National Broadband Network

Product Technical Specification

NBN Co Ethernet Bitstream Service - FTTB

This document forms part of NBN Co's Wholesale Broadband Agreement which is a Standard Form of Access Agreement for the purposes of Part XIC of the Competition and Consumer Act 2010.

NBNCo
Bringing broadband to life

NBN Co Limited

Product Technical Specification - NBN Co Ethernet Bitstream Service - FTTB

Version 1.0

Version	Description	Effective Date
1.0	NEBS supplied by means of the NBN Co FTTB Network published on 19 December 2014	Execution Date

Copyright

Disclaimer

This document is provided for information purposes only. The recipient must not use this document other than with the consent of NBN Co and must make their own inquiries as to the currency, accuracy and completeness of this document and the information contained in it. The contents of this document should not be relied upon as representing NBN Co's final position on the subject matter of this document, except where stated otherwise. Any requirements of NBN Co or views expressed by NBN Co in this document may change as a consequence of NBN Co finalising formal technical specifications, or legislative and regulatory developments.

Environment

NBN Co asks that you consider the environment before printing this document.

1 Scope and purpose

1.1 Purpose

This Product Technical Specification sets out the technical specifications for the NBN Co Ethernet Bitstream Service supplied by means of the NBN Co FTTB Network.

1.2 Scope

The NEBS supplied by means of the NBN Co FTTB Network aligns closely with the NEBS supplied by means of the NBN Co Fibre Network and NBN Co Wireless Network.

Access to the NEBS supplied by means of the NBN Co FTTB Network relies on VDSL2 Equipment at the End User Premises and the last segment of the distribution network uses VDSL2 DSLAM infrastructure including in-building copper wiring.

This Product Technical Specification describes the features of the NEBS supplied by means of the NBN Co FTTB Network, as offered by NBN Co.

1.3 Definitions

Capitalised terms used but not defined in this Product Technical Specification have the meaning given in the Dictionary.

If a capitalised term used in this document is not defined in the Dictionary, then that term has the ordinary meaning commonly accepted in the industry.

2 Supported Service Types

This section provides a brief overview of the service types that Customer may choose to deploy using the NEBS supplied by means of the NBN Co FTTB Network.

2.1 Unicast Data Services

The NEBS supplied by means of the NBN Co FTTB Network supports the flexible delivery of unicast data services. The NEBS supplied by means of the NBN Co FTTB Network uses logical, Layer 2 circuits that may be used for a variety of higher-level data applications, including internet access.

These unicast services provide physical point-to-multipoint (aggregated) connectivity between one or more UNI-DSLs and a centrally-aggregated NNI supplied to Customer by NBN Co.

2.2 IP-Based Telephony Services

Customer may choose to provision IP-based telephony services to a Premises using a dedicated, external ATA device. The supply, powering and operation of this device are the responsibility of Customer.

Such devices will, subject to compatibility, appear to the NEBS supplied by means of the NBN Co FTTB Network as a regular data device.

Customer may choose to operate the AVC in a manner that recognises the relative priority of telephony traffic above other applications sharing the same AVC.

Under this deployment scenario, the NEBS supplied by means of the NBN Co FTTB Network is agnostic[1] to the IP-based telephony protocols and data that Customer utilises for the delivery of IP-based telephony services to an End User.

When delivering IP-based telephony services using an external ATA, Customer is able to utilise capacity from any of the three traffic classes TC-1, TC-2 or TC-4.

3 Service Addressing

This section describes the options for service addressing, as required for accessing:

- AVC/CVC logical circuits through the NNI
- AVC logical circuits and traffic classes through the UNI-DSL

This section describes the IEEE802.1ad S-TAG/C-TAG structure, the allocation of S/C-VID values, and the addressing options available at the UNI-DSL. It describes the structure of the service frame with regard to fields used for individual service identification.

3.1 Addressing AVC/CVC Services through the NNI

The NEBS supplied by means of the NBN Co FTTB Network supports a common NNI addressing scheme for CVCs, using an IEEE802.1ad S-TAG to identify individual CVC services.

3.1.1 VLAN Tag Structure

When required for CVC/AVC service addressing (as described below), each S-TAG and C-TAG is required to contain the following fields:[2]

- S/C-TPID – Tag Protocol Identifier, used to identify the tag type
- S/C-PCP – Priority Code Point Identifier, used for priority marking
- S/C-CFI – Canonical Format Identifier, not used
- S/C-VID – VLAN Identifier, used for service identification

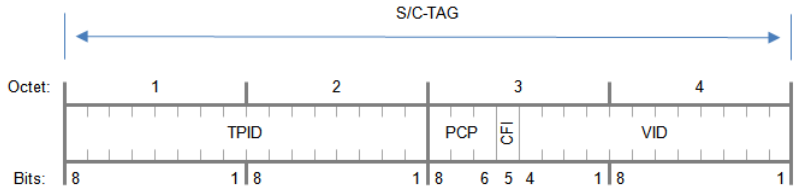

Figure 1: S/C-TAG Structure (4 Bytes)

These fields will be validated for all service frames at ingress to the NBN Co Network. Note that an ingress service frame must contain the same PCP value for both the S-TAG and C-TAG.

[1] Note that specific Class of Service (**CoS**) handling may be configured for voice packets (requires appropriate DSCP marking).

[2] Refer IEEE802.1ad for explanation of S/C-TAG fields.

3.1.2 Tag Protocol Identifier (TPID) Formats (NNI)

Table 1 describes the required TPID values for service frames at ingress to the NBN Co Network. The NNI TPID is set per NNI Group. Any received service frames that do not comply with these values will be discarded at ingress.

Interface	NNI Mode	S-TPID	C-TPID	Comment
NNI	Addressing Mode A	0x88A8 or 0x8100	0x8100	C-TPID value indicated is applicable to inner C-TAG. S-TPID value applicable to outer S-TAG.
	Addressing Mode C			Not applicable to the NEBS supplied by means of the NBN Co FTTB Network.
	Addressing Mode D			Not applicable to the NEBS supplied by means of the NBN Co FTTB Network.

Table 1: TPID (NNI) Requirements

Any tagged service frames with TPID settings outside of these values will be discarded at ingress.

3.1.3 Allocation of S/C-VID Values at the NNI

The allocation of S/C-VID values at the NNI must be co-ordinated between Customer and NBN Co.

When requested by Customer as part of a Product Order Form for a CVC or AVC, NBN Co will allocate each new CVC/AVC an internally-generated S/C-VID. This S/C-VID value will be returned to Customer in accordance with the NBN Co Operations Manual, and must be used for accessing the CVC/AVC at the NNI.

Customer may optionally elect to nominate the S/C-VID used to address each CVC/AVC service instance through the NNI by specifying a S/C-VID in the Product Order Form for the CVC/AVC, for the purpose of further alignment to its own backhaul network addressing schemes. Note that Customer is encouraged to use NBN Co's S/C-VID allocations, which will be unique to Customer's service. This will avoid any potential for S/C-VID mismatch between Customer and NBN Co.

For service addressing modes at the NNI that rely on MAC addressing for forwarding within the NBN Co Network, the allocation of a C-VID is not required.

3.1.4 CVC Addressing

CVCs are identified at the NNI using an outer IEEE802.1ad S-TAG, contained within each service frame. Each CVC within an NNI may be addressed and operated independently, allowing adjacent CVCs to be configured differently.

It is the responsibility of Customer to ensure that each supplied S-VID field conforms to the agreed service configuration. Any service frame received at the NNI with an S-VID that does not map to an agreed identifier for an active CVC service will be discarded.

At egress from the NBN Co Network at the NNI, the NEBS supplied by means of the NBN Co FTTB Network will insert the S-TAG with the agreed S-VID for identification of the CVC to Customer.

Within a CVC, a number of AVCs may be present. The mechanism used to address these individual AVCs depends upon the service being operated through the CVC.

The following service addressing modes are used at the NNI to access individual AVC services operating through a CVC.

3.1.5 AVC/CVC Service Addressing Mode A

AVC/CVC Service Addressing Mode A uses a two-level VLAN addressing scheme at the NNI, which is compliant with IEEE802.1ad (Provider Bridges) to identify individual 1:1 AVC and CVC services.

This mode is available for unicast data services between the NNI and UNI-DSL.

Figure 2 describes the frame structure for service frames presented at ingress to the NNI using AVC/CVC Service Addressing Mode A, highlighting the S-TAG and C-TAG provided by Customer, required to associate the service frame with an individual CVC/AVC.

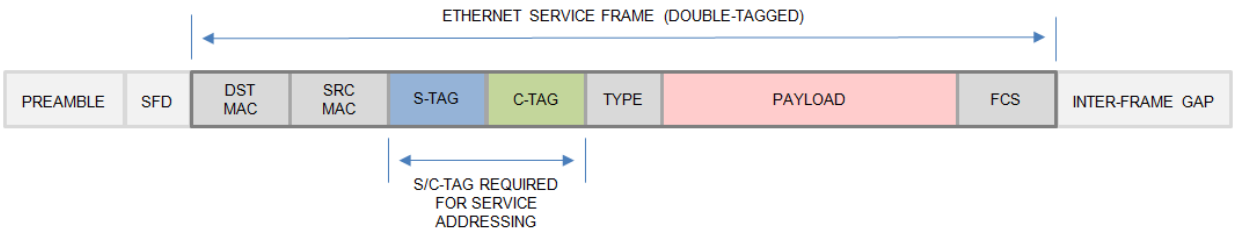

Figure 2: AVC/CVC Service Addressing Mode A Frame Format[3]

Services using this addressing mode use the inner IEEE802.1ad C- VID field to address each individual AVC within a CVC. This C-TAG is visible at the NNI, and for Default-Mapped and DSCP-Mapped UNI-DSL modes is stripped before passing across the UNI-DSL boundary.

The C-VID can be used to address up to 4000 individual AVCs through a single S-TAG. Note that the same C-VID may appear through different S-TAGs on a given NNI, even where both S-TAGs are directed to the same CSA. In such cases, the C-VIDs must always address different UNI-DSLs.

The S/C-PCP field is used to communicate priority information both across the UNI-DSL/NNI boundaries, and within the NBN Co Network.

AVC/CVC Service Addressing Mode A requires that traffic flowing in the downstream direction (from the Customer Network into the NNI) must be tagged with the appropriate S/C-VID settings. Traffic flowing in the upstream direction, upon ingress to the UNI-DSL, may utilise one of two addressing options (refer to section 3.2). It is the responsibility of Customer to ensure that all ingress traffic at the NNI is compliant with the assigned VID settings for each respective service.

3.1.6 AVC/CVC Service Addressing Mode C

This addressing mode is not applicable to the NEBS supplied by means of the NBN Co FTTB Network.

3.1.7 AVC/CVC Service Addressing Mode D

This addressing mode is not applicable to the NEBS supplied by means of the NBN Co FTTB Network.

[3] Refer IEEE802.3 for explanation of service frame fields.

3.2 Addressing AVCs and Traffic Classes at the UNI-DSL

The UNI-DSL supports four addressing modes for accessing AVCs, and indicating the priority of service frames across the UNI-DSL:

- Default-Mapped
- DSCP-Mapped
- Priority-Tagged
- Tagged

These options for addressing services at the UNI-DSL are shown in Table 2.

UNI-DSL Mode	Maximum Number of AVCs addressable at UNI-DSL	Ability to communicate priority information across UNI-DSL[4]?	Comments
Default-Mapped	1	N	Untagged service frames that carry no Layer 2 priority information, as per IEEE802.3.
DSCP-Mapped	1	Y	Untagged service frames that carry no Layer 2 priority information, as per IEEE802.3, where priority information is encoded into the DSCP field, as per RFC2474.
Priority-Tagged	1	Y	Service frames at the UNI-DSL that carry Layer 2 Priority Information in the VLAN tag, as per IEEE 802.1p, where priority information is encoded into the VLAN Priority-Code-Point (PCP) field.
Tagged	1	Y	

Table 2: AVC Addressing Modes at the UNI-DSL

The addressing mode must be specified at time of solution definition, and determines how Customer interfaces to the AVC and UNI-DSL.[5] These modes have no impact of the operation or allocation of AVC C-TAGs at the NNI.

3.2.1 Tag Protocol Identifier (TPID) Formats (UNI-DSL)

Table 3 describes the required TPID values for service frames at ingress to the NBN Co Network. The UNI-DSL TPID is set per UNI-DSL. Any received service frames that do not comply with these values will be discarded at the UNI-DSL ingress.

Interface Mode	S-TPID	C-TPID	Comment
Default-Mapped	N/A[6]	N/A	UNI-DSL operating in Default-Mapped or DSCP-Mapped modes do not support a S-TAG or C-TAG at ingress.

[4] Required for access to traffic classes other than TC-4 (default).

[5] Note the limitations on addressing mode and AVC traffic class combinations in Table 16.

[6] S-TPID appended by NBN Co Network and not visible at UNI-DSL.

DSCP-Mapped			Any tagged frames ingressing at the UNI-DSL may be discarded. For UNI-DSL, the C-TPID is supplied by NBN Co.
Priority-Tagged		0x8100	Priority-Tagged UNI-DSL requires all ingress service frames to comply with the C-TPID.
Tagged		0x8100	Tagged UNI-DSL require all ingress service frames to comply with the C-TPID, and subscribed C-VID.

Table 3: TPID (UNI-DSL) Requirements

Priority-Tagged and Tagged UNI-DSL modes require Customer to specify a C-VID value. The valid range of C-VID values is shown below in Table 4.

Interface Mode	Allowed VDSL2 Equipment-VLAN ID (C-VID)	Comment
Default-Mapped	N/A	C-VID is not supported at the UNI-DSL for this mode.
DSCP-Mapped	N/A	C-VID is not supported at the UNI-DSL for this mode.
Priority-Tagged	0 or Null	In Priority-Tagged mode, a C-VID allocation of anything other than 0 or Null (unpopulated) may result in unsupported behaviours.
Tagged	2 – 4004	In Tagged mode C-VID allocations must match the C-VID specified by Customer at the time Customer orders the associated AVC C-VID allocations outside of the allowed range will result in frames being discarded.

Table 4: C-TAG C-VID (UNI-DSL) Requirements

4 Class of Service (CoS)

The NBN Co Network implements a number of traffic classes that are distinguished in capability and performance, designed to accommodate the widest variety of higher-layer applications. Customer may take advantage of these traffic classes to provide more tailored performance and effective utilisation of the NBN Co Network.

4.1 Traffic Classes

The supported traffic classes are described in Table 5.

Traffic Class	Example Applications	Specification
TC-1	Voice	CIR
TC-2	Streaming standard and high definition video and real-time collaboration applications	CIR

TC-4	Best-effort data	PIR[7] (AVC) CIR[8] (CVC)

Table 5: Supported Traffic Classes

Customer may use these classes to allocate service capacity in a manner that reflects the demands and operation of its end-to-end applications.

Note that for traffic classes where Customer is required only to specify the CIR (i.e. for which the PIR is not specified), the PIR will be automatically set by NBN Co to align with the specified CIR. For example, the TC-1 traffic class of the unicast AVC allows only the specification of the CIR. If Customer specifies an AVC TC-1 CIR of X Mbps in relation to a unicast 1:1 AVC, then the PIR will also be set by NBN Co to X Mbps.

For traffic classes which do not support a CIR (e.g. AVC TC-4), no CIR is provided.

4.1.1 TC-1 Description

The TC-1 traffic class is targeted towards real-time, interactive multimedia applications, with the following characteristics:

- Low bit-rate
- Low frame delay, frame delay variation, frame loss

The attributes of this class are aligned to the characteristics of the DSCP Expedited Forwarding per-hop behaviour described in RFC4594.

TC-1 provides a committed level of premium capacity with limited ability to burst above its CIR, suitable for applications that require deterministic performance and are likely to be sensitive to packet loss.

4.1.2 TC-2 Description

The TC-2 traffic class is targeted towards real-time, interactive multimedia applications, with the following characteristics:

- High bit-rates, and large Ethernet frame sizes
- Low frame delay, frame delay variation, frame loss

The attributes of this class are aligned to the characteristics of the DSCP Assured Forwarding (**AF**) per-hop behaviour described in RFC4594.

TC-2 provides a committed level of premium capacity with limited ability to burst above its CIR, suitable for applications that require deterministic performance and are likely to be sensitive to frame delay variation (FDV/jitter) and frame loss (FLR).

---

[7] TC-4 is implemented as PIR at the AVC, meaning that AVC TC-4 capacity is shared with other traffic classes across the UNI-DSL and is available for TC-4 when higher-priority traffic classes are not utilising it.

[8] TC-4 is implemented as CIR at the CVC, meaning that CVC TC-4 capacity cannot be shared with other CVCs or traffic classes across the NNI.

4.1.3 TC-4 Description

The TC-4 traffic class is targeted towards “best effort” applications, as characterised by the DSCP Default Forwarding per-hop behaviour, described in RFC4594.

4.2 Traffic Class Scheduling

Traffic is scheduled within the NBN Co Network using strict priority, according to the traffic class.

4.3 Bandwidth Profile Parameter Definitions

This section provides clarification of the bandwidth profile parameters used within the NBN Co Network.

4.3.1 Calculation of Information Rate

All Information Rate limitations, including as set out in this Product Technical Specification, are enforced at ingress to the NBN Co Network, and are calculated on Customer Layer 2 Ethernet service frames, over the series of bytes from the first bit of the Destination MAC Address through the last bit of the Frame Check Sequence as defined at the NNI.

IEEE802.3 physical-layer fields such as the Preamble, Start of Frame Delimiter and Inter-Frame Gap are not included in the bandwidth profile.

Note that the effective Layer 2 payload rate of the NBN Co Network will also degrade slightly for lowest-sized Ethernet service frames. This is the expected behaviour for Ethernet-based services for which the bandwidth profile is based on the service frame definitions within section 3. It is the responsibility of Customer to accommodate any payload rate degradation as a result of Layer 2 frame sizes and physical-layer overhead.

4.3.2 Committed Information Rate

CIR defines a level of data throughput for which service frames are delivered according to the performance objectives of the applicable traffic class.

4.3.3 Committed Burst Size

The CBS is set by NBN Co for each CIR specification, and cannot be modified. The CBS may differ between traffic classes, and may be specified differently for the UNI-DSL and NNI, and between the AVC and CVC.

The CBS is used by the policing functions of the NBN Co Network at ingress to the NBN Co Network to determine whether a stream of ingress data complies with the subscribed CIR. Customer is responsible for ensuring that all ingress traffic is shaped to comply with the CIR/CBS as specified for the required traffic class and interface, before presentation to the UNI-DSL or NNI as relevant.

4.3.4 Peak Information Rate

PIR is defined as the maximum data throughput that may be delivered by the NEBS supplied by means of the NBN Co FTTB Network. Note that traffic capacity in excess of the CIR and within the PIR will be carried through the NBN Co Network without any performance objectives. Traffic that exceeds the PIR will be discarded at ingress to the NBN Co Network.

PIR is subject to the limitations described in sections 5.1.1.3 of this specification and sections 3.2 and 12 of the Product Description for the NBN Co Ethernet Bitstream Service.

4.3.5 Peak Burst Size

The PBS defines the length of a burst of Layer 2 traffic (either in bytes or milliseconds as set out below) that may be received at ingress to the NBN Co Network for a burst of traffic that pushes the average Information Rate above the configured bandwidth profile for a PIR traffic class. Traffic in excess of the PBS will be discarded by the NBN Co Network. The PBS is set by NBN Co for each PIR specification, and cannot be modified.

The PBS is used by the policing functions of the NBN Co Network at ingress to the NBN Co Network to determine whether a stream of ingress data complies with the subscribed PIR. Customer is responsible for ensuring that all ingress traffic is shaped to comply with the PIR/PBS as specified for the required traffic class and interface, before presentation to the UNI-DSL or NNI as relevant.

4.4 Bandwidth Specification Model – AVC

Customer is required to select the desired amount of capacity for each traffic class required for the AVC at time of order, as part of submitting a Product Order Form for an AVC.

The selectable AVC bandwidth profiles components for traffic classes are shown in Table 6 and specified limitations are enforced at the UNI-DSL.

Traffic Class	Component	Units	Description
TC-1	CIR	Mbps	CIR requirement for TC-1. Available settings are described in section in 5.3.2.3
	CBS[10]	Bytes	2,000
TC-2	CIR	Mbps	CIR requirement for TC-2 Available settings are described in section 5.3.2.3
	CBS[11]	msec	10
TC-4	PIR	Mbps	PIR requirement for TC-4. Available settings are described in section 5.3.2.3
	PBS	msec	10 Downstream at the NNI[12]
		Bytes	40,000 Upstream at the UNI-DSL[13]

Table 6: Bandwidth Profile Components – 1:1 Unicast AVC

Refer to section 5.3.2.3 for supported AVC bandwidth profiles.

[10] The AVC TC-1 CBS is bi-directional, set by NBN Co, and cannot be modified by Customer.

[11] The AVC TC-2 CBS is bi-directional, set by NBN Co, and cannot be modified by Customer.

[12] Specific PBS setting in Bytes is dependent on the TC-4 PIR (bandwidth profile) selected.

[13] The AVC TC-4 PBS is set by NBN Co and cannot be modified by Customer.

Note that the TC-1 CIR capacity is allocated within the TC-4 PIR. For example, a 12Mbps TC-4 PIR with a 0.15Mbps TC-1 CIR will be delivered with a total AVC capacity of 12Mbps, and when TC-1 is transmitting, this subtracts from the data that can be transmitted in TC-4.

4.5 Bandwidth Specification Model – CVC

Customer is required to nominate the capacity for each required traffic class within the CVC at time of order, as part of submitting a Product Order Form for the CVC. The CVC bandwidth profile components for traffic classes are shown in Table 7 with specified limitations enforced at the NNI.

Traffic Class	Component	Units	Description
TC-1	CIR	Mbps	CIR requirement for TC-1 Available settings are detailed in section 5.4.6
	CBS[14]	Bytes	16,000
TC-2	CIR	Mbps	CIR requirement for TC-2 Available settings are detailed in section 5.4.6
	CBS[15]	msec	10
TC-4	CIR	Mbps	CIR requirement for TC-4 Available settings are detailed in section 5.4.6
	CBS[16]	msec	10

Table 7: Bandwidth Profile Components – 1:1 Unicast CVC

Note: In relation to CVC TC-4 speed tiers of 4000 Mbps or greater, the maximum Committed Burst Size (CBS) value supported by NBN Co is 4 megabytes, and will not support a time-based 10 millisecond (ms) CBS value based on the CVC CIR bandwidth profile chosen by the Customer.

Note that capacity specified within a CVC bandwidth profile is inclusive of the S/C-TAGs, as described in the service frame definition in Figure 2.

Refer to section 5.4.6 for supported CVC bandwidth profiles.

4.6 Traffic Contention and Congestion Management

Customer may control End User experience of applications using the unicast functionality of the NEBS supplied by means of the NBN Co FTTB Network, through contention applied through dimensioning of capacity between the AVC and CVC.

Contention may be applied at the traffic class level, allowing Customer to independently control the economics and operation of each traffic class. This is controlled by Customer through careful dimensioning of AVC and CVC capacity, on a traffic class basis, to ensure a level of contention appropriate for each respective higher-layer application.

Customer must be aware of the implications of contending AVC and CVC components, as this will effectively degrade the performance of Customer Products and Downstream Products.

4.7 Priority Identification

Customer may use a number of methods to indicate relative priority of individual service frames depending on the NBN Co Network interface. The available methods differ for the UNI-DSL and NNI, as shown in Table 8.

Marking Scheme	UNI-DSL	NNI
PCP field (IEEE802.1p)	Y[19]	Y
DSCP (RFC2474)	Y[20]	N
Default-Mapped (Un-marked)	Y[21]	N

Table 8: Priority Marking Options

Note that the DSCP priority marking for ingress traffic at the UNI-DSL is supported only for traffic encapsulated as IP over Ethernet. Note also the limitations on addressing mode and AVC traffic class combinations in Table 16.

4.8 Priority Encoding

This section describes how Customer Equipment should encode priority information into service frames that ingress the NBN Co Network in order to ensure those frames are forwarded in the correct NBN Co traffic classes.

Customer must conform to the IEEE802.1P and DSCP settings indicated in Table 9 to map traffic into traffic classes at the UNI-DSL and NNI. Consequently:

- These ingress assignments are valid for ordered traffic classes only.
- For all NNI configurations, any ingress traffic that does not map to a provisioned CVC traffic class will be discarded at ingress.
- For UNI-DSL configured as Default-Mapped, all ingress traffic will be mapped to the TC-4 traffic class, irrespective of DSCP markings.
- For UNI-DSL configured as Priority-Tagged, any ingress traffic that does not map to a traffic class provisioned in respect of the associated AVC will be discarded at ingress.
- For UNI-DSL configured as Tagged, any ingress traffic that does not map to a traffic class provisioned in respect of the associated AVC will be discarded at ingress.
- For UNI-DSL configured as DSCP-Mapped, any ingress traffic that does not map to a provisioned AVC traffic class will be mapped to the TC-4 traffic class.

[19] Supported for Priority-Tagged and Tagged UNI-DSL mode only.

[20] Supported for DSCP mapped UNI-DSL mode only.

[21] Supported for Default mapped UNI-DSL mode only.

Customer will be required to specify all required UNI-DSL and NNI PCP assignments during the on-boarding phase for the NEBS supplied by means of the NBN Co FTTB Network.

Traffic Class	PCP/DSCP Assignment (Ingress)		
	CoS (UNI & NNI)	DSCP[22] (UNI) IPv4	
		DSCP	DSCP (Decimal)
TC-1	5	CS5, EF	40 – 47
TC-2	4	CS4, AF 41 - 43	32 - 39
TC-MC[23]	N/A[24]	N/A	N/A
TC-4	0	CS1, AF 11 – 13 CS0, Default	24-31, 16-23, 8 – 15, 0 – 7, 48-63

Table 9: Class of Service Encoding

4.9 Priority Decoding

This section describes how service frames carried in NBN Co traffic classes will have priority encoded at the egress from the NBN Co Network. Egress CoS decoding is described in Table 10.

Traffic Class	PCP/DSCP Assignment (Egress)
	CoS (UNI-DSL & NNI)
TC-1	5
TC-2	4
TC-4	0

Table 10: Class of Service Decoding

5 Product Component Attributes

5.1 User Network Interface (UNI-DSL)

Each UNI-DSL is logically connected to an NNI via an AVC and CVC. A UNI-DSL supports a single unicast AVC where the NEBS is supplied by means of the NBN Co FTTB Network.

[22] DSCP-mapping available at UNI-DSL only.

[23] Multicast AVCs are not supported for DSL services..

[24] Multicast AVC's are not supported for DSL services.

5.1.1 UNI-DSL

Each UNI-DSL is regarded as a fully independent interface, operating in total isolation from any other UNI-DSL interfaces.

5.1.1.1 FTTB Network Boundaries

The NBN Co Network Boundaries relating to the NEBS supplied by means of the NBN Co FTTB Network are specified in the Product Description for the NBN Co Ethernet Bitstream Service.

5.1.1.2 UNI-DSL Interface Modes

The UNI-DSL supports the VDSL (VDSL2) interface mode. For UNI-DSL services it is the Customer's responsibility to provide a VDSL2 modem, as outlined in Section 8.

5.1.1.3 UNI-DSL Scalability Factors

The UNI-DSL is scalable in terms of capacity and services. Each UNI-DSL has two capacity metrics that define its ability to carry Customer Products and Downstream Products.

5.1.1.3.1 *Line Rate*

The Line Rate defines the actual bit rate at which the physical interface will transfer data (**Line Rate**). The Line Rate sets the maximum bound on the information-carrying capacity of the link. The Line Rate achieved on the UNI-DSL is reflected by the reported DSL Actual Data Rate and is subject to the limitations described in sections 3.2 and 12 of the Product Description for the NBN Co Ethernet Bitstream Service.

Customer must be familiar with the inherent limitations of VDSL2 and that achieved Line Rates will depend on:

- the copper pair line length and attenuation, including in building cabling or lead-in length
- the state of copper wiring in-building or in the Premises
- the number of other data services that share common network cable runs
- framing overheads, asynchronous operation and the impact on bandwidth efficiency
- the presence of pre-existing exchange based services (e.g. ADSL) within a cable run and the use of Downstream Power Back-off
- G.Inp retransmissions.

The UNI-DSL will be configured to auto-negotiate Line Rates with the End User Equipment. NBN Co is not responsible for any traffic loss at the UNI-DSL that may result due to the UNI-DSL negotiating a Line Rate with any attached device beyond the NBN Co Network Boundary, or negotiating a Line Rate that is insufficient to deliver the required AVC capacity. NBN Co is not responsible for any degradation of Line Rate or traffic loss at the UNI-DSL as a result of degraded copper wiring, including bridged taps, beyond the NBN Network Boundary.

5.1.1.3.2 *Information Rate*

The Information Rate defines the amount of logical Layer 2 (Ethernet) capacity assigned to the UNI-DSL (**Information Rate**).

For DSL services the Information Rate is limited to the lesser of the aggregate AVC bandwidth

and the actual Line Rate on the UNI-DSL. Note also that for VDSL2 the Line Rate and Information Rate are subject to VDSL2 Ethernet over copper framing overheads as defined in the ITU-T VDSL2 specification G.993.2.

The Information Rate is also subject to the limitations described in sections 3.2 and 12 of the Product Description for the NBN Co Ethernet Bitstream Service.

Choice of AVC bandwidth profiles used, both PIR and CIR, and PIR used should be informed by predicted Line Rates, as indicated via Service Qualification, and actual Line Rates achieved in operation.

Note that once provisioned, AVC bandwidth profiles will not be automatically re-adjusted as a result of DSL negotiated Line Rates. Should a UNI-DSL auto-negotiate to a Line Rate less than the requested AVC rate, the End User may experience increased frame loss in excess of the frame loss targets for each traffic class on the provisioned AVC.

5.1.1.3.3 *CIR on DSL*

Committed Information Rate (CIR) bandwidth profiles and performance targets are subject to the Line Rate at the UNI-DSL, where:

$TC\text{-}1_{CIR} + TC\text{-}2_{CIR} + 1\ Mbps \leq$ Line Rate (for L2 Bitstream Capacity)

5.1.1.4 UNI-DSL Functional Attributes

5.1.1.4.1 *Frame Forwarding*

The UNI-DSL implements forwarding of service frames as per IEEE802.1ad, section 8.6.

Destination MAC Address	Application	Default Behaviour	Optional Configurable Behaviour
01-80-C2-00-00-00	Bridge Group Address	Discard	None
01-80-C2-00-00-01	IEEE Std 802.3 PAUSE	Discard	None
01-80-C2-00-00-02	LACP/LAMP	Discard	None
	Link OAM	Discard	None
01-80-C2-00-00-03	IEEE Std. 802.1X PAE address	Discard	None
01-80-C2-00-00-04 - 01-80-C2-00-00-0F	Reserved	Discard	None
01-80-C2-00-00-10	All LANs Bridge Management Group Address	Discard	None
01-80-C2-00-00-20	GMRP	Discard	None
01-80-C2-00-00-21	GVRP	Discard	None
01-80-C2-00-00-22 - 01-80-C2-00-00-2F	Reserved GARP Application addresses	Discard	None

01-80-C2-00-00-30 - 01-80-C2-00-00-3F	CFM	Tunnel[29]	None

Table 11: UNI-DSL Frame Forwarding Details

Note the following definitions for the purposes of the above table:

- Discard – the service frame will be discarded at ingress to the NBN Co Network
- Tunnel – the service frame is passed to the AVC/CVC and carried through the NBN Co Network

Note that ingress frames to the UNI-DSL (in Default-Mapped or DSCP-Mapped modes) that contain an IEEE802.1Q VLAN tag may be discarded.

5.1.1.4.2 *MAC Address Limitations.*

Each UNI-DSL is capable of supporting up to eight simultaneous MAC source addresses. This imposes a limit on the number of Layer 2 devices that Customer may allow to connect directly to each UNI-DSL. Any attempt to connect a number of devices directly to a UNI-DSL that exceeds this limit will result in traffic from the newly-attached devices being discarded.

The NBN Co Network will learn the first eight MAC source addresses detected at ingress to the UNI-DSL, based upon ingress service frames. A MAC address ageing function ensures that any obsolete MAC addresses are removed from the active list, after a period of 300 seconds.

Note that this limitation applies for the UNI-DSL irrespective of the service type and does not imply MAC address-based forwarding for unicast services based on 1:1 VLANs.

Customer should use a device that performs Layer 3 routing to interconnect to the UNI-DSL. If Customer does not do so, Customer accepts the consequences of any issues arising from MAC address restrictions.

5.1.1.4.3 *Resiliency*

By default, the UNI-DSL is an unprotected physical interface. If an unprotected UNI-DSL suffers a failure, all services being delivered across that UNI-DSL will be disrupted.

5.2 Access Virtual Circuit (AVC)

5.2.1 Overview

The AVC implements the C-VLAN component of an IEEE802.1ad Provider Bridge, as described in section 3 of this Product Technical Specification.

Customer may deliver multiple End User applications (such as voice and video) using a single AVC (using CoS to manage the capacity between applications).

The NEBS supplied by means of the NBN Co FTTB Network supports the unicast, 1:1 AVC over the UNI-DSL.

5.2.2 AVC Scalability

For the NEBS supplied by means of the NBN Co FTTB Network, a single Unicast AVC is supported on a single UNI-DSL interface.

At the NNI AVCs are logically isolated from each other via the use of distinct S-TAG/C-TAG VIDs, and are designed to be individually dimensioned by Customer from a set of selectable parameters according to the service needs of each End User. An AVC is designed to be scaled in capacity (through its bandwidth profile), within the bounds of the product constructs and the physical limits of the underlying access network technology.

5.2.3 Access Loop – Line Characteristics and Identification

Customer may optionally configure a unicast AVC to have information inserted into relevant upstream Layer 3 control packets, which may assist Customer to identify the individual logical circuit to upstream devices beyond the NNI in the NBN Co Network Boundaries.

This section describes the supported protocols and information that may be optionally inserted.

5.2.3.1 DHCP Option 82 Support

An AVC may be optionally configured to provide support for DHCP Option 82.

DHCP Option 82 is designed to allow the following fields to be set:

- Circuit-ID
- Remote-ID
- Actual Data Rate Upstream
- Actual Data Rate Downstream

NBN Co will insert DHCP Option 82 fields into upstream DHCP DISCOVER and REQUEST messages upon ingress to the AVC at the UNI-DSL. The fields should be set as follows:

- Circuit-ID – The Circuit-ID should be set to the following format: the first three bytes will signify the AVC product prefix and the next 12 bytes will be a unique string identifying the AVC. Concatenated together, these values will form the **AVC Service ID**. If End User Equipment attached to the AVC populates the Circuit-ID field, the NBN Co infrastructure will replace it with the AVC Service ID. The format for the AVC Service ID is illustrated in Figure 3 below.

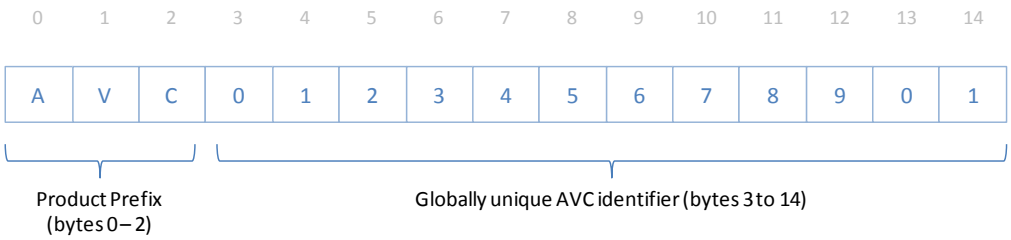

Figure 3: DHCP Option 82 Circuit-ID Field Format

- Remote-ID – The Remote-ID will not be populated. If End User Equipment attached to an AVC populates the Remote-ID field, the NBN Co Network will strip this field.
- Actual Data Rate upstream (sub-option: 0x81) and Actual Data Rate downstream (sub-option: 0x82) - The “Actual Data Rate” fields are encoded as a 32 bit unsigned integer and represent the bit rate in kbps. This value takes into account the negotiated DSL bit rate and G.INP retransmission budget. Note that the DSL Line Rate may exceed the line rate required to

support the AVC PIR. In these cases, it is recommended that if traffic shaping is required by Customer then this is done according to the AVC rate rather than DSL Line Rate.

Customer must ensure that upstream DHCP DISCOVER and REQUEST messages comply with the BOOTP length guidelines contained within RFC1542 (section 2.1) before presentation at the UNI-DSL.

5.2.3.2 DHCPv6 Option 18/37 Support

An AVC may be optionally configured to provide support for DHCPv6 Option 18 (Interface-ID).

When the Access Loop Identification functionality is enabled, NBN Co will encapsulate all DHCPv6 messages received at the UNI-DSL in a DHCPv6 Relay Forward message, with Option 18 (Interface-ID) set to the AVC (as per RFC 3315).

The fields will be set as follows:

- Interface-ID – The Interface-ID will be set to the following format: the first three bytes will signify the AVC product prefix and the next 12 bytes will be a unique string identifying the AVC. Concatenated together, these values will form the **AVC Service ID**. If End User Equipment attached to the AVC populates the Interface-ID field, the NBN Co infrastructure will replace it with the AVC Service ID. The format for the AVC Service ID is illustrated in Figure 4 below.

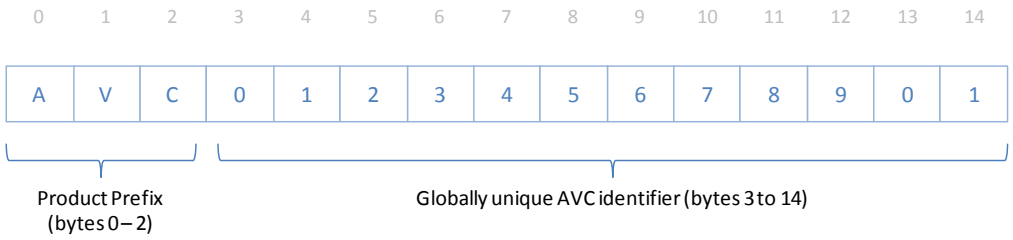

Figure 4: DHCPv6 Option 18 Interface-ID Field Format

Option 37 (Remote-ID) is not supported. The Remote-ID will not be populated in the DHCPv6 Relay Forward message.

If End User Equipment attached to an AVC sends a DHCPv6 Relay Forward message, the entire message will be encapsulated as an option (Option-20, Relay-Message) in the NBN DHCPv6 Relay Forward message; in this case, any DHCPv6 options attached by the End User Equipment, including Option 18 or Option 37, will be carried transparently in the encapsulated message.

5.2.3.3 PPPoE Intermediate Agent Support

An AVC may be optionally configured for PPPoE Intermediate Agent support.

The PPPoE Intermediate Agent support configuration allows for the following fields to be set:

- Circuit-ID
- Remote-ID
- Actual Data Rate upstream
- Actual Data Rate downstream

NBN Co will insert PPPoE Intermediate Agent Option 82 fields into upstream PPP PADI messages upon ingress to the AVC at the UNI-DSL. The fields will be set as follows:

- Circuit-ID – The Circuit-ID will be set to the following format: the first three bytes will signify the AVC product prefix and the next 12 bytes will be a unique string identifying the AVC. Concatenated together, these values will form the AVC Service ID. If End User Equipment attached to the AVC populates the Circuit-ID field, the NBN Co Network will replace it with the AVC Service ID. The format for the AVC Service ID is illustrated in Figure 5 below.

Figure 5: PPPoE Intermediate Agent Circuit-ID Field Format

- Remote-ID – The Remote-ID will not be populated. If End User Equipment attached to an AVC populates the Remote-ID field, the NBN Co Network will strip this field.
- Actual Data Rate Upstream – TR-101 Sub-Tag-Number: 0x81
- Actual Data Rate Downstream – TR-101 Sub-Tag-Number: 0x82

  The "Actual Data Rate" fields are encoded as a 32 bit unsigned integer and represent the bit rate in kbps. This value takes into account the negotiated DSL bit rate and G.INP retransmission budget. Note that the DSL Line Rate may exceed the line rate required to support the AVC PIR. In these cases, it is recommended that if traffic shaping is required by Customer then this is done according to the AVC rate rather than DSL Line Rate.

5.3 Access Components

Access Components, for the purposes of this Product Technical Specification only comprise each instance of the UNI-DSL and AVC Product Components supplied by NBN Co to Customer to use as an input to a Customer Product or Downstream Product.

Each Access Component is delivered using two sets of attributes:

- **configuration attributes** – provided through Product Templates
- **service attributes** – provided through Product Order Forms for each AVC order

This section describes the Access Components in the context of configuration and service attributes.

5.3.1 Configuration Attributes

The following tables detail all AVC and UNI-DSL attributes which must be specified within a Product Template, for the delivery of the relevant Access Components.

Customer may construct its end-to-end service from a combination of these configuration attributes and service attributes selected in relation to each Ordered Product.

Certain settings required to interface to the NBN Co Network must be decided at time of On-boarding during the solution definition phase, and captured in a Product Template. These details cannot be tailored for each specific Ordered Product.

Product Templates apply to the Access Components only. Product Templates, combined with per-Ordered Product service attributes selected in a Product Order Form at time of order, are required for NBN Co to supply an Ordered Product.

5.3.1.1 UNI Configuration Attributes

The following set of configuration attributes are supported by the UNI-DSL. These parameters are captured during the solution definition phase, as part of the On-boarding process.

Configuration Attribute	Configuration Attribute Options
VLAN Mode	Default-Mapped[31]
	DSCP-Mapped
	Priority-Tagged
	Tagged

Table 12: UNI-DSL Configuration Attributes

5.3.1.2 AVC Configuration Attributes

The following set of configuration attributes are supported by the AVC (and Multicast AVC). These parameters are captured during the solution definition phase, as part of the On-boarding process.

Component	Configuration Attribute	Configuration Attribute Options
AVC	AVC Type	Unicast 1:1 (UNI-DSL)
	Supported bandwidth profiles	Refer to section 5.3.2.5

Table 13: AVC Configuration Attributes

5.3.2 Service Attributes

This section describes the service attributes relating to the technical operation of the service that Customer must select for each Access Component, at the time of ordering an Ordered Product.

5.3.2.1 Unicast AVC Service Attributes

The following service attributes must be specified at the time of order for each unicast 1:1 AVC:

Component	Service Attribute	Specification (Provided by Customer)
AVC	CVC ID	CVC ID
	C-VID at NNI (1:1 AVC only)	0 – 4000[34]

[31] Note the limitations on addressing mode and AVC traffic class combinations in Table 17.

	Bandwidth Profile	Specified from list of supported unicast AVC Bandwidth Profiles in Table 16	
	Access Loop Identification	Active, Inactive	
		If Active, Insert DSL line rate (used in DHCP or PPP response [RFC 4679 support]	True / False
	Interface mode	Default-Mapped / Priority-Tagged/Tagged/DSCP Mapped	

Table 14: Service Attributes for AVC

5.3.2.2 DSL Service Attributes

The following DSL service attributes must be specified at time of order:

Component	Service Attribute	Specification (Provided by Customer)
UNI-DSL	DSL Stability Profile	Standard - means the standard VDSL2 line profile.
		Stable - means a VDSL2 line profile designed to optimise layer 1 stability, through an increased noise margin and G.Inp retransmission buffer.

Table 15: Service Attributes for UNI-DSL

Note that DSL Mode is VDSL and cannot be changed.

5.3.2.3 Supported Unicast 1:1 AVC Bandwidth Profiles

This table shows the valid combinations that may be used to populate the bandwidth profile (upstream and downstream) for a unicast 1:1 AVC. The bandwidth profiles in the table below are subject to the limitations described in sections 3.2 and 12 of the Product Description for the NBN Co Ethernet Bitstream Service. The bandwidth profile to be used for a specific order for an Access Component will be provided at time of order, and will be chosen as per the End User's service requirements.

[34] The value of zero indicates that NBN Co will select the C-VID, and does not indicate that a C-VID of zero may be used.

Profile Number	AVC_TC-4 (DOWN-STREAM) (Mbps)	AVC_TC-4 (UPSTREAM) (Mbps)	AVC_TC-2 (UPSTREAM, DOWN-STREAM) (Mbps)	AVC_TC-1 (UPSTREAM, DOWN-STREAM) (Mbps)	UNI Interface	UNI-D Supported Interface Mode[37]	
						Default-Mapped	DSCP-Mapped, Priority-Tagged and Tagged
1	12	1	0	0	UNI-DSL	Y	Y
2	12	1	0	0.15	UNI-DSL	N	Y
3	12	1	0	0.3	UNI-DSL	N	Y
4	25	5	0	0	UNI-DSL	Y	Y
5	25	5	0	0.15	UNI-DSL	N	Y
6	25	5	0	0.3	UNI-DSL	N	Y
7	25	5-10	0	0	UNI-DSL	Y	Y
8	25	5-10	0	0.15	UNI-DSL	N	Y
9	25	5-10	0	0.3	UNI-DSL	N	Y
10	25	5-10	5	0	UNI-DSL	N	Y
11	25	5-10	5	0.15	UNI-DSL	N	Y
12	25	5-10	5	0.3	UNI-DSL	N	Y
13	25-50	5-20	0	0	UNI-DSL	Y	Y
14	25-50	5-20	0	0.15	UNI-DSL	N	Y
15	25-50	5-20	0	0.3	UNI-	N	Y

[38] Refer to section 1.3 of this Product Technical Specification.

Profile Number	AVC_TC-4 (DOWN-STREAM) (Mbps)	AVC_TC-4 (UPSTREAM) (Mbps)	AVC_TC-2 (UPSTREAM, DOWN-STREAM) (Mbps)	AVC_TC-1 (UPSTREAM, DOWN-STREAM) (Mbps)	UNI Interface	UNI-D Supported Interface Mode[37]	
						Default-Mapped	DSCP-Mapped, Priority-Tagged and Tagged
					DSL		
16	25-50	5-20	5	0	UNI-DSL	N	Y
17	25-50	5-20	5	0.15	UNI-DSL	N	Y
18	25-50	5-20	5	0.3	UNI-DSL	N	Y
19	25-100	5-40	0	0	UNI-DSL	Y	Y
20	25-100	5-40	0	0.15	UNI-DSL	N	Y
21	25-100	5-40	0	0.3	UNI-DSL	N	Y
22	25-100	5-40	5	0	UNI-DSL	N	Y
23	25-100	5-40	5	0.15	UNI-DSL	N	Y
24	25-100	5-40	5	0.3	UNI-DSL	N	Y

Table 16: Supported Unicast 1:1 AVC Bandwidth Profiles

5.3.2.4 Modification of an AVC bandwidth profile and service interruption

Customer may modify an AVC TC-4 bandwidth profile in accordance with the NBN Co Operations Manual. There will be a brief service interruption when the Modify Order is processed.

5.3.3 Speed during co-existence of ADSL and Special Services

During Co-existence Period for the NEBS supplied by means of the NBN Co FTTB Network, exchange based ADSL and Special Services may also both be present. During this period optimal VDSL2 line speeds will not be possible due the use of Downstream Power Back-off (DPBO) at the VDSL2 node and cross talk from the exchange based services. Customer should therefore consider these factors in the selection of AVC bandwidth profiles. Sections 3.2 and 12 of the Product Description for the NBN Co Ethernet Bitstream Service describe the speeds which will be available during this period.

5.4 Connectivity Virtual Circuit (CVC)

This section describes the technical interface and operational requirements of the CVC.

5.4.1 Overview

The CVC implements the S-VLAN component of an IEEE802.1ad Provider Bridge. This is an Ethernet virtual circuit that provides connectivity between an NNI and CSA. It is dimensioned with a specific, configured amount of bandwidth capacity to deliver a higher-layer service (or number of services) to a range of AVCs within a particular CSA.

The CVC must be configured as 1:1 VLAN, for 1:1 AVC unicast services delivered using the UNI-DSL interface.

The NNI, and all CVCs delivered through it, are specific to Customer. It is possible that Customer may have multiple CVCs within a CSA delivered using a number of NNI.

Customer may request to cancel a CVC. A CVC cancellation can only proceed once all member AVCs have been removed from that CVC.

5.4.2 CVC Scalability

CVCs are isolated from each other on an NNI via the use of distinct S-VIDs and can each be individually dimensioned according to the service needs of each CSA and each AVC contained within the CVC. CVCs using different service modes (including the Multicast Domain) are able to co-exist on the same NNI.

Customer should consider scalability in conjunction with contention. Customer may control End User experience through contention applied by dimensioning of capacity between the AVC and CVC.

5.4.2.1 1:1 Unicast CVC Scalability

A single 1:1 unicast CVC can support up to 4000 1:1 unicast AVCs, and is able to deliver AVCs to any UNI-DSL within a single CSA. Each of the 4000 1:1 unicast AVCs is addressed using a single, unique C-VID, locally significant to the CVC. The number of CVCs that Customer may purchase in relation to a given CSA is limited only by the NNI resources that Customer has purchased for that CSA.

Note that where Customer requires access to more than 4000 AVCs in a given CSA, it is necessary to utilise more than one CVC.

5.4.3 CVC Interfacing

Each CVC is directly accessed by Customer at the NNI. The VLAN tagging options for interfacing to the CVC at the NNI are described in section 3.

The CVC S-VID is designed to be validated at ingress to the NNI. Any traffic that does not comply with this tagging structure, or contains S-VID settings that are not agreed values, will be discarded at ingress to the NNI.

5.4.4 CVC Congestion Management

Customer should control AVC:CVC contention for the purpose of managing service utilisation. In the event of AVC:CVC congestion within unicast services, the NBN Co Network will discard traffic in accordance with section 4 of this Product Technical Specification.

5.4.5 CVC Service Attributes

There is no Product Template required for a CVC. Table 17 describes the set of service attributes which are generic to all CVC variants.

Component	Attributes	Attribute Description	Selectable Options
End-Point Identification	NNI Group identification[38]	Identification of the NNI that the CVC is to be terminated on.	NNI Group identification (Existing)
	B-END CSA	Identification of the CSA that the CVC is terminated on.	CSA identification
S-TAG Mapping	S-TAG (NNI)	Customer may choose a locally-significant S-TAG at the NNI. Optional parameter. If set to zero, NBN Co will assign the next available value.	Requested S-TAG (0 for NBN Co-supplied S-TAG) Default = 0 S-TAG: (1 – 4000)

Table 17: Generic CVC Service Attributes

5.4.5.1 Unicast 1:1 CVC

Each unicast 1:1 CVC order must specify each of the service attributes listed in below, in addition to those detailed in Table 17.

Component	Attributes	Attribute Description	Selectable Options
Bandwidth profile	Bandwidth profile	CVC_TC-1_CIR (upstream and downstream)	Refer Table 19
		CVC_TC-2_CIR (upstream and downstream)	Refer Table 20
		CVC_TC-4_CIR (upstream and downstream)	Refer Table 21

Table 18: 1:1 Unicast CVC Additional Service Attributes

5.4.6 Supported CVC Bandwidth Profiles

5.4.6.1 Unicast 1:1 and N:1 CVC Bandwidth Profiles

The bandwidth profile for a unicast CVC may be constructed by independently selecting the TC-1 and TC-4 capacities, from the following tables.

[38] Refer to section 1.3 of this Product Technical Specification.

Profile Number	CVC_TC-1 (Mbps)
1	0
2	5
3	10
4	20
5	50
6	100
7	150
8	200
9	250
10	300
11	400
12	500

Table 19: Unicast CVC TC-1 Bandwidth Profile Capacities[39]

Profile Number	CVC_TC-2 (Mbps)
1	0
2	50
3	100
4	150
5	200
6	250
7	300
8	400
9	500
10	600
11	700
12	800
13	900

[39] Available for Unicast CVC services configured as N:1 or 1:1.

14	1000

Table 20: Unicast CVC TC-2 Bandwidth Profile Capacities[40]

Profile Number	CVC_TC-4 (Mbps)
1	0
2	100
3	150
4	200
5	250
6	300
7	400
8	500
9	600
10	700
11	800
12	900
13	1000
14	1100
15	1200
16	1300
17	1400
18	1500
19	1600
20	1700
21	1800
22	1900
23	2000
24	3000

[40] Available for Unicast CVC services configured as 1:1 only..

Profile Number	CVC_TC-4 (Mbps)
25	4000
26	5000
27	6000
28	7000
29	8000
30	9000
31	10,000

Table 21: Unicast CVC TC-4 Bandwidth Profile Capacities[41]

5.5 Network-Network Interface (NNI)

The NNI defines the interface through which Customer accesses CVC instances.

Each physical interface (**NNI Bearer**) is configured as a member of a logical group (**NNI Group**) using IEEE802.1ax Link Aggregation (LACP enabled) within the Ethernet Fanout Switch (**EFS**).

5.5.1 NNI Group

The NNI Group has the following attributes:

- Location
- Interface Rate
- Redundancy Mode
- Set of NNI Bearers
- Layer 2 Functional Characteristics

5.5.1.1 NNI Group Location

The location of the NNI Group must be specified at time of NNI Group creation.

In order to change the location of an NNI Group (i.e. re-locate NNI Bearers to a different location), it is necessary to purchase a new NNI Group in the intended location, and transition existing AVCs and CVCs from the old NNI Group. Once completed, the previous NNI Group may be cancelled.

5.5.1.2 NNI Group Interface Rate

A new NNI Group will be configured with a group interface rate that determines the interface rate of each NNI Bearer within the NNI Group. The following group interface rates are supported:

- 1Gbps

[41] Available for Unicast CVC services configured as 1:1 only.

- 10Gbps

The group interface rate is set through the selection of the first NNI Bearer (Single Chassis mode), or pair of NNI Bearers (Diverse Chassis mode) at the time the NNI Group is created (each mode is described in section 5.5.1.3).

The group interface rate is fixed per NNI Group and will restrict the type of NNI Bearer that can be added to the NNI Group. For example, if the NNI Group is created with an initial NNI Bearer operating at 1Gbps, then any further NNI Bearers added to this group must also have an interface rate of 1Gbps.

In order to change the group interface rate of an NNI Group (i.e. change all 1Gbps NNI Bearers to 10Gbps), it is necessary to purchase a new NNI Group in the intended group interface rate and associated NNI Bearers, and transition existing AVCs and CVCs from the old NNI Group. Once completed, the previous NNI Group may be cancelled by Customer.

5.5.1.3 NNI Group Redundancy Mode

The NNI Group must be configured in one of the following redundancy modes:

- **Single Chassis** (where all NNI Bearers are connected to the same EFS chassis)
- **Diverse Chassis** (where NNI Bearers are connected across a pair of EFS chassis)

5.5.1.3.1 *Single Chassis Redundancy Mode*

When an NNI Group is configured in Single Chassis mode, all NNI Bearers of the NNI Group will be provisioned on the same EFS chassis.

These NNI Bearers will operate in an N:1 protection mode, meaning that if any NNI Bearer within the NNI Group fails, the NNI Group will continue to operate at an aggregate capacity that is reduced by the capacity of the failed NNI Bearer.

5.5.1.3.2 *Diverse Chassis Redundancy Mode*

When an NNI Group is configured in Diverse Chassis mode, half of the NNI Bearers of the NNI Group will be provisioned on one EFS (working) chassis, and the other half will be provisioned on a second EFS (protect) chassis.

The NNI Group will operate in a 1:1 protection mode, meaning that if any NNI Bearer on the working EFS fails, traffic will be re-directed to the NNI Bearers on the protect EFS chassis.

5.5.1.3.3 *Redundancy Mode Modification*

The redundancy mode is configured per NNI Group at the time that the NNI Group is ordered, and cannot be modified once activated.

In order to change the redundancy mode of an NNI Group, Customer must purchase a new NNI Group in the intended redundancy mode and transition existing AVCs and CVCs from the old NNI Group. Once completed, the previous NNI Group may be cancelled.

5.5.1.4 Set of NNI Bearers

An NNI Group can support up to 8 NNI Bearers[42] . All NNI Bearers within an NNI Group must be consistent with the group interface rate for that NNI Group[43] (i.e. 1Gbps, or 10Gbps). The following activities may be performed on an NNI Group, with respect to the set of NNI Bearers:

- establish a new NNI Group through ordering at least one NNI Bearer (Single Chassis mode) or at least one pair of NNI Bearers (Diverse Chassis mode)
- modify an existing NNI Group through adding/removing NNI Bearer(s)
- cancel an existing NNI Group – all underlying NNI Bearers will be automatically cancelled

For NNI Groups configured as Single Chassis, NNI Bearers may be ordered as single interfaces.

For NNI Groups configured as Diverse Chassis, NNI Bearers must be ordered in pairs, with each NNI Bearer of each pair provisioned on different EFS.

For NNI Groups comprising 1Gbps Ethernet interfaces, NBN Co intends to use reasonable endeavours to provide the ability to seamlessly scale an NNI Group up to four NNI Bearers. Beyond four NNI Bearers, NBN Co will schedule an Outage with Customer unless NBN Co notifies Customer that an Outage is not necessary.

For NNI Groups comprising 10Gbps Ethernet interfaces, NBN Co intends to schedule an Outage with Customer in order to augment the NNI Group with additional NNI Bearers unless NBN Co notifies Customer that an Outage is not necessary.

5.5.1.5 LACP Peering

The determination of the working/protect status of the links within an NNI Group is based only on whether or not the NNI is able to connect to an LACP partner on the link. It cannot be influenced by LACP signalling (IN_SYNC/OUT_OF_SYNC messages) from Customer Equipment. Only loss of LACP connectivity between the NNI and Customer Equipment (as a result of a fibre break or interface failure for example), will prevent a link from being selected for working status.

5.5.1.6 Layer 2 Functional Characteristics

5.5.1.6.1 *TPID Setting*

The NNI Group must be configured with an S-TPID that is common across all NNI Bearers within the NNI Group. This must be selected by Customer in the NNI Product Order Form at time of order. S-TPIDs are described in section 3.1.2. Allowable settings are as follows:

- 0x88A8 (default); and
- 0x8100.

[42] Note that the addition of NNI Bearers to an NNI Group may result in the degradation of aggregate NNI Group link efficiency, as a result of IEEE802.3ad frame distribution.

[43] Optical characteristics may vary, providing the interface rate is consistent.

5.5.1.6.2 *CVC Support*

An NNI Group can support up to 4,000 CVCs in aggregate, including any mix of CVC types and Multicast Domains.

Customer is not permitted to over-book CVC capacity within an NNI Group.

5.5.1.6.3 *Customer Network Restrictions*

All service frames exiting the NNI (i.e. from the NBN Co Network to the Customer Network through the NNI) must traverse an IP device before being injected back into the NBN Co Network. This is necessary to avoid CPE MAC addresses from appearing as source addresses on traffic ingress to the NNI. This operating restriction must be observed by Customer even if service frames are being switched between VLANs or forwarded via other service provider networks.

5.5.1.6.4 *Layer 2 Frame Forwarding*

The NNI implements forwarding of service frames as detailed in Table 22, providing all CVC VLAN tag conditions are met.

Destination MAC Address	Application	Default Behaviour	Optional Configurable Behaviour
01-80-C2-00-00-00	Bridge Group Address	Discard	None
01-80-C2-00-00-01	IEEE Std 802.3 PAUSE	Discard	None
01-80-C2-00-00-02	LACP/LAMP	Peer[44]	None
	Link OAM	Discard	None
01-80-C2-00-00-03	IEEE Std. 802.1X PAE address	Discard	None
01-80-C2-00-00-04 - 01-80-C2-00-00-0F	Reserved	Discard	None
01-80-C2-00-00-10	All LANs Bridge Management Group Address	Discard	None
01-80-C2-00-00-20	GMRP	Discard	None
01-80-C2-00-00-21	GVRP	Discard	None
01-80-C2-00-00-22 - 01-80-C2-00-00-2F	Reserved GARP Application addresses	Discard	None
01-80-C2-00-00-3X	CFM	Tunnel[47]	None

Table 22: NNI Frame Forwarding Details

[44] Note conditions in Section 5.5.1.5

[47] Tunnelling supported for Maintenance Domains (MD) 4, 5, 6, 7 (refer to IEEE802.1ag-2007)

Note the following definitions for the purposes of the above table:

- Discard – service frame will be discarded at ingress to the NBN Co Network
- Peer – service frame will be terminated within the NBN Co Network
- Tunnel – service frame will be passed to the AVC/CVC and carried through the NBN Co Network

5.5.1.6.5 *Class of Service*

The traffic class model will operate transparently across an NNI.

For NNI Groups configured as Single Chassis, the failure of one or more NNI Bearers may result in the discard of traffic due to insufficient NNI Group aggregate capacity to carry the provisioned CVC capacity. In such cases, traffic is designed to be discarded according to the priority as indicated at the CVC level.

5.5.1.7 NNI Group Orderable Attributes Summary

A summary of attributes that must be specified for each NNI Group order is shown in Table 23.

Component	Attributes	Attribute Description	Selectable Options
Service details	Physical Location	Physical location of NNI	POI Site
NNI Group Attributes	TPID	Ability to specify the S-TAG TPID used for service frames across the NNI	0x88A8 (default)
			0x8100
	Redundancy Mode	Physical interface type	Single Chassis (default)
			Diverse Chassis

Table 23: NNI Group Orderable Attributes

Each successful NNI Group order is intended to yield an NBN Co-supplied NNI Group identification.

5.5.2 NNI Bearer

5.5.2.1 NNI Bearer Types

The physical interface options for an NNI Bearer are as follows:

- 1000BaseLX
- 1000BaseEX
- 10GBaseLR
- 10GBaseER

The selection of interface type will be restricted depending on the interface rate of the NNI Group.

All NNI Bearers must have auto-negotiation disabled.

5.5.2.2 NNI Bearer Ordering

NNI Bearers are ordered through an NNI Group (refer to section 5.5.1.4).

A feasibility check will be required upon addition of any NNI Bearer to a NNI Group, to determine whether the number of allowable NNI Bearers within the NNI Group has been exceeded.

Each ordered NNI Bearer will be provisioned by NBN Co in an administratively "down" state, and will be activated by NBN Co in co-ordination with Customer. Billing will commence when the NNI Bearer is initially provisioned, irrespective of when it is activated.

5.5.2.3 NNI Bearer Orderable Attributes

Each NNI Bearer order must specify each of the service attributes listed in Table 24.

Component	Attributes	Attribute Description	Selectable Options
Service details	NNI Group	The NNI Group to which the NNI Bearer is intended to be associated	NNI Group identification
NNI Bearer	Type	Physical interface type	1000BaseLX
			1000BaseEX
			10GBaseLR
			10GBaseER

Table 24: NNI Bearer Service Attributes

Each successful NNI Bearer order will yield an NBN Co-supplied NNI Bearer identification, which will indicate a physical port on the NBN Co ODF to which the NNI Bearer has been cabled.

Customer must separately acquire the necessary facilities access rights to connect the NNI Bearer to Customer's backhaul transmission cables or Customer Active Equipment.

5.5.2.4 NNI Bearer Attributes

The optical interface parameters for each offered NNI Bearer are described in Table 25.

Parameter	1000BaseLX	1000BaseEX	10GBaseLR	10GBaseER
Wavelength	1310nm	1310nm	1310nm	1550nm
Fibre Type	Single Mode (Separate TX/RX Fibre)	Single Mode (Separate TX/RX Fibre)	Single Mode (Separate TX/RX Fibre)	Single Mode (Separate TX/RX Fibre)
Connector Type	SC-APC	SC-APC	SC-APC	SC-APC
Launch Power (max) (dBm)	-3	0	0.5	4
Launch Power (min) (dBm)	-11.0	-4.5	-8.2	-4.7
Receiver Power	-3	-3	0.5	-1

(max) (dBm)				
Receiver Power (min) (dBm)[48]	-19	-22.5	-10.3 (-14.4)	-11.3 (-15.8)

Table 25: Optical Interface Parameters (NNI Bearer)

Note that any reach indications provided by NBN Co from time to time are a guideline only and Customer must calculate its own optical path loss budgets.

Where Customer is acquiring the Facilities Access Service from NBN Co, NBN Co recommends that unless specified otherwise, any optical path loss budget calculations performed by Customer take into account a maximum, additional, loss of 1dB that may be attributed to the operation of the components of the Facilities Access Service.

NBN Co will use reasonable endeavours to advise of any other specific circumstances that it is aware of which may impact these optical characteristics.

6 Dependencies

NBN Co supplies the NEBS supplied by means of the NBN Co FTTB Network, as further described in the Product Description for the NBN Co Ethernet Bitstream Service.

NBN Co will determine what Product Components can be offered in respect of a Premises, based on the location of the Premises.

This section describes the Product Component availability and restrictions for the NEBS supplied by means of the FTTB Network.

6.1 Supported Service Types

This section describes the availability of features described in section 2.

Supported Service Types	FTTB
Unicast data services	Supported on UNI-DSL
IP-based telephony services (External ATA)	Supported on UNI-DSL

Table 26: Supported Service Types by NBN Co Network

[48] Stress eye sensitivity values are shown, sensitivity values shown in brackets are approx IEEE definition for informative use only.

6.2 Product Feature Availability

6.2.1 Service Level Options

This section describes the Service Levels supported.

Supported Service Level Option	FTTB
Service Fault Rectification – standard	Supported

Table 27: Supported Service Level Options by NBN Co Network

6.3 NNI Availability

The NNI Product Component as described in section 5.5 is available across the NBN Co Fibre Network, NBN Co Wireless Network and NBN Co FTTB Network. There are no restrictions in the ability to deliver NNI features as a result of the type of NBN Co Network.

6.4 CVC Availability

This section describes the availability of features as described in section 5.4.

CVC Type	FTTB
1:1 Unicast	Supported

Table 28: CVC Type Availability by NBN Co Network

6.5 UNI Feature Availability

6.5.1 UNI Type Availability

UNI Type	FTTB
UNI	One single UNI-DSL port

Table 29: UNI Type Availability by NBN Co Network

6.5.2 UNI Mode Availability

UNI Mode	FTTB
Default-Mapped	Supported on UNI-DSL
Priority-Tagged	Supported on UNI-DSL
DSCP-Mapped	Supported on UNI-DSL
Tagged	Supported on UNI-DSL

Table 30: UNI Mode Availability by NBN Co Network

6.6 AVC Feature Availability

6.6.1 AVC Type

This section describes the availability of features described in section 5.2.

AVC Type	FTTB
1:1 Unicast	Supported on UNI-DSL

Table 31: AVC Feature Availability – AVC Type by NBN Co Network

One AVC inclusive of multiple traffic classes may be supported per UNI-DSL.

6.6.2 Access Loop Identification

This section describes the availability of the Access Loop Identification feature for unicast AVCs (described in section 5.2.3).

AVC Traffic Class	FTTB
IPv4 DHCP Option 82	Supported on UNI-DSL
IPv6 DHCP Option 18	Supported on UNI-DSL
PPPoE IA Insertion	Supported on UNI-DSL

Table 32: AVC Feature Availability – Access Loop Identification by NBN Co Network

6.6.3 Bandwidth Profile - Traffic Class

This section describes restrictions on the availability of a traffic class according to access technology.

AVC Traffic Class	FTTB
TC-1, TC-2 and TC-4	Supported on UNI-DSL

Table 33: AVC Feature Availability – Traffic Class by NBN Co Network

6.6.4 Bandwidth Profile – Unicast 1:1 AVC TC-1 Speed Tiers

This section describes restrictions on the availability of TC-1 AVC speed tiers (described in section 5.3.2.5) according to access technology.

Bandwidth Profile Speed Tier (TC-1)	FTTB
0 Mbps	Supported on UNI-DSL
0.15 Mbps	Supported on UNI-DSL
0.3 Mbps	Supported on UNI-DSL

Table 34: Unicast 1:1 AVC Feature Availability – Bandwidth Profile (TC-1) by NBN Co Network

6.6.5 Bandwidth Profile – Unicast 1:1 AVC TC-2 Speed Tiers

This section describes restrictions on the availability of TC-2 AVC speed tiers (described in section 5.3.2.3) according to access technology.

Bandwidth Profile Speed Tier (TC-2)	FTTB
0	Supported on UNI-DSL
5 Mbps	Supported on UNI-DSL

Table 35: Unicast 1:1 AVC Feature Availability – Bandwidth Profile (TC-2) by NBN Co Network

6.6.6 Bandwidth Profile – Unicast 1:1 AVC TC-4 Speed Tiers

This section describes restrictions on the availability of TC-4 unicast 1:1 AVC speed tiers (described in section 5.3.2.3) according to access technology.

Bandwidth Profile Speed Tier (TC-4)*	FTTB
12/1 Mbps	Supported on UNI-DSL
25/5 Mbps	Supported on UNI-DSL
25/5-10 Mbps	Supported on UNI-DSL
25-50/5-20 Mbps	Supported on UNI-DSL
25-100/5-40 Mbps	Supported on UNI-DSL

Table 36* *To be read subject to section 4.3.1*: **AVC Feature Availability – Bandwidth Profile (TC-4) by NBN Co Network**

6.7 Supported Maximum Layer 2 Frame Size

The NBN Co Network has limitations around the maximum Layer 2 frame size of ingress traffic at its network boundaries.

Customers should use a maximum data payload MTU of 1500 bytes for FTTB End Users. This will equate to different Ethernet frame sizes – excluding Inter-Frame Gap, Preamble and Start of Frame Delimiter (SFD) – at the E-NNI and UNI-DSL based on the use of C- and S-tags.

Figure 6 depicts the definition of the maximum layer 2 frame size at the NNI, highlighting the inclusion of the S-TAG and C-TAG. Note that this example shows an NNI service frame using AVC/CVC Addressing Mode A (section 3.1.5).

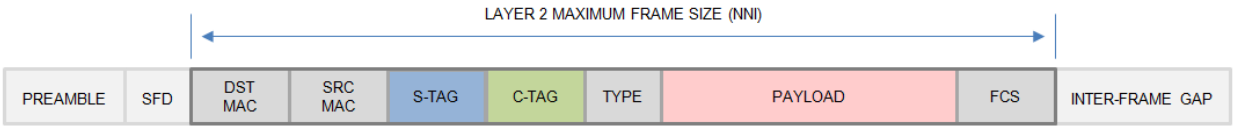

Figure 6: Definition of Maximum Layer 2 Frame Size (NNI)

Figure 7 depicts the definition of the maximum Layer 2 frame size at the UNI-DSL, highlighting the exclusion of the S-TAG and C-TAG. Note that this example shows a UNI-DSL service frame using either Default-Mapped or DSCP-Mapped modes.

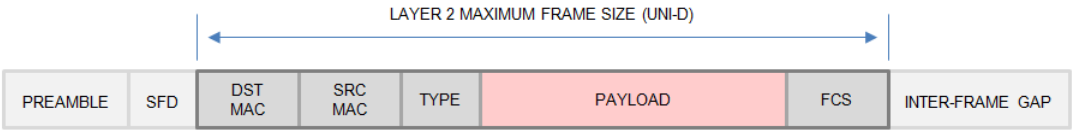

Figure 7: Definition of Maximum Layer 2 Frame Size (UNI-DSL – Default-Mapped)

Figure 8 depicts the definition of the maximum Layer 2 frame size at the UNI-DSL, highlighting the inclusion of the VLAN tag as provided by Customer. Note that this example shows a UNI-DSL service frame using either Priority-Tagged or Tagged modes.

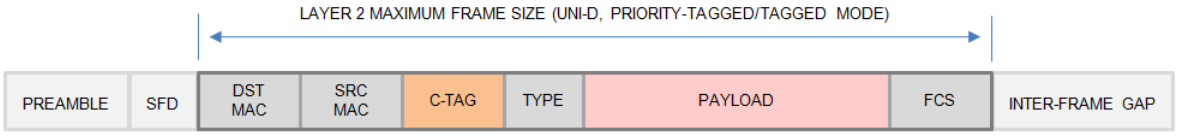

Figure 8: Definition of Maximum Layer 2 Frame Size (UNI-DSL, Priority-Tagged)

Table 36 describes the maximum Layer 2 frames sizes that will be accepted by the NBN Co Network, taking into consideration the different interfaces and type of NBN Co Network.

Parameter	FTTB
Maximum Layer 2 Frame Size at NNI (NNI Addressing Mode A)[51]	1522 Bytes
Maximum Layer 2 Frame Size at UNI-DSL (Default-Mapped, DSCP mapped)[52]	1518 Bytes
Maximum Layer 2 Frame Size at UNI-DSL(Tagged, Priority-Tagged)[53]	1522 Bytes

Table 37: Layer 2 Maximum Frame Size by Access Technology and NBN Co Network

Frames that exceed frame size limits will be silently discarded. It is the responsibility of the Customer to manage the frame size of their traffic before it enters the NBN Co Network.

6.8 Network Performance

6.8.1.1 TC-4 Traffic Performance Characteristics

Traffic class 4 is designed for applications that can benefit from a peak capacity and can tolerate variable throughput. TC-4 offers capacity as a PIR only.

The performance of Customer Products that use TC-4 AVCs as an input will vary depending on factors both within and outside of the NBN Co Network. Customer should use suitable higher-layer intelligent flow control mechanisms to achieve optimum results for Customer Products that use TC-4 AVCs as an input. The particular access technology used to deliver the NBN Co Ethernet Bitstream Service will also have an impact on TC-4 performance.

8 UNI VDSL2 Equipment Compatibility

8.1 VDSL2 Registration

NBN Co encourages but does not require Customer to register VDSL2 Equipment to be used with the NEBS supplied by means of the NBN Co FTTB Network. The NBN Co Operations Manual sets out when NBN Co will, and will not, investigate and repair any faults associated with services that utilise non-registered VDSL2 Equipment, and whether any fees will apply to the investigation and repair of such faults.

The registration process consists of a self-certification, executed by Customer, followed by a registration of the self-certification by Customer to NBN Co. To register VDSL2 Equipment, Customer must supply the VDSL2 Equipment Vendor ID, System ID and Version Number as described in ITU-T G.993.2 section 11.2.3.6, as well as a clear-text name uniquely identifying the combination of hardware and firmware to be entered into the registration database.

Customer must not register VDSL2 Equipment, unless:

- the VDSL2 Equipment and its firmware supports all applicable mandatory ITU-T requirements for vectored VDSL2 and NBN Co UNI-DSL specification referenced below;
- the VDSL2 Equipment and its firmware has been tested successfully against every feature of the NBN Co UNI-DSL Specification outlined below; and
- upon request, Customer can provide evidence that the above requirements are met.

Where Customer updates VDSL2 Equipment hardware or firmware, re-certification and re-registration for the new hardware and firmware combination is required.

Irrespective of whether VDSL2 Equipment is registered, where specific VDSL2 Equipment or a certain model and/or firmware of VDSL2 Equipment is causing (or NBN Co reasonably considers that it is likely to cause) detriment to other services, NBN Co may:

- remove the VDSL2 Equipment from the VDSL2 Equipment registration list;
- place an Ordered Product using that VDSL2 Equipment into a Repair Profile; and/or
- Suspend an Ordered Product using that VDSL2 Equipment in accordance with the Head Terms.

8.2 UNI Specification

For the purposes of VDSL2 Equipment self-certification by Customer, NBN Co will maintain a specification of the UNI-DSL interface comprised of three separate sections:

- a DSLAM chipset and firmware list;

- a list of mandatory DSL and OAM Features that the VDSL2 Equipment must support; and
- a minimum rate-reach performance specification that the VDSL2 Equipment must achieve.

These specifications will be updated regularly and it is the responsibility of Customer to source VDSL2 Equipment hardware and firmware updates to maintain compatibility.

8.2.1 DSLAM Chipset and Firmware

The NBN Co Equipment, used in connection with the NEBS supplied by means of the NBN Co FTTB Network, utilises the chipsets listed below to provide UNI-DSL services. VDSL2 Equipment hardware and firmware intended for use with the UNI-DSL must support full vectored interoperability with all of the DSLAM chipsets and firmware combinations listed:

ID	Chipset	Firmware
1	Broadcom BCM65300	12.35.2 VE_10_8_59

Table 38: DSLAM Chipset and Firmware

8.2.2 DSL and OAM Features

The UNI-DSL will utilise the DSL features listed below. VDSL2 Equipment hardware and firmware intended for use with the UNI-DSL must be able to demonstrate compatibility with all of the requirements listed:

ID	Requirement	Standard References	Comment
1	All mandatory vectoring related functionality	ITU-T G.993.5 and related corrigenda, BBF WT-249	Crosstalk / FEXT reduction, substantial bit rate and stability improvements
2	G.inp	ITU-T G.998.4, BBF TR-115 Issue2 section 5.2. Test setup is intended for FEC testing - only 200us noise burst and some test adaptation required	Improved impulse noise protection with respect to I-FEC approach, improving end user experience and throughput under conditions of impulse noise.
	Support for on-line reconfiguration (OLR) specifically bit swapping and Seamless Rate Adaptation	ITU-T G.998.4 Amendment 1, BBF TR-115 Issue2 section 5.4	Improved stability. Higher throughput. Faster recovery when conditions change
	Intra-DTU interleaver, extended memory for Enhanced Net Data Rates with Vectoring, and Improved ATTNDR calculation methods	ITU-T G.998.4 Amendment 2	Further stability, throughput, recovery improvements
3	Seamless Rate Adaptation (SRA)	ITU-T G.993.2, BBF TR-115 Issue 2 section 5.4.3	Maximises throughput during showtime, and improves stability under slowly varying noise conditions

ID	Requirement	Standard References	Comment
4	Requirements 1 to 3 of this table supported in both upstream and downstream directions		Some VDSL2 chipsets do not support G.inp in the upstream direction at this time.
5	Requirements 1 to 4 of this table useable simultaneously without restriction		Not acceptable that the listed capabilities are usable only separately, or are encumbered by restrictions regarding simultaneous use
6	Error(f) packets sent over layer 2 backchannel	ITU-T G.993.5 section 7.4.1	G.993.5 section 7.4.2 describes an alternative Error(f) technique but section 7.4.1 method will be deployed due to shortcomings of the alternate method.
7	Modem prioritises processing of Error(f) packets even in condition of end user traffic congestion or other overload		Necessary for satisfactory operation of vectoring
8	Support for orderly and disorderly shut-down (within 10ms) events	ITU-T G.993.5 section 9	Stability of neighbouring lines, stability of neighbouring vectored lines
9	Protection against single wire connections and disorderly leaving events in the upstream direction (e.g. when cable is cut)	BBF WT-249 section 8.9 (single wire interruption test)	VDSL2 Equipment must pass this test, interrupting upstream transmissions promptly upon detection of changes or interruption in the downstream received signal
10	Monitored tones / sub-carriers	ITU-T G.993.2, sections 3.36, 10.3.3.1, 10.3.4.4, BBF TR-115 Issue 2 section 5.4.1, + Issue 2 Amendment 1 section 5.4.5, + need to add a bit loading recovery test	Support for monitor tones, and recovery of tones with zero bit loading to a non-zero bit loading
11	Alternative Electrical Length Estimation Method (AELEM)	ITU-T G.993.2 Amendment 7	Reduces loop length estimation errors in presence of bridged taps. Reduced impact on neighbouring lines in presence of bridged taps, particularly when operating unvectored.
12	Special vectoring loop diagnostics mode with vectoring	ITU-T G.993.5 Amendment 3 section 10.7	Enhanced loop diagnostics and initialisation for challenging loops avoiding intermediate transition to showtime
13	Inventory identification request supported and returns valid and unique responses for Modem and Chipset Vendor ID and version	ITU-T G.993.2 sect 11.2.3.6, G.994.1, G.997.1 sects 7.4.2, 7.4.4, 7.4.6, 7.4.8, and BBF ITU-T TR-115	Unique and valid responses required for both VDSL2 Equipment vendor ID and firmware version number, plus Chipset vendor ID and firmware version number - so that VDSL2 Equipment and its chipset can be uniquely identified both in terms of HW and firmware
14	Reporting of valid H-log in all parts of spectrum, with and without DPBO/UPBO applied in that part of spectrum	ITU-T G.993.2 section 11.4.1	Some VDSL2 Equipment reports false H-log and other tone/spectrum data in parts of spectrum where power backoff applied.

ID	Requirement	Standard References	Comment
	Reporting of valid TxPSD in all parts of spectrum, with and without DPBO/UPBO applied in that part of spectrum		
	Reporting of valid QLN in all parts of spectrum		
	Reporting of valid SNR in all parts of spectrum, with and without DPBO/UPBO applied in that part of spectrum		
15	US0 band	ITU-T G.993.2	Support for US0 is critical to the operation of assurance activities in connection with the remediation of loop impairments such as bridged taps.
16	B8-11 profile	ITU-T G.993.2	
17	Virtual noise	ITU-T G.993.2 section 11.4.1, BBF TR-113 Issue 2 section 8.4	Improved stability and throughput in presence of Time Of Day dependent or varying noise environment
18	DELT loop diagnostics mode		
19	Different delay and INP settings for each direction		
20	Upstream and Downstream Power Backoff must be supported	ITU-T G.993.2, ITU-T G.997.1	
21	Use of at least 16 RFI band notches simultaneously		
22	Robust Overhead Channel (ROC)	ITU-T G.993.2 section 9.5.3.1	Improves stability in harsh conditions
23	Support for autonomous transmission of Loss-Of-Power (LPR) message	ITU-T G.997.1 section 7.1.1.1.3, BBF TR-115 Issue 2 Amendment 1 section 5.10	Assist determination of the cause of intermittent service issues
24	Save Our Showtime (SOS)	ITU-T G.993.2 section 13	Improves stability and recovery in harsh conditions
25	Downstream Frequency Dependent Pilot Sequence (FDPS)	ITU-T G.993.5 Amendment 1 section 7.2	Reduces initialisation time when entering a vectoring group
	Upstream Frequency Dependent Pilot Sequence (FDPS)	ITU-T G.993.5 Amendment 1 section 7.3.3	
26	BER no greater than 1E-10 with 6dB noise margin, no impulse noise, in both fast and interleaved modes	BBF TR-114 section 8.1 Table 23	VDSL2 Equipment PHY capable of supporting a higher layer service that can achieve a basic / repeatable end to end SLA

ID	Requirement	Standard References	Comment
	BER no greater than 1E-7 with 0dB noise margin, no impulse noise, in both fast and interleaved modes		
27	Sufficient memory and processing resources to sustain 100 Mbit/s (Layer 2) across the UNI-DSL port in the downstream direction, in presence of correctable REIN and SHINE with G.inp active		Must be simultaneous with upstream sustained traffic requirement
	Sufficient memory and processing resources to sustain 40 Mbit/s (Layer 2) across the UNI-DSL port in the upstream direction, in presence of correctable REIN and SHINE with G.inp active		
28	In upstream direction, all possible data rates from 64 Kbit/s to 50 Mbit/s to be supported in steps no larger than 64 Kbit/s		
	In downstream direction, all possible data rates from 64 Kbit/s to 100 Mbit/s to be supported in steps no larger than 64 Kbit/s		
29	Single Rate Three Colour upstream traffic shaping for TC1 / TC2 / TC4	IETF RFC-2697	Ensure that modem correctly shapes upstream traffic to a rate that will pass DSLAM traffic policers according to contracted service rates
30	Support for Ethernet OAM. Specifically, the VDSL2 Equipment WAN interface must respond to LBM, SLM and DMM at MD level 2 and 3, directed at multicast MAC address 01-80-C2-00-00-32 (for MD level 2), 01-80-C2-00-00-33 (for MD level 3) and as well as the VDSL2 Equipment's WAN unicast MAC address	Y.1731 (11/13)	Support for OAM is critical to the operation of assurance activities.

Table 39: Mandatory DSL and OAM Features

8.2.3 VDSL2 Equipment Performance Requirements

VDSL2 Equipment hardware and firmware intended for use with the UNI-DSL must pass the performance tests and conditions defined in TR-114 version 2, with the modifications described below:

- TR-114 specifies non-vectored performance. The bitrates in Table 39 are therefore non-vectored performance rates. NBN Co will modify these VDSL2 Equipment performance requirements to include vectored performance when the Broadband Forum evolves TR-114 to incorporate vectoring. Although these benchmark performances are non-vectored rates, NBN Co's network requires all VDSL2 Equipment hardware to support and interoperate correctly with NBN Co's vectoring implementation.
- TR-114 does not cover the band plan and TxPSD masks that NBN Co will be deploying in its NBN Co Fibre Network and NBN Co FTTB Network footprints. When performing TR-114 tests, DSLAMs and modems should be configured in Fast Path mode, with the 998ADE17-M2x-A masks and band plan (also known as B8-11). The benchmark results below assume this band plan and Fast Path mode. Testing should otherwise be conducted in accordance with TR-114 998ADE17-M2x-B (B8-12) masks and band plan, and relevant G993.2 Annex B configurations and requirements.

Distance	Minimum Net Data Rate Achieved DS (B8-11 Fast mode)	Minimum Net Data Rate Achieved US (B8-11 Fast mode)
150m	56841	20327
450m	36382	14346
1050m	16449	1956
1500 m	8789	540

Table 40: VDSL2 Equipment Performance Requirements

8.3 Central Splitter (Filter)

Central Splitters (or Filters) used in the Premises in conjunction with the NEBS supplied by means of the NBN Co FTTB Network must comply with the following Communications Alliance Draft Australian Standard and any further draft and final form of that standard**.**

AS/CA S041.3:2014 "Requirements for DSL Customer Equipment for connection to the Public Switched Telephone Network – Part 3: Filters for use in connection with all DSL services".

Note it is anticipated that following public comment and review, this draft will be finalised as an Australian Standard.