	Discard Generic Attribute Registration Protocol (GARP)
	Pass Spanning Tree Protocol (STP)
	Discard a protocol multicasted to all bridges in a bridged LAN
	Discard Link OAM
	Discard E-LMI frames

3.4 Other Attributes

Service attribute	Valid attribute values
Ethernet Protocols	Transparent. All service frames at the UNI mapped to one OVC
Untagged Frames	Transparent.
Default OVC	No
Fibre Network Resiliency	Yes for businesses within defined areas and for priority users.
Diverse Ring/Single Lead-in	Yes for businesses within defined areas where requested.
Layer 2 Resiliency	Yes for priority users in defined areas.
Number of UNIs at premises	4
Number of VLANs per OVC	Transparent. All service frames at the UNI mapped to one OVC
Additional Parameters	MAC transparency

	No MAC Filtering
	LFC selects NNI SVID mapping

ANNEX 4 – Service Profiles – Business Premium

4.1 UNI –E-APL

Service attribute	Valid attribute values
UNI Identifier	OSS/BSS
Physical Medium	1000Base-T / 1000 Base LX / 1000 Base SX
Speed	1000 Mbit/s
Mode	FDX
MAC Layer	IEEE 802.3-2005
UNI MTU Size	9100 bytes
Service Multiplexing	No
Bundling	No
All to One Bundling	Yes
CE-VLAN ID for untagged and priority tagged Service Frames	Transparent. All service frames mapped to one OVC
Maximum number of OVCs	1
Ingress Bandwidth Profile Per UNI	Not Allowed
Egress Bandwidth Profile Per UNI	Not Allowed
L2CP Processing	See OVC table

4.2 OVC per UNI & OVC attributes - E-APL

Service attribute	Valid attribute values
UNI OVC ID	OSS/BSS
CE-VLAN ID/OVC Map	Transparent. All service frames at the UNI mapped to one OVC
Access bandwidth	To be specified, need to be granular enough yet practical
Ingress Bandwidth Profile Per OVC	To be specified, need to be granular enough yet practical
Ingress Bandwidth Profile per CoS Identifier	EIR = 0, CIR > 0
Maximum number of MAC addresses	Unlimited
OVC Type	Point-to-Point
OVC ID	E-APL-[Access Seeker ID]-123 OSS/BSS
UNI List	OSS/BSS
Maximum Number of UNIs	1
Maximum Number of OVCs at each NNI	4095
OVC MTU size	9100 byte

CE-VLAN ID Preservation	Yes
CE-VLAN CoS Preservation	Yes
Unicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6.
Multicast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6.
Broadcast Service Frame Delivery	Unconditional * [to within the service CIR]. Refer to clause 6.6.

4.3 Other Attributes

Service attribute	Valid attribute values
Untagged Frames	Transparent.
Default OVC	No
Fibre Network Resiliency	Yes if requested
Diverse Ring/Single Lead-in	Yes if requested
Layer 2 Resiliency	Yes if requested
LAG	Yes if requested
Multi-chassis LAG	No
Number of UNIs at premises	1
Number of VLANs per OVC	Transparent. All service frames at the UNI mapped to one OVC
Additional Parameters	MAC transparency
	No MAC Filtering
	LFC selects NNI SVID mapping

ANNEX 5 - Option 82 - Discussion Paper

Author: Peter Coleman
26 November 2010

This discussion paper was presented to the UFB Layer 2 Working Party for consideration and has only been included into this document as a reference paper.

1. Overview

1.1 This discussion looks at the creation of non-repudiated credentials through the use of network inserted unique identifiers that can be used by RSPS to identify End Users, and particularly the TR-156 Option 82 parameter.

1.2 The purpose of the network-inserted unique identifier is to provide a non-repudiated (non-spoofable) credential to the RSP so they have a strong level of confidence that the traffic/service is coming from that end user or a particular location.

1.3 TR-156 recommends two options for this:

- The vlan combination (svid/cvid)
- The Logical Port ID inserted into DHCP Option 82 or PPPoE Calling Station ID field.

2. Why a network unique identifier?

2.1 Geographical confidence:
This is particularly useful for emergency services since the origin of a call is known irrespective of what the End User might (or might not) say. CPE-based credentials have been problematic overseas in this respect.

2.2 Authentication, Authorisation, Auditing and Accounting:
There are very tight Consumer Guarantees and Commerce Act issues around ensuring that you give the right services to the right customer and bill the correct customer the correct amount.
A key advantage of network-inserted unique identifiers is that they can usually be published to a AAA system, such as Radius, which then uses industry standard tools to provide these functions.

2.3 Non-repudiated Credential:
As this is inserted by the network it cannot be corrupted or altered by end user.
User-based credentials may either be compromised by the CPE being compromised or simply spoofed.
User-based credentials also require a complex and secure credential distribution mechanism and may be difficult for users to use – a lot of Service Providers have turned this off in DSL-broadband because of the complexity in getting customers to programme a wide variety of CPE when the credentials change.

2.4 Usage Billing:
Most Internet services today use some form of usage counting that need to be tied back to the End User – either in charging per volume or some kind of usage cap. These control/charging mechanisms require a secure mechanism for counting traffic on a per site basis – typically using a AAA system or similar. Network credentials have proven more secure for this than user credentials – and billing requires a high level of security.

VLAN ID or Logical Port ID (Option 82)

	Pros	*Cons*
VLAN	Must be provided in order to work, so exists regardless. Identifies unique services.	Harder to use as dynamic credential – requiring more expensive Provider Edge and more complex provisioning*.
Port ID	Identifies site/location. Relatively simple to integrate with AAA	Does not identify unique service, only site

* *Based on today's experience. Most Service Providers using vlan ids use static provisioning of sub interfaces on Provider Edge, which is much less flexible than directory-managed policies. However unsure if this is a legacy limitation (which presumably would continue to exist for some time).*

3.1 Based on feedback from customers, the two main mechanisms used by vlan broadband services today (Enhanced UBA) are:

- Static sub-interfaces per svid/cvid which require per user configuration of the edge; or
- Dynamic sub-interfaces which are configured using AAA policies based on Port ID.

3.2 With fibre I would expect dynamic sub-interfaces to be preferred but it might be possible to do this using svid/cvid. However if it is possible it is likely to depend on Service Provider refresh – which suggests that if Service Providers did not support Port ID they would at least initially deploy static sub-interfaces. This would be a barrier to entry for providers who rely on dynamic interfaces.

3.3 In practice these identifiers are complementary and may be more useful in some scenarios than others.

3. OSS/BSS implications – Option 82 in context

4.1 Although this document is primarily concerned with Logical Port IDs, it is useful to see how Logical Port IDs map to all external or published identifiers used in LFC Layer 2 services and under what circumstances they might change.

4.2 This paper does not consider the plant information or internal references required by the LFC.

4.3 Definition of different Identifiers

4.4 The name for these fields may be different for different groups or organisations.

ID	**Purpose**
Access Service ID	FAB reference for the physical access to an End User site.
Logical Port ID	TR-101 logical port id. Provides a network-inserted unspoofable unique reference to the access. 1:1 mapping to Access Service ID.
Service ID	FAB reference for each service sold. It maps to an E-APL/E-AVPL/Multicast OVC. The network attributes associated with each OVC are the UNI and UNI

ID	Purpose
	VLAN ID (End User location) and the ENNI VLAN ID (RSP handover).
UNI	Physical port that service is delivered to at End User site.
UNI VLAN ID	VLAN ID(s) that service is delivered to at End User site. Not required for E-APL.
ENNI VLAN ID	SVID/CVID VLAN IDs that service is delivered to at ENNI. Only SVID for E-APL.
ENNI Service ID	FAB reference for the physical ENNI. May include multiple components, such as: • Handover Connection • Handover Fibre(s)

4.5 FAB references are used for Fulfil (provisioning, MACS), Assure and Billing to provide a common reference between the LFC and the RSP and included in eTOM transactions to identify what service/component the transaction is for.

4.6 Operational Impact to Unique Identifiers

4.7 The following table shows what Identifiers will change under standard operational activities. Some of these will be subject to the specific design of the service – it may become a balance in whether the complexity is in the RSP or LFC.

4.8 For example, if the logical port id is the MAC address of the ONT then the circumstances in which it changes will be more limited. If it is a geographical site id then it would change under very different circumstances.

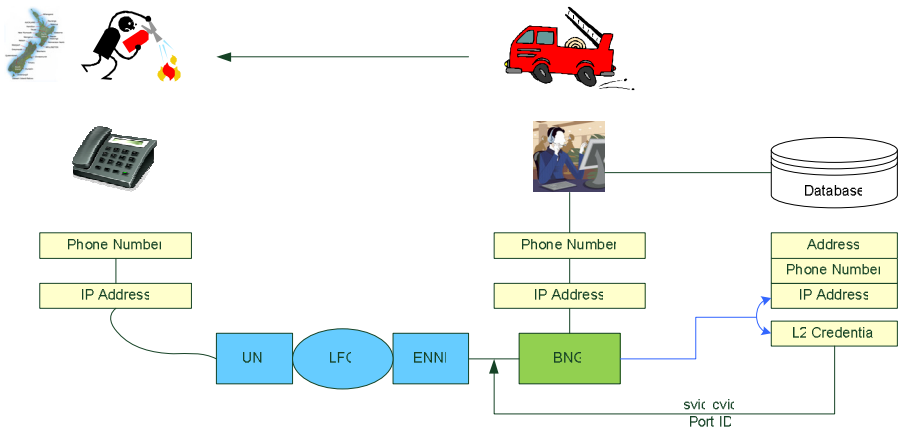
4.9 Note that unless the LFC does ENNI VLAN remapping (which is not a requirement), the ENNI VLAN ID will change under a significant number of operational scenarios.

Scenario	Unaffected	Affected
Provision Access	Service ID UNI UNI VLAN ID ENNI VLAN ID ENNI Service ID	Access Service ID Logical Port ID
Provision Service	Access Service ID Logical Port ID ENNI Service ID	Service ID UNI UNI VLAN ID ENNI VLAN ID
Move Address	Access Service ID Logical Port ID Service ID UNI UNI VLAN ID ENNI VLAN ID ENNI Service ID	-
Faulty UNI	Access Service ID Logical Port ID Service ID UNI VLAN ID ENNI VLAN ID ENNI Service ID	UNI
Faulty ONT	All	-

Scenario	Unaffected	Affected
Faulty Access Node Port/Card	Access Service ID Service ID ENNI Service ID	Logical Port ID UNI UNI VLAN ID ENNI VLAN ID
Network Grooming	Access Service ID Service ID UNI UNI VLAN ID	Logical Port ID ENNI VLAN ID ENNI Service ID
Remapping - Move service to new ENNI	Access Service ID Logical Port ID Service ID UNI UNI VLAN ID	ENNI VLAN ID ENNI Service ID
Churn: Move service to new RSP	Access Service ID Logical Port ID	Service ID UNI UNI VLAN ID ENNI VLAN ID ENNI Service ID

4. Emergency Services Requirement

5.1 Emergency Services is a well-understood requirement for a location-based service, refer to diagram below:



5.2 In order for the Emergence Services CSR to dispatch the emergency services they need to know what physical location the service should be sent to. Several solutions are possible, refer to the below table:

Verbal Description	Assumes caller is able to be heard or understood, and is open to caller being mistaken deliberately or accidentally.
Phone Number	In an IP world this is less useful because a Phone Number may not be tied to a physical location or even a single device.
IP Address	This is only useful if it can be traced to a physical location. A common way to do this is to have a database record that associates the IP Address to the Layer 2 Credential

NB: This excludes GPS-based IDs which is more appropriate for mobile solutions, requires CPE support and may require some lookup functionality.

5.3 The Layer 2 credential is NOT visible to the Call Centre. It would normally be mapped to the IP address in the BNG and the site address is presented to the Call Centre using either the phone number, or the IP Address, or a combination.

5. Conclusion

6.1 A significant number of Enhanced UBA services, which use svid/cvid at the interface like UFB, rely on the Logical Port ID as a non-reputiated credential to operate today. It would probably be significantly easier for these RSPs to consume UFB if the feature was available.

6.2 It would also ensure compatibility with the NBN, which would benefit trans-Tasman economies of common equipment and solutions.

6.3 However the long-term direction for this feature may require more research.

ANNEX 6 – FTTP Definitions

Term	Definition
Access Provider	a person or organisation that has a [contractual] relationship with an Access Seeker for the provision of access to End-users
Access Seeker	a person or organisation that has a [contractual] relationship with an LFC for the provision of a Permitted Service (and may include a Service Provider)
AFS	Access Fibre Service
ANTP	Access Network Termination Point
AON (Active Optical Network)	a general term that describes any network configuration in which each end-user is connected to their own dedicated port on Access Seeker's access/aggregation equipment in the Central Office, using a direct point-to-point physical connection
Backhaul	Refers to backhaul within an LFC.
CO (Central Office)	An environmentally controlled facility hosting active and passive telecommunications plant and infrastructure. The CO is a point of interconnect and co-location area for Access seekers, who require access to the End-user premises serviced from the CO
Communal Infrastructure	Being the network infrastructure in the Proposed Coverage Area which is deployed independently of any specific End User commitment and which is not located on End Users' sites or premises.
Dark fibre	Optical fibre physical infrastructure without any active equipment attached. Dark, as it has no source of light inherent in the network design.
End-user	Ultimate recipient of services provided over Dark fibre or ALA, including both residential consumers and business users
End user specific infrastructure	Being the network infrastructure which is deployed specifically for an End User commitment and which may be located on End Users' sites or premises.
Ethernet Access Service (EAS)	Ethernet service between the Central Office and the End-user premises provided by the EAS-provider to the EAS-user
ETP (External Termination Point)	"The External Termination Point on the End User's premises is a suitable fibre termination facility located as an attachment to an external part of the building or structure located at the End User's premises. Specifically, the termination point will be the SC connector which plugs into the ONU or NTU inside the End User's premises
Events	Service failure
Fibre Concentration Point	The FCP "aggregates" small fibre count cables into larger fibre count cables. The FCP function can occur in cabinets, pits or Pedestals.
FTTC	Fibre to the Curb
FTTH	Fibre to the Home
FTTN	Fibre to the Node
FTTP	Fibre to the Premise
ITP	Internal Termination Point – as ETP, but located inside the premises
Layer "0'	means the unofficial layer 0, not part of the actual OSI model, which is sometimes used to refer to the Physical media for OSI (such as dark fibre or copper cables), and sometimes also used to refer to ducts, poles and radio spectrum
Layer 1	means the "Physical Layer", of the OSI Model. The Physical Layer provides for transparent transmission of bitstreams between data link (layer 2) entities across physical connections

Layer 2	means the "Datalink Layer", of the OSI Model, which provides the functional and procedural means to transfer data between network entities and to detect and possibly correct errors that may occur in the Physical Layer
Layer n Service	means any service which operates at Layer n
LFC	means a Local Fibre Company, being an entity in which CFH, the government and a Partner will hold shares, and through which the investment of CFH and the Partner in relation to the UFB Initiative will be effected
LFC Coverage Area(s)	in respect of any LFC, means the geographic area over which that LFC's Network will be deployed
MDU	Multi Dwelling Unit
MOFDF	Main Optical Fibre Distribution Frame
MTBE	Mean Time Between Events
MTU	Maximum Transmission Unit
Multiplexer (MUX)	A general term used to describe a piece of network equipment that terminates many Dark fibres in an Active Optical Network (AON) configuration, and is installed in Central Offices
Non Building Access Point (NBAP)	A location for a fibre termination that does not have a physical address (e.g. a bus shelter, lamp post, traffic light).
Network	means, in respect of any LFC, the fibre-optic communications network inside and outside plant and facilities which is, or will be, owned and/or operated by that LFC
NID	Network Interface Device is a device provided and operated at the End-user's premises that terminates the network and provides the UNI.
ODN (Optical Distribution Network)	the optical fibre network between a dark fibre PoI in the CO and the ETP at the End-user's premise [review after Service Descriptions]
ODF	Optical Distribution Frame
OFDF	Optical Fibre Distribution Frame
OLT (Optical Line Terminal)	a general term for a specialised piece of PON network equipment that terminates dark fibres and is installed in Central Offices within the LFC Network. An OLT is connected to multiple Optical Network Units (ONUs)
ONT (Optical Network Terminal)	An ONU used for FTTP applications that provides multiple end-user ports to directly connect end-user devices
ONU (Optical Network Unit)	a general term for a specialised piece of equipment that terminates a single fibre and is located at the end-user's premises
Optical splitter	A specialised piece of passive network equipment that connects a single dark fibre from one side to many dark fibres on the other.
OSI Model	means the seven-layer Open Systems Interconnection Model, described in ISO/IEC standard 7498 and ITU-T Rec. X.200
PoI (Point of Interconnect)	Point of interconnect between the Access seeker and the LFC (dark fibre service) or between EAS provider and EAS user (Ethernet Access Service).The physical point of interconnect is the Central Office
Point-to-point (p2p)	A fibre architecture providing a dedicated optical fibre or fibre pair between the end-user's premises and the Central Office
Point-to-multipoint (p2mp)	A fibre architecture providing a fibre between the end-user's premises and the Central Office that is partly shared by multiple end-users through the deployment of optical splitters or passive multiplexing devices.

PON (Passive Optical Network)	a point-to-multipoint fibre architecture deployed with either GPON, EPON, XGPON, 10G PON or WDM PON technologies or their future variants
Premises	Single building or structure located on a defined geographical site. A premises can contain one potential End User, e.g., stand alone house), or more than more potential End User e.g., apartment building or high rise office building.
Priority Users	means businesses (of any size, including private sector health providers), schools (including state, state integrated and independent schools) and health service providers (hospitals and significant health care provider sites, for example emergency and medical centres, and radiologists)
Product	A purchasable component of an end-to-end service. Products include: Handover circuit (at the ENNI); UNI (shared or dedicated of different physical types); OVC service type (for example E-APL, E-AVPL, E-Tree) defined as the component between the ENNI and UNI and will have variable service type attributes (for example CoS classes); support SLAs (including availability, response times, service hours).
QoS (Quality of Service)	the ability to provide different priority to different categories of data
Residential Gateway (RG/RGW)	is a home networking device, used as a gateway to connect devices in the home to the network.
SC type connector	A special type of connector installed on the ends of a fibre
Service	A service is defined as a single end-to-end service (in an MEF context) for a including UNI, OVC and ENNI.
Service Provider	Provider of Information, Communications and or Entertainment services to an End-user
User-Network Interface	interface between the Network and the End-user at the customer premises