MARKETING REPORT

MR-229
Leveraging Standards for Next Generation Wholesale Access

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Issue History

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Table of Contents

List of Figures

Executive Summary

The continuing trend of increasing broadband adoption and utilisation is driving the deployment of technologies with greater capabilities. This has been widely referred to as Next Generation Broadband Access. This paper discusses the drivers for the deployment of these technologies and the open access principles often adopted to support the widespread of utility of these next generation access networks.

The open access principles with respect to the network infrastructure are translated into the support of wholesale services to enable downstream retail service providers to leverage and share the next generation access investments.

There are Standards Development Organisations which have produced specifications applicable to both wholesale network operators and retail service providers. This paper discusses the Broadband Forum and Metro Ethernet Forum specifications and the manner in which they are applicable to these open access next generation networks.

MR-229 describes the Broadband Forum Technical Reports that are applicable across the areas of service requirements, broadband architecture and control and management. In addition relevant work in progress within the Broadband Forum is highlighted.

The Metro Ethernet Forum specifications that are applicable across the areas of service requirements, architecture, control and management and interfaces are described.

This paper provides a blueprint for wholesale and retail service providers, as well as for regulators and other industry bodies, to determine the relevant standards work that is available for next generation broadband access networks operating in an open access environment.

1 Wholesale Broadband Opportunities

1.1 Global Market

The continued growth in utilisation of broadband networks is driving investment in next generation access technologies.

In conjunction, policy and regulatory objectives have been formulated in a number of countries around the world to support investment in Next Generation Access (NGA) networks. Some of these policies are based on open access principles that give rise to wholesale services that enable innovative retail services.

1.1.1 Applications driving the need for fibre

There are a number of applications driving the use of broadband networks. The following aspects are specifically driving the deployment of next generation broadband access networks based on fibre:

1. Cost-effective Bandwidth & Transport Infrastructure Scaling
2. Faster Interconnects (1 Gbit/s & 10 Gbit/s) at NNI
3. More Fibre, Less Copper = Less Line Qualification Complexity
4. FTTH can Reduce Opex Compared to Copper (with respect to corrosion, noise etc.)
5. Easy to Integrate with Modern DSL Architectures (BBF TR-101)

1.1.2 Competitive provider issues and opportunities

The benefits of fibre NGA networks come at the cost of upgrading copper access networks or deploying new green and brown field fibre access networks. The economics associated with these investments has lead to many NGA initiatives are being progressed with “open access” as a requirement. This has resulted with a focus on wholesale access models.

Open access provides competitive service providers with the ability to leverage a wholesale NGA deployment. This represents an opportunity for competitive service providers to take advantage of the benefits afforded by fibre NGA, either where that opportunity may not have existed or in a more economical manner.

1.2 Options for wholesale & competitive operators

Competition, based on NGA networks, is likely to take many different forms depending on the local conditions and the state of market development.

Options for communications providers can take the form of building NGA infrastructure, leveraging passive wholesale access or leveraging active wholesale access to NGA infrastructure.

1.2.1 Build

The option to build out NGA infrastructure is likely only to be possible or practical for relatively few communications providers. As a result, other options can be made available to communications providers to provide the opportunity to leverage NGA networks..

1.2.2 Passive Access

Where economically viable, wholesale passive access can enable competition and encourage network investment while maximizing freedom to innovate in broadband deployments. Wholesale passive access is based on renting network owners' physical infrastructure (e.g. duct and pole access, dark fibre or wavelength) and combining with their own active electronic equipment. These approaches and associated supporting SDO specifications are outside the scope of this paper.

1.2.3 Active Access

Wholesale active access can enable a high degree of efficiency where more wholesale services and therefore retail service provider are able to leverage the underlying network infrastructure. This can encourage competition in areas where passive access is not viable for whatever reason. Wholesale active access refers to wholesale products that use access network owners' physical infrastructure and active electronic equipment, such as Access Nodes, Ethernet switches and IP/MPLS routers.

Ethernet has become a key technology in broadband networks in recent years, being used for aggregation and backhaul for multiple types of access technology. Ethernet as a service has also been identified as something attractive to base wholesale open access upon.

Some regulators have developed requirements for Ethernet-based active wholesale access services, including support for security, quality of service, multicast, flexible interconnection and flexible customer premises equipment.

In addition to Ethernet active wholesale access, there remain approaches based on PPP and L2TP as well as native IP for NGA networks.

2 Standards and global specifications to assist development of competitive market

Standards Development Organisations (SDO), operating in the broadband and carrier Ethernet environment, have developed specifications that are applicable to NGA networks. The work of these SDOs aims to provide networking specifications addressing interoperability, architecture and management.

This paper focuses on the specifications from the Broadband Forum and the Metro Ethernet Forum. There are many networks deployed based on the specifications of the Broadband Forum and the Metro Ethernet Forum. This presents an opportunity for the emergence of wholesale broadband services on NGA networks. The existing networks can be extended to incorporate NGA and the existing specifications utilised to provide the necessary services. This provides a solution in the near term to capitalise on the benefits of NGA. The remainder of this section describes the applicability of the Broadband Forum and MEF specifications to the NGA initiatives for broadband wholesale and carrier Ethernet.

2.1 Architecture

2.1.1 BBF TR-058, "Multi-Service Architecture & Framework Requirements"

TR-058 outlined the existing DSL architectures of the time and the market requirements driving towards a multi-service architecture that supported new service models and capabilities to support a range of applications and services.

TR-058 introduced into the framework certain wholesale fundamentals which continue to be relevant in later specifications and today. These aspects are addressed in Section 7/TR-058 "*Service Provider Interconnection Models*", which provides a description of the roles of the various providers, including the Network Service Provider (NSP), Application Service Provider (ASP), Regional Network Provider and Access Network Provider.

The description of the business and service requirements in TR-058 has fed into the architectural and nodal functional requirement definitions of subsequent Technical Reports. This group of Technical Reports includes Technical Reports such as TR-059, TR-101 and TR-156 described further in the following sections.

2.1.2 BBF TR-101, "Migration to Ethernet Based DSL Aggregation"

TR-101 outlines how an ATM based broadband aggregation network can be migrated to an Ethernet based aggregation broadband network. In doing so it defines the architecture for an Ethernet broadband network.

The TR-101 Ethernet architecture is shown in Figure 1 below. The architecture is described in detail with respect to the differential from the TR-059 ATM architecture. The TR-101 architecture depicts the NSP L2 Ethernet wholesale use case as highlighted in the shaded box.

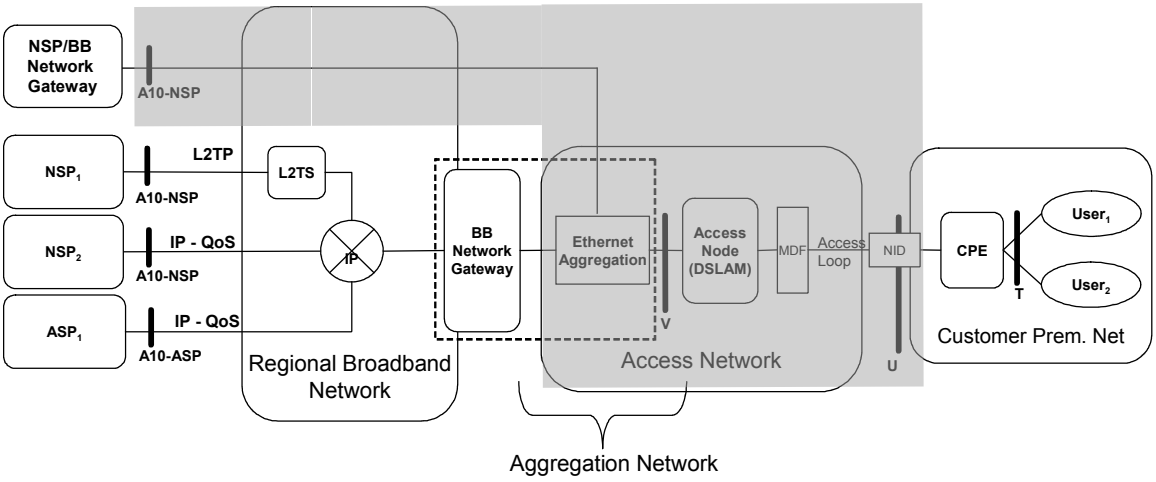

Figure 1: TR-101 "Figure 3 – Network architecture for Ethernet-based DSL aggregation"

The TR-101 architecture provides additional options for active wholesale services, which could be relevant in open access environments. In particular there are options for the ASP IP wholesales services and NSP IP wholesale services.

The TR-101 Ethernet architecture is relevant in next generation access networks due to wide spread adoption of Ethernet for broadband access aggregation and in many cases the direct encapsulation of Ethernet in the access network.

2.1.3 BBF TR-156, "Using GPON Access in the context of TR-101"

TR-156 is a part of the TR-058 and TR-101 family of Technical Reports. TR-156 extends to GPON the Ethernet broadband architecture defined for DSL in TR-101. Many next generation access networks are being based on GPON access technology. TR-156 provides a description of the TR-101 Ethernet network capabilities as applicable for GPON.

The TR-156 GPON broadband network architecture is shown in Figure 2 below.

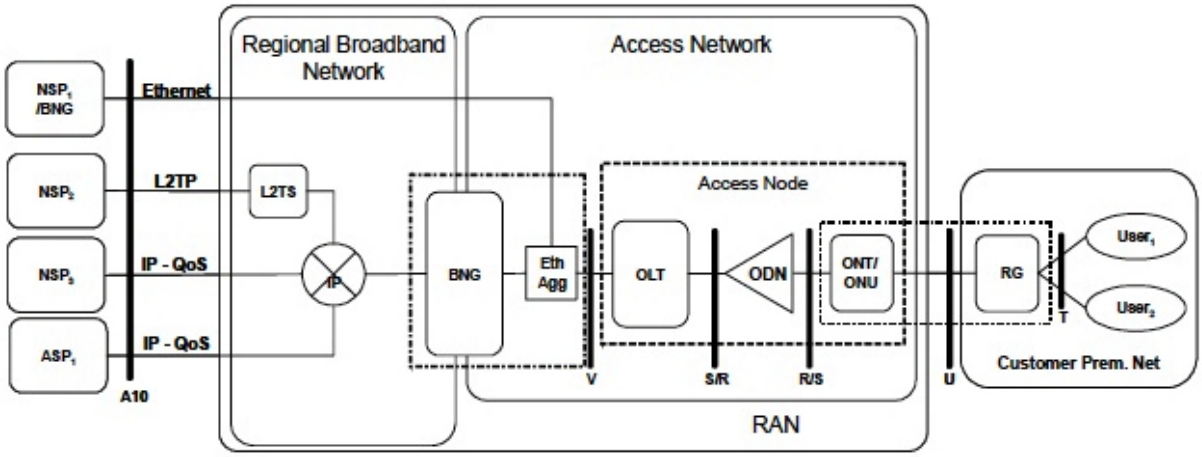

Figure 2: TR-156 "Figure 1 – Network architecture for Ethernet-based GPON aggregation"

TR-156 aims to reduce operational complexity and maximise equipment interoperability. This is of particular interest in broadband networks and particularly open access wholesale access networks. Several geographies see a benefit in driving interoperability between the GPON OLT and ONT components. This is similar to the original tight coupling of the DSLAM and DSL modem components. Benefits in the DSL market derive from interoperability where retail service providers or end-users could provide DSL modems that closely matched their respective requirements, rather than being dependent on the wholesale access providers choice of DSL modem. It should be noted that not all geographies are pursuing this path. The alternative of the wholesale access provider supplying the ONT is justified where multiple wholesale services could share the ONT simultaneously. Therefore, to protect open access, the wholesale access provider may or may not need to supply the ONT.

2.1.4 BBF TR-144, "Broadband Multi-Service Architecture & Framework Requirements"

TR-144 describes a converged Broadband Multi-Service network architecture that supports a broad range of services, including both emerging and legacy services; as well as a broad range of market segments including residential, business, retail, and wholesale markets.

The TR-144 broadband multi-service reference model, as shown in Figure 3, provides support for the long standing services defined previously in TR-058, as well as new services, like IPTV,

and business services that drive some aspects of the network architecture. The network architecture encompasses the transport layer, access network, aggregation network, and edge routing. The network at the end-user premise is addressed to the extent needed to deliver the end to end services.

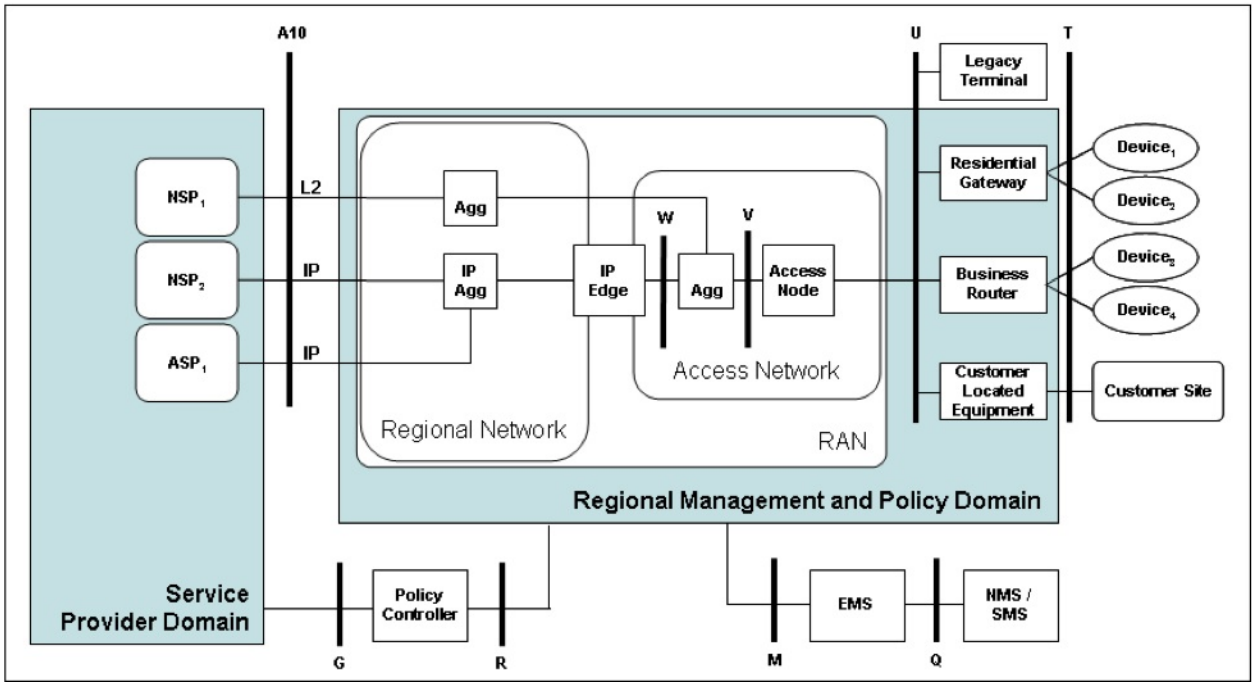

Figure 3: TR-144 "Figure 2 - Broadband Multi-Service Reference Model"

The Broadband Forum uses the term *Network Service Provider* (NSP) to refer to the type of operator that is responsible for providing the IP layer in the delivery of services to end users. A NSP may buy Ethernet wholesale active access services from an Access Network Provider, or may operate its own access network. The L2 NSP service type is included in the broadband multi-service reference model operating from the A10-L2-NSP reference point to the U reference point.

TR-144 describes the drivers and characteristics of broadband services. These are then translated into requirements for the broadband architecture. The business models described in TR-144 support open access and the enabling of retail and wholesale services. The architectural requirements for the support of QoS and multicast are critical.

The description of the business and service requirements in TR-144 will feed the architectural and nodal functional requirement definitions of subsequent Technical Reports.

2.1.5 MEF 4 'Metro Ethernet Network Architecture Framework Part 1: Generic Framework'

MEF 4 provides the Metro Ethernet Forum generic architectural framework for Metro Ethernet Networks. The generic architecture framework describes the high-level constructs used to model the various architectural components of Ethernet transport services.

Figure 4 below shows the connection of subscribers to a Metro Ethernet network via MEF User-Network Interfaces (UNI). The T-interface shown aligns with the T-interface in the Broadband Forum architecture, although the nature of the network demarcation devices used varies between deployments.

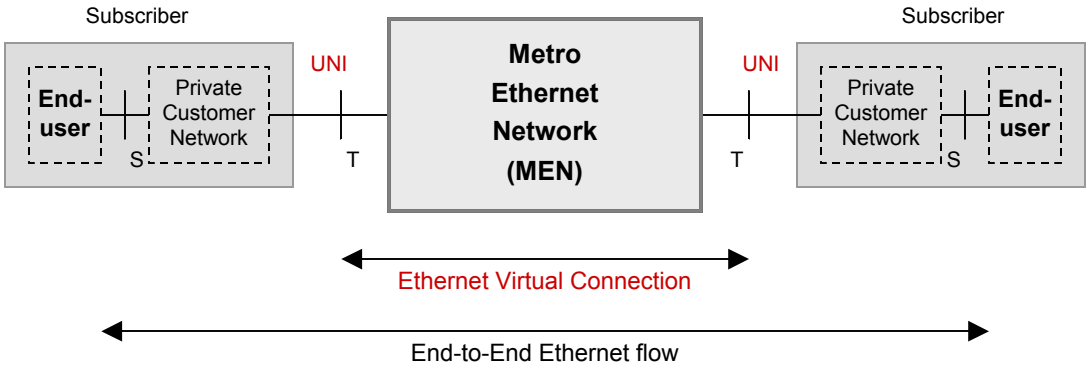

Figure 4: MEF 4 "Figure 1 - Basic Network Reference Model"

Figure 5 shows how Metro Ethernet Networks can be interconnected via MEF External Network-Network Interfaces (ENNI) to provide services between UNIs across networks operated by different providers. The use of this ENNI for Wholesale Access is discussed further in Section 2.3 below.

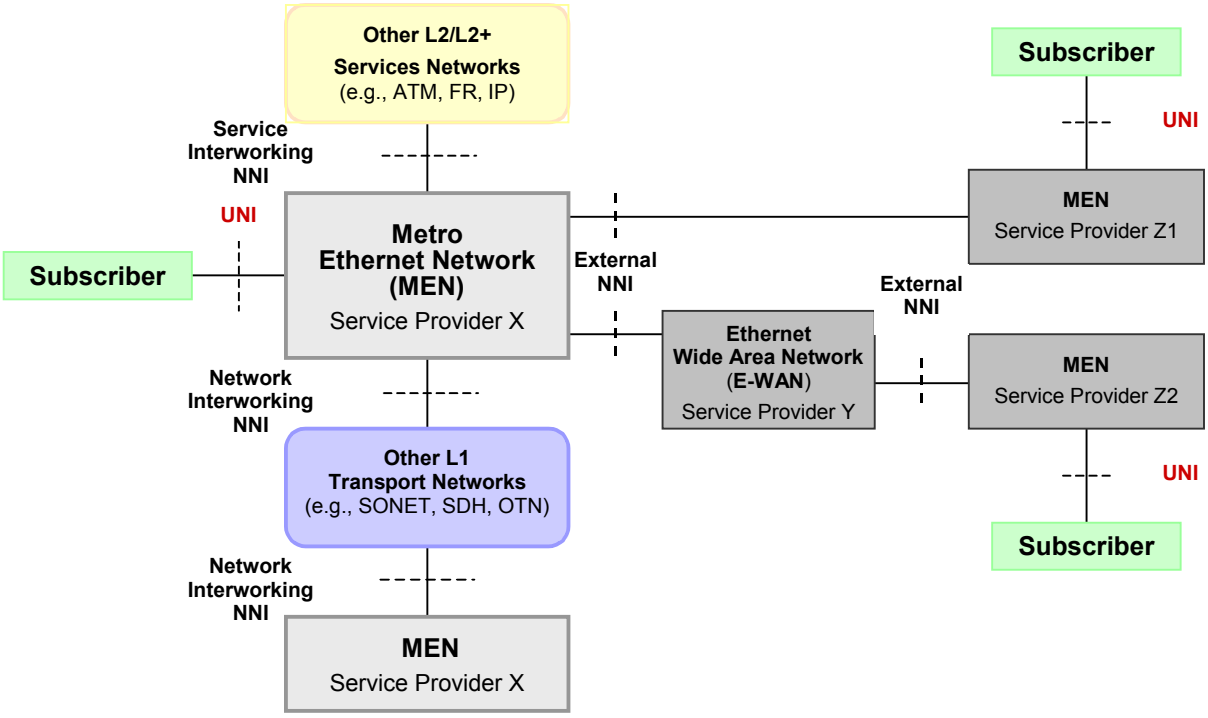

Figure 5: MEF 4 "Figure 3 - MEN External Interfaces and associated reference points"

2.2 Service Definition

MEF 6.1 defines Ethernet services that are offered between UNIs. This includes E-Line (Point-to-Point), E-LAN (Multipoint-to Multipoint) and E-Tree (Point-to-Multipoint) services. These services are defined with reference to the service attributes defined in MEF 10.2. These service definitions are aware of customer VLAN tags, which allows service multiplexing at a network interface.

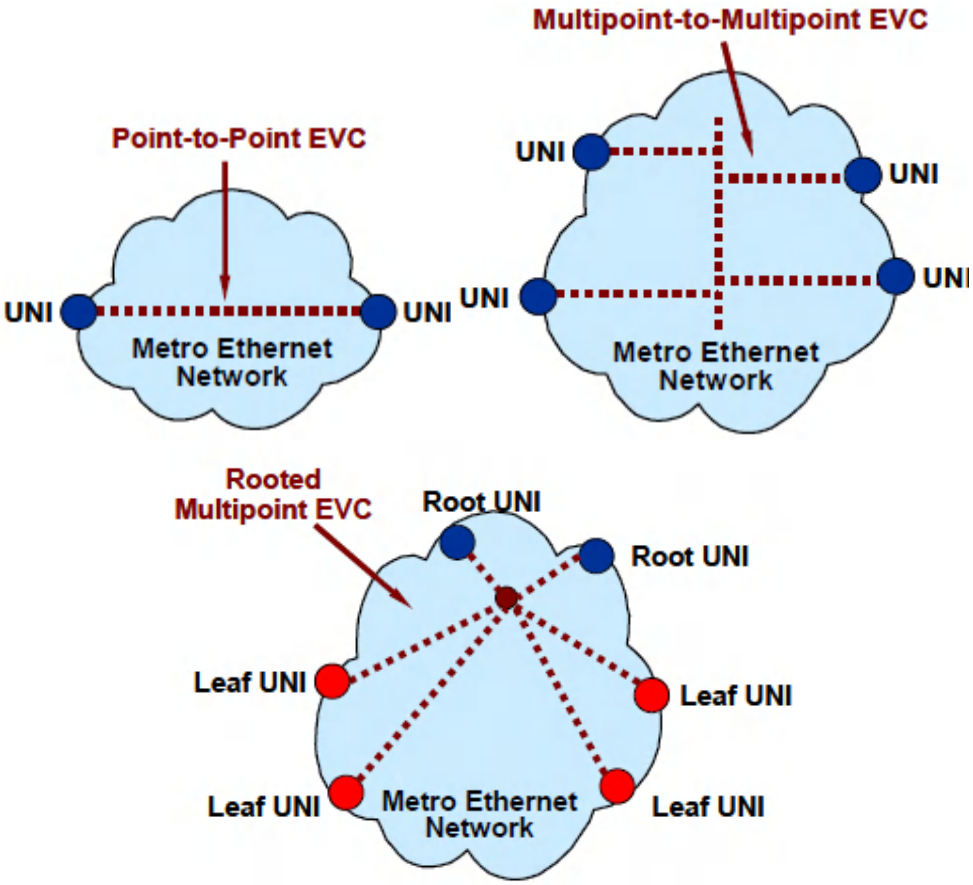

Figure 6: MEF E-Line, E-LAN and E-Tree Services

The Broadband Forum Technical Report TR-101 defines N:1 and 1:1 VLAN architectures that perform the same function as MEF E-Tree and E-Line services. The N:1 VLAN architecture allows multiple end-users to share a single VLAN within the service provider network.

Additional functions implemented within the N:1 VLAN architecture prevent user-to-user layer 2 communication and provide security for unicast services while allowing point-to-multipoint connectivity for multicast services. The 1:1 VLAN architecture provides point-to-point backhaul by mapping each end-user's traffic to a separate VLAN.

TR-156 and TR-167 describe how the 1:1 and N:1 VLAN architectures are supported on GPON systems. This allows the same network architecture to be supported by multiple access technologies including DSL, point to point fiber and passive optical networks.

Wholesale access can be implemented based on both MEF service definitions and the Broadband Forum VLAN architectures. Typically the MEF service definitions are used to describe business Ethernet services while the Broadband Forum architectures are used for residential broadband services.

2.3 Interconnection

To offer services over a broadband access network, a service provider will need to interconnect with the access network provider both at the customer premises and at a service provider's point of interconnect. The location of point of interconnects can be at any point in the aggregation or core networks.

TR-101 and TR-156 define the U reference point between the Access Network and the customer premise network and the A10-NSP reference point between the Access Provider network and the NSP network.

MEF 13 and MEF 20 define requirements for the MEF UNI interface. This interface is at the endpoint of the Ethernet services defined by MEF6.1. MEF 26 defines the MEF ENNI interface that is used to provide inter-MEN interconnect between MENs that carry segments of MEF 6.1 services.

The MEF ENNI can be implemented by an IEEE 802.1ad compliant provider edge bridge but is limited to the 4094 service instances that are supported by the VLAN-ID space. The Broadband Forum A10 reference point offers greater scalability that may be required for the interconnect of wholesale access services by allowing multiple end-users to share the same S-VLAN in the N:1 VLAN architecture and by allowing the use of both an S-VLAN and a C-VLAN to identify an end-user in the 1:1 VLAN architecture.

2.3.1 BBF TR-147, "Layer 2 Control Mechanism For Broadband Multi-Service Architectures"

TR-147 defines Layer 2 Control Mechanism as a means that runs directly between a Broadband Network Gateway (BNG) and an Access Node (AN), in order to perform QoS-related, service-related and subscriber-related operations. With L2C, the transmission of the information does not need to go through distinct element managers but rather can use direct BNG-AN communication. This allows access link related operations to be performed within those network elements, while avoiding any impact on the existing management systems.

TR-147 identified four use cases for DSL access network, which are Access Port Discovery, Access Port Configuration, Layer 2 OAM and Multicast. TR-147 provides a retailer the ability to remotely monitor, configure DSL ports on a DSLAM, as well as triggering a Layer 2 OAM and configuring a multicast control list for a certain DSL port.

L2C could be leveraged to enable retail operators to query information in the wholesale provider's access network without the need to build EMS/OSS interfaces.

TR-147 can cater for the partitioning of access nodes, which would allow appropriate separation in a wholesale environment. In addition, TR-147 allows for a L2C proxy, which could reside in the wholesale provider's network and broker L2C communications from retail operators to the wholesale provider's access nodes.

2.4 Quality of Service (QoS)

2.4.1 BBF TR-101, QoS Model

The BBF TR-101 architecture defines 3 QoS models in Section 2.9/TR-101. For supporting NGA L2 Ethernet wholesale services, the model called "*Distributed precedence and scheduling*" is most relevant as it is implemented in the aggregation and access networks without relying on all frames being scheduled by a single BNG.

BBF TR-156, being based on the TR-101 architecture, follows this model and specifically specifies the implementation of QoS in Section 5.2/TR-156, which can be leveraged for L2 Ethernet wholesale.

2.4.2 BBF TR-126, "Triple-Play Services Quality of Experience (QoE) Requirements"

TR-126 takes the perspective of the end-user and, with respect to the subjective QoE for the considered applications, derives objective engineering measures. This produced QoE guidelines for entertainment video (Video on Demand & broadcast), voice and data services.

The QoE guidelines presented are independent of access technology, which results in the continued relevance for next generation access.

In addition the clarity that arises from application oriented QoE mapped to network orientated QoS is of significant value when application services transit multiple operator networks, as is the case in open access wholesale environments.

The QoE recommendations for the network layer provided in Section 9/TR-126 can be used as input to the industry in geographies adopting specifications of wholesale services.

In addition some of the appendices continue to be relevant in a next generation access environment. For example the discussion of error protections mechanisms can provide value for retail service providers that will utilise wholesale services for entertainment video delivery.

2.4.3 MEF 10 / MEF 26

MEF 10 and MEF 26 define QoS attributes that are relevant to the implementation of QoS in broadband aggregation and access networks.

The MEF performance attributes relate to a L2 Ethernet wholesale service in terms of defining the attributes of the Service Level Specification. MEF 10 defines performance attributes for Frame Delay, Frame Delay Variation, Frame Loss Measurement and Availability.

MEF bandwidth profiles define Committed Information Rate (CIR) and Excess Information Rate (EIR). These attributes in conjunction with performance attributes are utilized to define and

manage a Class of Service. Bandwidth profiles can be matched with Classes of Service and Ethernet Virtual Connections (EVCs) in particular combinations.

L2 Ethernet wholesale services can be treated as EVCs with the Classes of Service, Bandwidth Profiles and Performance Attributes defined. This provides the means for the open access infrastructure to be shared and managed for supporting the services offered to retail operators.

2.4.4 MEF 23, "Carrier Ethernet Class of Service – Phase 1"

MEF 23 defines a Class of Service model that defines three standard Class of Service labels (H, M and L) and the relationships between their Frame Delay, Frame Delay Variation and Frame Loss Ratio performance objectives. The Broadband Forum TR-101 QoS model can be used to implement these standard Classes of Service. Supporting this model for wholesale access services will in turn enable competitive service providers to offer MEF23 compliant services.

2.5 Multicast

Multicast in the context of L2 wholesale access networks largely relates to the provision of a L2 Ethernet wholesale service across the aggregation and access networks. The multicast architecture defined in Section 2.8/TR-101 and Sections 5.3, 5.4/TR-156 defines a solution for the wholesale service based on a Multicast VLAN. The necessary functions of the aggregation and access networks nodes are defined in these Technical Reports.

2.6 Ethernet OAM

A next generation wholesale access solution, with interconnect at customer premises and NNI, will need mechanisms to manage connectivity and performance issues within the domains of the wholesale access network provider and the user of services on that network. The Broadband Forum and MEF have both defined OAM architectures that place requirements on network equipment to support these OAM capabilities at the Ethernet Layer. The specifications describing Ethernet OAM functionality are:

- Broadband Forum TR-101 and TR-156
- MEF 17 – Service OAM Framework and Requirements
- MEF 20 – UNI Type 2 Implementation Agreement
- MEF Service OAM Fault Management IA (work in progress)
- MEF Service OAM Performance Management IA (work in progress)

The Broadband Forum specifications place requirements on the Ethernet Access Node which will be particularly applicable for wires-only access deployments, while the MEF specifications are widely implemented by Ethernet demarcation devices that will be applicable to deployments with active Ethernet devices at the customer premise.

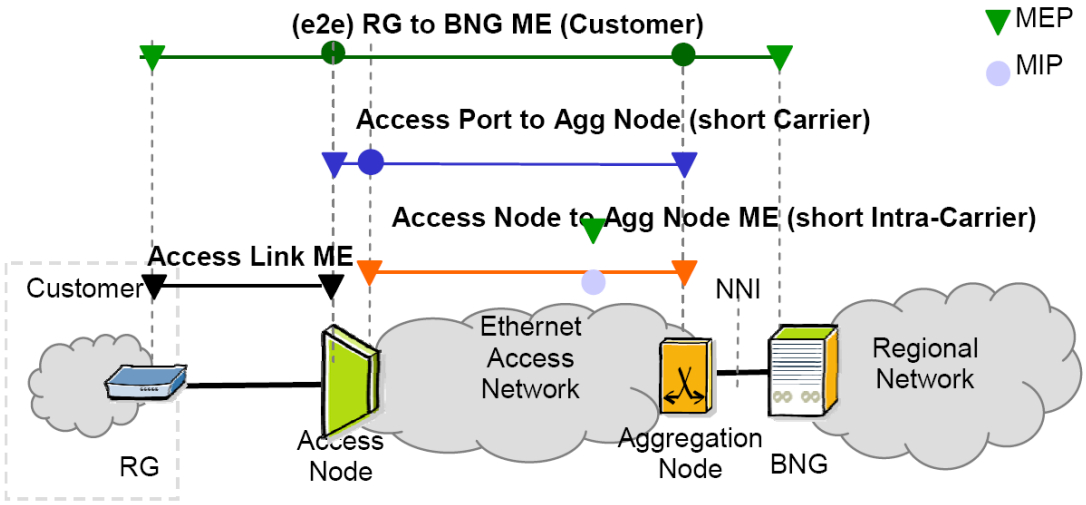

Figure 7: Broadband Forum TR-101 OAM architecture

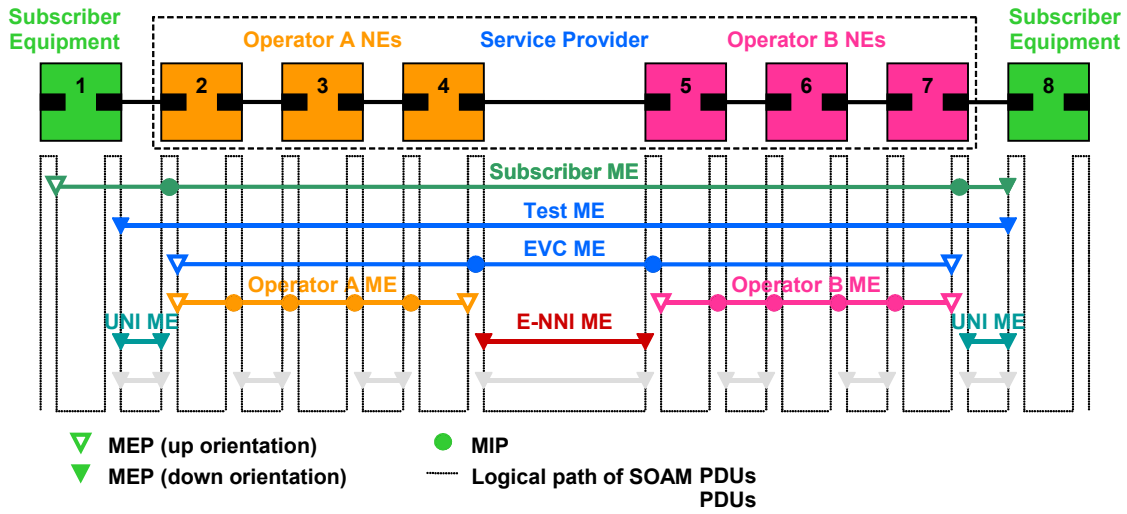

Figure 8: MEF OAM architecture

2.7 Connected Home

Broadband Forum TR-069 defines a CPE WAN Management Protocol that is widely deployed to manage broadband residential gateways. This protocol is compatible with wholesale broadband access network deployments, as a broadband service provider can manage his CPE by tunneling TR-069 management frames over IP across the Access Network Provider's network along with end-user traffic.

2.8 Work in progress and on horizon

The following sections describe standards specification work in progress that is relevant to next generation wholesale access networks.

2.8.1 Broadband Forum

The Broadband Forum has the following documents in development, which are known as Working Texts.

2.8.1.1 WT-145, "Multi-service Broadband Network Functional Modules and Architecture"

Following on from TR-144 "*Broadband Multi-Service Architecture & Framework Requirements*" the BBF End-to-End Architecture Working Group is specifying the functional architecture in WT-145.

Within WT-145, Layer 2 NSP Wholesale is being specified as a discrete use case. This aims to map out the functional architecture to support an open access network delivering Ethernet services for wholesale active access. This work will address aspects such as scaling, availability, security, provisioning and multicast.

2.8.1.2 WT-207, "L2C Part II"

WT-207 was initiated to expend L2C to new access technologies like EPON, GPON and XG-PON. A PON network has different access network infrastructure as it has OLT and ONU together act as an Access Node for certain cases, while ONU acts as an Access Node and OLT acts as an aggregation node for some other cases. Configuration of PON network and interworking between OMCI and L2C will be defined.

WT-207 will also define new use cases and applications, such as L2C relay and more profound capabilities for configuring services on a wholesaled partition.

Identified contents that need to be studied include:

- Application of L2C Mechanism in PON networks
- Application of L2C Mechanism on new wholesale and retail business arrangements.
- Application of L2C Mechanism in Multi-Edge Architectures.
- Application of L2C Mechanism in a redundant and resilient access network Architecture
- L2C use case for unified unicast and multicast admission Control.
- L2C use cases for remote OAM messages

3 Global Next Generation Access and Open Access Initiatives

3.1 UK NICC

The Network Interoperability Consultative Committee (NICC) in the UK is producing technical specifications for Ethernet Active Line Access (http://www.niccstandards.org.uk) based on requirements provided by OFCOM, the UK regulator. This will include an architecture and wholesale service definition that will satisfy the regulatory requirements. Specifically, ALA User and ALA Provider in the OFCOM terminology are respectively equivalent to Layer 2 NSP and Access Network Provider in the Broadband Forum terminology.
The Broadband Stakeholder Group (http://www.broadbanduk.org/) in the UK are also working, in a broader sense, on next generation broadband, focusing on the areas of policy, commercial, regulation and public sector intervention.

3.2 Australia

The Australian government has a policy to deploy a National Broadband Network (NBN) to 100% of the Australian population (http://www.dbcde.gov.au/all_funding_programs_and_support/national_broadband_network). The network will utilise FTTP access technology to reach 93% of the population with wireless and satellite used for the remaining 7%.

3.2.1 NBN Co

The Australian government has established NBN Co as a Government Business Enterprise to build and operate the network. NBN Co is in the process of building the NBN, starting with Tasmania and 5 first release sites on the mainland.

The wholesale services that NBN Co plans to offer Retail Service Providers (RSP) is being developed in consultation with the telecommunications industry. NBN Co plans to offer a range of L2 Ethernet wholesale services.

3.2.2 Communications Alliance

The Communications Alliance (http://www.commsalliance.com.au/) is an industry body that contributes to public policy and facilitate solutions to industry problems for its membership.

The Communications Alliance has been leading the industry in the development of requirements to address implementation of the NBN (http://www.commsalliance.com.au/Activities/nbn). The project has developed a number of reports ranging from a reference model, service frameworks and migration models.

3.3 New Zealand

The New Zealand government is pursuing a policy to accelerate the deployment of what they refer to as Ultra-Fast Broadband (UFB). The UFB objective is to "accelerate the roll-out of ultra-fast broadband to 75 percent of New Zealanders over ten years, concentrating in the first six years on priority broadband users such as businesses, schools and health services, plus greenfield developments and certain tranches of residential areas."

The implementation of the UFB policy was initiated by the Ministry of Economic Development (http://www.med.govt.nz/templates/ContentTopicSummary____41902.aspx). Following this, the government has established the entity *Crown Fibre Holdings* to manage their investment in UFB infrastructure. The Government will invest in partnership with the private sector and the investment will be deployed to provide Layer 1 and Layer 2 wholesale services on an open access basis.

3.3.1 Crown Fibre Holdings

Crown Fibre Holdings (CFH) (http://www.crownfibre.govt.nz/) is managing the process of selecting partners for the deployment of the UFB infrastructure. CFH will facilitate and, where

necessary, lead the development of operational and technical standards that will be applied across all of the selected partners.

3.3.2 Telecommunications Carriers' Forum

The Telecommunications Carriers' Forum (TCF) (http://www.tcf.org.nz/content/97b4e3bb-7823-4b56-b789-38378890a13c.html) has established a UFB working party, in conjunction with CFH, that prepare standards for product, technical, and operational matters where a combined industry-developed solution is desirable.

This includes the development of standards on UFB Co-location, Intra-Area Access Backhaul and Ethernet Line Access Services.

4 References and Terminology

4.1 References

The following references are of relevance to this Marketing Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Marketing Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at www.broadband-forum.org.

A list of currently valid Metro Ethernet Forum Technical Specifications is published at http://metroethernetforum.org/page_loader.php?p_id=29.

Document		Title	Source	Year
[1]	TR-058	*Multi-Service Architecture & Framework Requirements*	Broadband Forum	September 2003
[2]	TR-059	*DSL Evolution - Architecture Requirements for the Support of QoS-Enabled IP Services*	Broadband Forum	September 2003
[3]	TR-069	*CPE WAN Management Protocol v1.1*	Broadband Forum	December 2007
[4]	TR-101	*Migration to Ethernet Based DSL Aggregation*	Broadband Forum	April 2006
[5]	TR-126	*Triple-Play Services Quality of Experience (QoE) Requirements*	Broadband Forum	December 2006
[6]	TR-144	*Broadband Multi-Service Architecture & Framework Requirements*	Broadband Forum	August 2007
[7]	TR-147	*Layer 2 Control Mechanism For Broadband Multi-Service Architectures*	Broadband Forum	December 2008
[8]	TR-156	*Using GPON Access in the context of TR-101 Issue 2*	Broadband Forum	September 2010
[9]	TR-167	*GPON-fed TR-101 Ethernet Access Node Issue 2*	Broadband Forum	September 2010
[10]	WT-145	*Multi-service Broadband Network Functional Modules and Architecture*	Broadband Forum	Work-in-Progress
[11]	WT-207	*Layer 2 Control Mechanism For Broadband Multi-Service Architectures - Part II*	Broadband Forum	Work-in-Progress

[12]	MEF 4	*Metro Ethernet Network Architecture Framework Part 1: Generic Framework*	MEF	May 2004
[13]	MEF 6.1	*Metro Ethernet Services Definitions Phase 2*	MEF	June 2008
[14]	MEF 10.2	*Ethernet Services Attributes Phase 2*	MEF	October 2009
[15]	MEF 20	*UNI Type 2 Implementation Agreement*	MEF	July 2008
[16]	MEF 23	*Class of Service Implementation Agreement - Phase 1*	MEF	June 2009
[17]	MEF 26	*External Network Network Interface (ENNI)–Phase 1*	MEF	January 2010

4.2 Abbreviations

This Marketing Report uses the following abbreviations:

ALA	Active Line Access
ASP	Application Service Provider
BBF	Broadband Forum
BNG	Broadband Network Gateway
CPE	Customer Premise Equipment
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexor
GPON	Gigabit Passive Optical Network
IPTV	Internet Protocol Television
MEF	Metro Ethernet Forum
MEN	Metro Ethernet Network
NGA	Next Generation Access
NNI	Network to Network Interface
NSP	Network Service Provider
OAM	Operations Administration and Maintenance
OLT	Optical Line Termination
ONT	Optical Network Termination
QoE	Quality of Experience
QoS	Quality of Service
SDO	Standards Development Organisation
TR	Technical Report

UNI	User-to-Network Interface
VLAN	Virtual Local Area Network
WT	Working Text

Notice

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