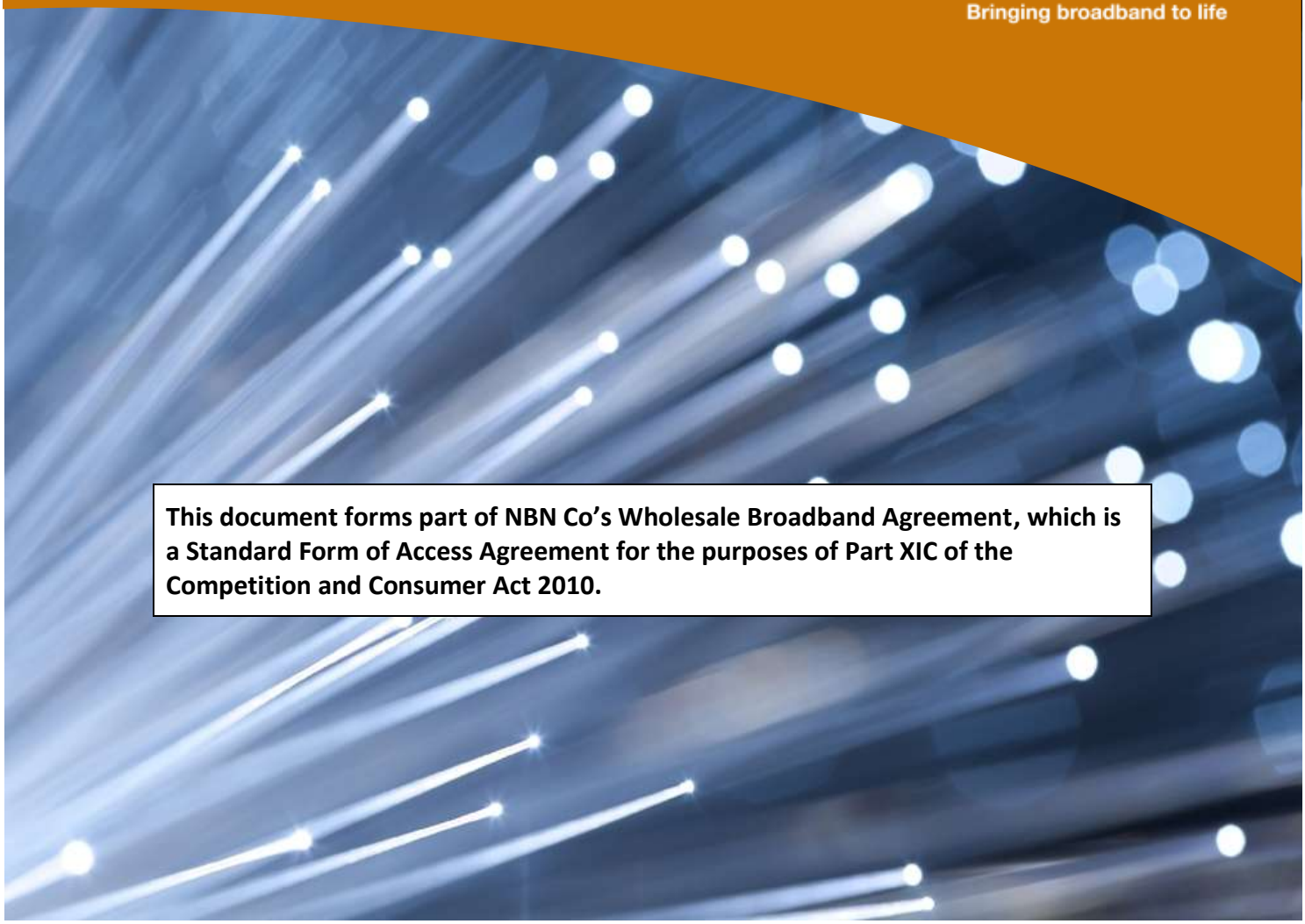
NBN Co Fibre Access Service

Product Technical Specification

~~26 JUNE~~29 August 2012



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.

NBN Co Limited

NBN Co Fibre Access Service Product Technical Specification

~~26/06~~29/08/2012

Copyright

Environment

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

Contents

1 Scope and Purpose

This Technical Specification document describes the functional and high-level operational aspects of the NBN Co Fibre Access Service (**NFAS**).

It is intended for a technical audience, who are responsible for integrating the NFAS into their own service delivery architecture.

This Technical Specification document is specific to NFAS and may be updated by NBN Co from time to time in accordance with the Wholesale Broadband Agreement between NBN Co and each Customer.

Terms used in this Technical Specification document have the meaning given in the Dictionary to the Wholesale Broadband Agreement and the Glossary to the Operations Manual.

2 Supported Service Types

This section provides a brief overview of the service types that ~~Customers~~Customer may choose to deploy using NFAS.

2.1 Unicast Data Services

NFAS supports the flexible delivery of unicast data services. It 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 UNIs located at End User Premises, and a Customer's centrally-aggregated NNI.

2.2 IP-Based Telephony Services

A Customer may choose to use NFAS for the provision of IP-based telephony services to End Users via two means:

- An Analogue Telephony Adaptor (**ATA**) port (integrated into the Network Termination Device (**NTD**)), with integrated Session Initiation Protocol (**SIP**) capabilities for legacy telephony applications (**UNI-V**)
- Access to external, Access Seeker-supplied ATA devices using a UNI-D port (as a unicast data service)

A Customer who wishes to use NFAS for the delivery of IP-based telephony services is expected to provide and manage its own IP-based telephony network capabilities that interface to, and operate across, the NBN Co Network.

All IP-based protocols and functions that the Customer utilises to implement IP-based telephony services will pass transparently through the NNI, AVC, CVC and UNI-D NFAS Product Components. Where utilised, the UNI-V will terminate all IP-based telephony protocols and functions at the End User Premises.

NFAS supports the provision of voice-grade, IP-based telephony services through the use of specific traffic handling mechanisms that are tailored toward deterministic performance for real-time, conversational applications. The TC-1 traffic class is designed to accommodate the needs of IP-based telephony applications.

Capacity within this traffic class is available to the Customer via the UNI-D or UNI-V interfaces, ensuring a consistent telephony service experience regardless of the interface used.

2.2.1 Legacy Telephony Applications

Using the UNI-V, a Customer may access the NTD's in-built ATA port, with integrated SIP capabilities for legacy telephony applications. A range of configuration options enable a Customer to migrate an existing telephony service, with minimal impact to in-building wiring or equipment installed at the End User Premises.

IP-based telephony services deployed using the UNI-V are automatically provisioned with a specific TC-1 capacity allocation.

A Customer must interface its own IP-based telephony network with the IP-based telephony functions provided by the internal ATA of the UNI-V port. This will require integration testing between the Customer and NBN Co prior to service deployment in accordance with the Wholesale Broadband Agreement.

2.2.2 External ATA Device Support

A Customer may choose to deliver IP-based telephony services to an End User Premises using a dedicated, external ATA device using the NFAS UNI-D. The supply, powering and operation of this device is the responsibility of the Customer.

Such devices are readily available for consumer applications today, and will appear to NFAS as a regular data device, connected to a UNI-D port.

The 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, NFAS is agnostic[1] to the IP-based telephony protocols and data that the Customer utilises for the delivery of IP-based telephony services to an End User.

When delivering IP-based telephony services using an external ATA through a UNI-D, the Customer is able to utilise capacity from any of the two NFAS traffic classes (TC-1 or TC-4).

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

3 Service Addressing

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

NFAS supports a common NNI addressing scheme for CVCs, using an IEEE802.1ad S-TAG to identify individual CVC services.

NFAS supports two different NNI service addressing modes for AVCs, capable of being selected at a CVC-level. These service addressing modes define how each individual AVC service within a CVC will be addressed by a Customer through the NNI.

3.1 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-VID – VLAN Identifier, used for service identification
- S/C-PCP – Priority Code Point Identifier, used for priority marking

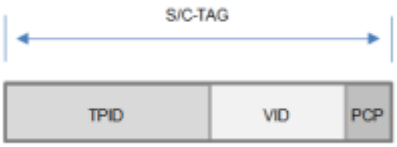


Figure 1 S/C-TAG Structure (4 bytes)

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.

3.2 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 the Customer to ensure that each supplied S-TAG VID field conforms to the agreed service configuration. NFAS will discard any service frames received at the NNI with an S-VID that does not map to an agreed identifier for an active CVC service.

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

[2] Refer IEEE802.1ad for explanation of S/C- TAG fields. Note CFI field of the IEEE802.1ad standard is not used.

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.

3.3 Service Addressing Mode A

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-D ports.

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

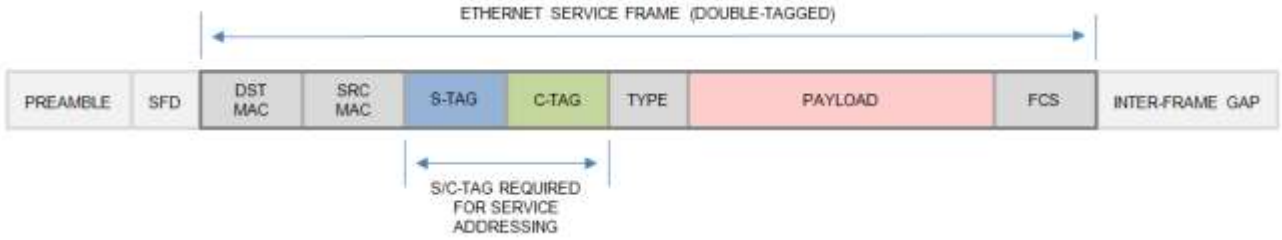


Figure 2 Service Addressing Mode A Frame Format[3]

Services using this addressing mode use the inner IEEE802.1ad C-TAG VID field to address each individual AVC within a CVC. This C-TAG is visible at the NNI, and is stripped before passing across the UNI 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 Connectivity Serving Area. In such cases, the C-VIDs must always address different NTD UNI-D ports.

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

Service Addressing Mode A requires that traffic flowing in the downstream direction (from the Customer's 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, may utilise one of two addressing options (refer to Section 5.1.1.3). It is the responsibility of the Customer to ensure that all ingress traffic at the NNI is compliant with the assigned VID settings for each respective service.

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

3.4 Service Addressing Mode C

Service Addressing Mode C implements N:1 addressing for IP-based telephony applications using the UNI-V. These services require the frame format shown in Figure 3 at the NNI:

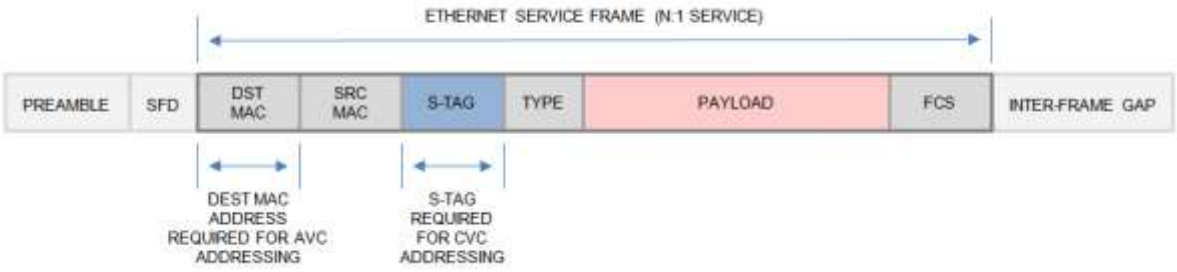


Figure 3 Service Addressing Mode C Service Frame Format

Figure 3 describes the frame structure for service frames presented at ingress to the NNI for this type of service, highlighting the S-TAG provided by the Customer, required to associate the service frame with an individual N:1 CVC, and the unicast Destination MAC address which identifies the individual destination UNI-V.

Note that under this addressing mode, there are no restrictions imposed by C-TAG VID range limitations on the number of AVCs that can be addressed through an S-TAG.

3.5 S/C-VID Allocation

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

When requested by the Customer during the ordering process, NBN Co will allocate each new CVC/AVC an internally-generated S/C-VID. This S/C-VID value will be returned to the Customer, and must be used for accessing the requested service at the NNI.

~~Customers~~Customer may optionally elect to nominate the S/C-VID used to address each CVC/AVC service instance through the NNI, for further alignment to their own backhaul network addressing schemes. Note that ~~Customers are~~Customer is encouraged to use NBN Co's S/C-TAG default VID allocations, which will be unique to the Customer's service. This will avoid any potential for S/C-VID mismatch between the Customer and NBN Co.

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

3.6 Tag Protocol Identifier (TPID) Formats

Table 1 describes the required TPID values for service frames at ingress to the NBN Co Network. The TPID is set per NNI Group (as described in section 5.5 below). Any received service frames that do not comply with these values will be discarded at ingress.

Table 1 TPID (NNI) Requirements

Interface	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		N/A	Addressing Mode C utilises MAC forwarding for the AVC, and does not require a C-TPID.

Table 2 TPID (UNI-D) Requirements

Interface	S-TPID	C-TPID	Comment
UNI-D	N/A[4]	N/A	Untagged UNI-D do not support a S-TAG or C-TAG at ingress. Any tagged ingress frames may be discarded. For UNI-D, the C-TPID is supplied by the NFAS.

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

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

4 Class of Service (CoS)

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

4.1 NFAS Traffic Classes

NFAS traffic classes are described in Table 3.

Table 3 NFAS Traffic Classes

Traffic Class	Example Applications	Specification[5]
TC-1	Voice	CIR
TC-4	Best-effort data	PIR[6] (AVC) CIR[7] (CVC)

~~Customers~~Customer may use these classes to allocate service capacity in a manner that reflects the demands and operation of their end-to-end applications. The performance attributes of each respective traffic class are detailed in Section 6.2.

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 AVC allows only the specification of the CIR. If Customer specifies an AVC TC-1 CIR of X Mbps, 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:

[5] CIR means Committed Information Rate. PIR means Peak Information Rate.

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

[7] 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.

- 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 (**EF**) per-hop behaviour described in RFC4594.

TC-1 provides a committed level of premium capacity with no 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-4 Description

The TC-4 traffic class is targeted towards "best effort" applications, as characterised by the DSCP Default Forwarding (**DF**) 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 (**Bandwidth Profiles**) used within the NBN Co Fibre Network.

4.3.1 Calculation of Information Rate

All Information ~~Rates~~Rate limitations, including as set out in this Technical Specification, are enforced at ingress to the NBN Co Network, and are calculated on Access Seeker 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. Note that 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 Fibre Network will degrade slightly for lowest-sized Ethernet service frames, where the AVC PIR/CIR approaches the Interface Rate of the UNI. This is the expected behaviour for Ethernet-Based services for which the Bandwidth Profile is based on the Service Frame ~~definition as per~~ definitions within Sections 3.3~~.~~ and 3.4. It is the responsibility of the Customer to accommodate any payload rate degradation as a result of layer 2 frame sizes.

4.3.2 Committed Information Rate

Committed Information Rate (**CIR**) defines a level of data throughput for which service frames are delivered according to the performance objectives of the respective traffic class.

4.3.3 Committed Burst Size

Committed Burst Size (**CBS**) defines the length of a burst of layer 2 traffic (either in bytes, or milli-seconds as set out below) that may be received at ingress to the NBN Co Network, for a traffic class which is subject to a CIR before traffic is discarded by the NBN Co Network.

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-D and NNI.

The CBS is used by the policing functions 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-D or NNI as relevant.

~~4.3.3~~4.3.4 Peak Information Rate

Peak Information Rate (**PIR**) is defined as the maximum data throughput that may be delivered by the service. 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.

4.4 Bandwidth Specification Model – AVC

The Customer is required to select the desired amount of capacity for each traffic class required for the AVC at time of order.

The AVC Bandwidth Profile components for NFAS Traffic Classes are shown in Table 4~~.~~ and specified limitations are enforced at the UNI.

Table 4 Bandwidth Profile Components – AVC

Traffic Class	Component	Units	Description
TC-1	CIR	Mbps	CIR requirement for TC-1. Available settings are detailed in Section 5.3.2.6
	CBS[8]	Bytes	2000 Bytes
TC-4	PIR[9]	Mbps	PIR requirement for TC-4. Available settings are detailed in Section 5.3.2.6

Refer to Section 5.3.2.6 for supported AVC Bandwidth Profiles.

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

[9] Note that the UNI-D may accommodate ingress TC-4 traffic bursts of up to 40kB.

Note that in some circumstances, 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 may be delivered with a total AVC capacity of 12Mbps. Details are set out in the WBA Product Catalogue, in section 2.2 of the NBN Co Fibre Access Service Product Description.

4.5 Bandwidth Specification Model – CVC

The Customer is required to nominate the capacity for each required traffic class within the CVC at time of service order. The CVC Bandwidth Profile components for NFAS Traffic Classes are shown in Table 5~~.~~ and specified limitations are enforced at the NNI.

Table 5 Bandwidth Profile Components – CVC

Traffic Class	Component	Units	Description
TC-1	CIR	Mbps	CIR requirement for TC-1.
	CBS[10]	Bytes	16,000
TC-4	CIR	Mbps	CIR requirement for TC-4
	CBS[11]	msec	10

Note that capacity specified within a CVC bandwidth profile is inclusive of the S/C-TAGs, as per 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

~~Customers are~~Customer is free to control their own End User experience, through contention applied through dimensioning of capacity between the AVC and CVC.

Contention may be applied at the traffic class level, allowing Customers to independently control the economics and operation of each class. This is controlled by 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.

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

[11] The CVC TC-4 CBS is set by NBN Co, and cannot be modified by the Customer.

~~Customers~~Customer must be aware of the implications of further contending NFAS, as this will effectively degrade the performance of a Customer's services.

4.7 Priority Identification

~~A~~ 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 and NNI, as shown in Table 6.

Table 6 NFAS Priority Marking Options

Marking Scheme	UNI-D	NNI
PCP field (IEEE802.1p)	N	Y
DSCP (RFC2474)	Y	N
Default-Mapped (Un-marked)	Y	N

Note that the DSCP priority marking for ingress traffic at the UNI-D is supported only for traffic encapsulated as IP over Ethernet (**IPoE**).

4.8 Priority Encoding

~~A~~ Customer must conform to the IEEE802.1P and DSCP settings indicated in Table 7 to map traffic into NFAS traffic classes at the UNI and NNI.

These ingress assignments are valid for ordered NFAS 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-D configured as DSCP-Mapped, any ingress traffic that does not map to a provisioned AVC traffic class may be discarded at ingress.

For UNI-D configured as Default-Mapped, all ingress traffic will be mapped to the TC-4 traffic class, irrespective of DSCP markings.

~~Customers~~Customer will be required to identify and validate all required UNI-D DSCP and NNI PCP assignments during the on-boarding phase.

Table 7 NFAS Class of Service Encoding

Traffic Class	PCP/DSCP Assignment (Ingress)		
	CoS (NNI)	DSCP[12] (UNI-D)	
		DSCP	DSCP (Decimal)
TC-1	5	CS5, EF	40 – 47
TC-4	0	CS1, AF 11 – 13 CS0, Default	8 – 15, 0 – 7

4.9 Priority Decoding

Egress CoS decoding is indicated in Table 8.

Table 8 NFAS Class of Service Decoding

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

[12] DSCP-mapping available at UNI-D only.

5 Product Component Attributes

5.1 User Network Interface (UNI)

The supported UNI types are as follows:

- Data UNI (Ethernet port) – referred to as “UNI-D”
- Voice/Telephony UNI (Analogue POTS port) – referred to as “UNI-V”

Each UNI is logically connected to an NNI via an AVC and CVC, and supports a single AVC.

5.1.1 UNI-D

Each UNI-D is regarded as a fully independent interface, operating in total isolation from any other UNI residing on the same NTD.

5.1.1.1 UNI-D Interface Attributes

The following ~~interfaces~~interface modes are supported for UNI-D ports:

- 10/100/1000BASET/TX (Electrical, auto-negotiated speed and full/half-duplex~~)~~), or
- 100BASE-T (Electrical, fixed speed, auto-negotiated full/half-duplex~~)~~).

When no AVC services are active on the UNI-D, the UNI-D will be de-activated in accordance with clause 4.6 of the NBN Co Fibre Access Service Product Description within the WBA Product Catalogue.

5.1.1.2 UNI-D Scalability Factors

Each UNI-D has two capacity metrics that define its ability to carry End User services.

5.1.1.2.1 Line Rate

The Line Rate defines the rate at which the physical interface will transfer data. The UNI-D supports the following Ethernet Line Rates:

- 10Mbps
- 100Mbps
- 1000Mbps

The **Line Rate** sets the maximum bound on the information-carrying capacity of the link. ~~Customers are~~The Customer is advised that ~~they~~the Customer should be familiar with the inherent limitations of Ethernet in relation to the impact of framing overhead and asynchronous operation on bandwidth efficiency, and accommodate this within any NFAS capacity allocation.

By default, the UNI-D will be configured to auto-negotiate the Line Rate with the equipment at the End User Premises attached to the NTD. An active UNI-D may be configured by NBN Co as a 100Mbps interface if required.

The Customer is responsible for ensuring that the UNI-D is operating with a Line Rate that is sufficient to carry the requested AVC capacity, using auto-negotiation or a fixed Line Rate setting.

The Customer is also responsible for the Duplex mode of the UNI-D.

NBN Co is not responsible for any traffic loss at the UNI-D that may result due to the UNI-D negotiating a Line Rate or Duplex mode with any attached device beyond the NBN Co Network Boundary, or being configured to a specific Line Rate that is insufficient to deliver the required AVC capacity.

5.1.1.2.2 Information Rate

The **Information Rate** defines the amount of logical capacity assigned to the UNI. This is calculated using the AVC Bandwidth Profile active on the UNI-D.

The UNI-D is capable of supporting an Information Rate up to the active Line Rate. For example,[13] a UNI-D that has an auto-negotiated Line Rate of 100Mbps is capable of supporting an AVC with a PIR of 100Mbps.

Note that once provisioned, AVC capacity will not be automatically re-adjusted as a result of changing Line Rates through auto-negotiation. Should a UNI-D 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 UNI-D Interfacing

There are two options for addressing services at the UNI-D, shown in Table 9.

Table 9 AVC Addressing Modes at the UNI-D

UNI-D Mode	Maximum Number of AVCs supported at UNI-D	Comments
Default-Mapped	1	Untagged service frames that carry no layer 2 priority information, as per IEEE802.3
DSCP-Mapped	1	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

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

5.1.1.4 UNI-D Functional Attributes

5.1.1.4.1 Frame Forwarding

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

[13] Note that this is an illustrative example only, and does not take into account Ethernet protocol overhead.

Table 10 UNI-D Frame Forwarding Details

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	None

Note the following definitions:

- 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-D that contain an IEEE802.1Q VLAN tag may be discarded.

5.1.1.4.2 Auto Negotiation

Each UNI-D port provided at the NTD individually supports auto-negotiation as per IEEE802.3ab.

5.1.1.4.3 MAC Address Limitations

Each UNI-D is capable of supporting up to eight simultaneous MAC source addresses. This imposes a limit on the number of layer 2 devices that a Customer can connect directly to a UNI-D. Any attempt to connect a number of devices directly to a UNI-D 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-D, 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-D irrespective of the service type and does not imply MAC address-based forwarding for unicast services based on 1:1 VLANs.

A Customer must use a layer 3 device to interconnect to the UNI-D. If the Customer does not do so, the Customer accepts the consequences of any issues arising from MAC address restrictions.

5.1.1.4.4 Resiliency

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

5.1.2 UNI-V

This section details the functional attributes of the UNI-V. Additional details and parameters will be provided during the on-boarding process.

5.1.2.1 UNI-V Supported Features

The UNI-V supports a limited set of IP-based telephony features, each delivered in accordance with the NBN Co UNI-V Electrical Specification and the NBN Co UNI-V Functional ~~specification.~~Specification. It is the responsibility of the Customer to interface to the UNI-V with a soft switch, located beyond the NNI, and complete the delivery of these features with complementary feature support within its own network.

The IP-based telephony features supported by the UNI-V are described in Table 11.

Table 11 UNI-V Supported Features

End-User Feature	Supporting NBN Co Feature
Call Waiting	Supported by Call Hold, Flash hook and Flash Recall
Calling Number Display	Supported by Calling Line Identification Presentation
Calling Number Display Blocking	Supported by Calling Line Identification Restriction

Message wait indicator: visual and audible	Supported by Message Wait Indicator (light on phone) and distinctive dial tone (stutter dial tone)
Hot Line	Supported by immediate Hot Line

~~Customers~~Customer may choose to provide other end-user call handling features that are implemented in the Customer soft switch and/or CPE and do not require specific support by the UNI-V including call barring and call forwarding.

~~5.1.2.2~~*5.1.2.1.1 UNI-V ~~Interface Attributes~~Configuration*

The UNI-V must be further configured by Customer after the UNI-V has been activated by NBN Co. The configuration method for UNI-V release 2 will use TR-069, which is defined in the UNI-V Functional Specification version 2.0. TR-069 Configuration requires Customer to configure the UNI-V via a configuration process as described by TR-104, downloaded to the NTD using a mechanism compliant with TR-069.

Historically, NBN Co has only supported FTP configuration, which is defined in the UNI-V Functional Specification version 1.0. FTP configuration requires Customer to configure the UNI-V via an XML file downloaded to the NTD via FTP.

There will be a transition period to transition UNI-V functionality from release 1 to release 2. During that time, UNI-V Functional Specification version 1.0 continues to apply to each UNI-V which has not been transitioned. NBN Co will give migration directions to assist Customer in making the transition to UNI-V Functional Specification version 2.0. Customer will be responsible for complying with NBN Co directions in UNI-V Functional Specification version 2.0. The two versions of the UNI-V Functional Specification will each apply in relation to different Premises concurrently for a period notified by NBN Co while the transition occurs.

5.1.2.2 UNI-V Physical Port Characteristics

Each UNI-V will exhibit the physical port characteristics described in Table 12.

Table 12 UNI-V Physical Port Characteristics

Parameter	Specification
Maximum Loop Length	150 metres (300m loop) of 0.5mm diameter, Cat 3 cable[14]
Loop Voltage	42 to 56VDC
Ring Voltages	≥50 Vrms
Ringer Equivalence	Up to 3 REN per UNI-V
Loop Current	≥18mA

[14] Customer cabling should comply with the Premises wiring recommendations outlined in the NBN Co UNI-V Functional Specification

Line voltage drop in event of NTD upgrade or power outage	Less than 1 minute

5.1.2.2.1 Physical Interface

The internal NTD UNI-V line connection supports a miniature, 6-position socket as specified in ANSI/TIA 968 A 2002. The external NTD provides screw-down connections for each of the UNI-V ports. Section 5.3.2.1 provides details of the supported NTD types.

5.1.2.3 UNI-V Functional Attributes

5.1.2.3.1 Voice CODEC

The UNI-V supports the CODEC configuration described in Table 13.

Table 13 UNI-V CODEC Description

Parameter	Value
CODEC	G.711 A-law[15]
Packetisation Rate	20msec
DTMF Tones	In-band
Echo Cancellation	Support for G.168 Section 7 CPE must conform to AS/CA S002:2010 Appendix A for echo canceller/suppressor disable tones.

5.1.2.3.2 Traffic Management and Identification

All traffic associated with the UNI-V is carried within the NBN Co Fibre Network using the TC-1 traffic class.

Upstream UNI-V traffic will be presented at egress from the NNI with S-PID = 5 (TC-1). ~~Customers~~Customer must ensure that UNI-V service traffic appears at ingress to the NNI with S-PID = 5 (TC-1).

Furthermore, the NFAS will mark traffic generated by the UNI-V ATA in the upstream direction with the DSCP markings described in Table 14.

[15] As per ITU-T G.711

Table 14 UNI-V DSCP Markings (NNI Egress)

Traffic Type	DSCP Marking (Decimal)
SIP Signalling	40
RTP Media	41
Management and Operations	42

5.1.2.3.3 IPv6 Support

The NFAS UNI-V currently supports IPv4-based SIP services only. NBN Co currently intends to support IPv6-based SIP services in the future.

~~*5.1.2.3.4 UNI-V configuration*~~

~~UNI-V services are configured by the Customer via an XML file downloaded to the NTD via FTP, as described in the NBN Co UNI-V Functional specification. NBN Co currently intends to change the UNI-V configuration file format and transmission method in mid 2012 and the current file format and transmission method will no longer be available for new services or existing services. NBN Co currently intends to change the method of configuration from XML file download to TR-104 and the transfer method will change from FTP to TR-069.~~

~~*5.1.2.3.5*~~*5.1.2.3.4 Layer 3 Connectivity*

It is the responsibility of the Customer to manage allocation of IP addresses and associated network parameters to the SIP User Agent associated with each UNI-V. DHCP will be used as the mechanism to manage address distribution.

~~Customers~~Customer must provide DHCP server infrastructure and assign the following parameters:

- IP Address (IPv4)
- Subnet Mask (Option 1)
- Default Router Address (IPv4) (Option 3)
- DNS server (required if a hostname is used for proxy server SIP URI) (Option 6)
- FTP Server (Option 66) for UNI-V release 1, or ACS Server for UNI-V release 2.

Within the NBN Co Network, DHCP Option 82 fields will be populated with the identifier of the AVC attached to a given UNI-V.

~~*5.1.2.3.6*~~*5.1.2.3.5 Dial Plan*

The *Telecommunications Numbering Plan 1997* is supported on the UNI-V including national, international, regional, emergency and free call numbers and short dial codes as used for IVR, preselect, override, etc.

~~*5.1.2.3.7*~~*5.1.2.3.6 Digit Tone Handling*

The UNI-V ATA supports in-band DTMF transmission across an IP network.

~~5.1.2.3.8~~5.1.2.3.7 Low-Speed Data, Fax and Modem Support

The G.711 codec will support transmission of low speed data including TTY, fax with rates up to 9.6 kbps and modems with rates up to 14.4 kbps. CPE must conform to AS/CA S002:2010 Appendix A for echo canceller/suppressor disable tones.

~~5.1.2.3.9~~5.1.2.3.8 Ring Cadence

The ring cadence supported by each UNI-V is DR0, DR1, DR3, DR6, DR7 as per AS/CA S002:2010.

~~5.1.2.3.10~~5.1.2.3.9 Service Tone Characteristics

The service tones supported by each UNI-V are described in Table 15 below. For further detail, refer Communications Alliance Technical Specification AS/CA S002:2010 Appendix A.

Table 15 Service Tones

Service Tone	Frequency/Nominal Approximate Level	Cadence
Dial tone	400Hz at -22.5dBm 425Hz at -22.5dBm 450Hz at -22.5dBm	Continuous for up to 12s
Ringing (Ring-back) tone	400Hz at -22.5dBm 425Hz at -22.5dBm 450Hz at -22.5dBm	On-400ms, Off-200ms, On-400ms, Off-2000ms, repeated
Special Dial Tone (message waiting)	400Hz at -22.5dBm 425Hz at -22.5dBm 450Hz at -22.5dBm	On-100ms, Off-40ms, repeated for up 12s
Busy tone (Disconnect* tone)	425Hz at -16dBm	On-375ms, Off-375ms, repeated for up to 60s
Call Waiting tone	425Hz at -16dBm	On-200ms, Off-200ms, On-200ms, Off-4400ms, repeated for up to 45s

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.

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

5.2.2 AVC Scalability

The maximum number of AVCs that can be supported on a single UNI port depends on the UNI type and operation.

AVCs are isolated from each other via the use of distinct S-TAG/C-TAG VIDs, and can be individually dimensioned according to the service needs of each End User. An AVC can 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 Identification

The Customer may optionally configure an 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 network boundary.

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

~~5.2.3~~5.2.3.1 DHCP Option 82 Support

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

DHCP Option 82 allows for two fields to be set:

- Circuit-ID
- Remote-ID

NBN Co will insert DHCP Option 82 fields into upstream DHCP DISCOVER and REQUEST messages upon ingress to the AVC at the UNI-D. 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 equipment at the End User Premises 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 4 below.

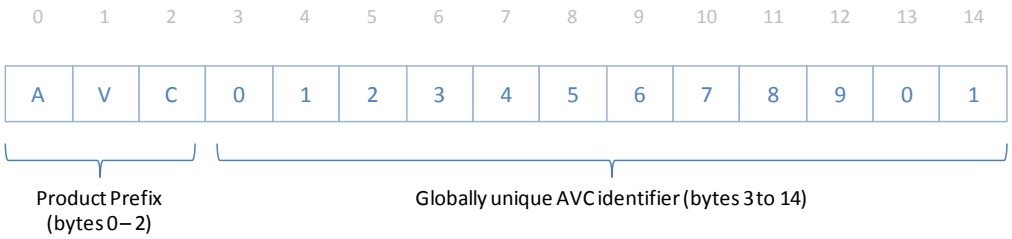


Figure 4 – DHCP Option 82 Circuit-ID Field Format

Remote-ID – The Remote-ID will not be populated. If equipment at the End User Premises attached to an AVC populates the Remote-ID field, the NBN Co Network will strip this field.

Note that the customer is responsible for ensuring that upstream DHCP DISCOVER and REQUEST messages comply with the BOOTP length guidelines as per RFC1542 (section 2.1) before presentation at the UNI-D.

~~5.2.4~~5.2.3.2 PPPoE Intermediate Agent Support

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

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

- Circuit-ID
- Remote-ID

NBN Co will insert PPPoE Intermediate Agent Option 82 fields into upstream PPP PADI messages upon ingress to the AVC at the UNI-D. 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 equipment at the End User Premises 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.

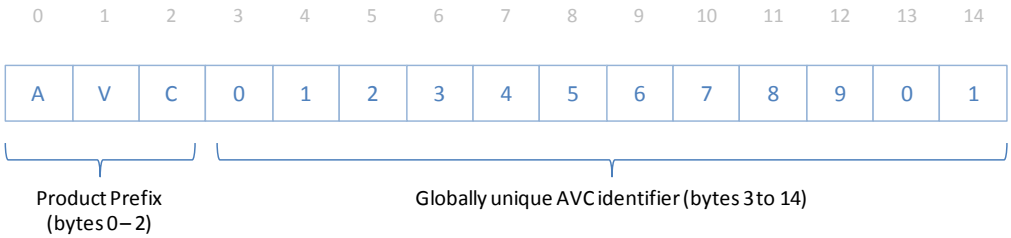


Figure 5 – PPPoE Intermediate Agent Circuit-ID Field Format

Remote-ID – The Remote-ID will not be populated. If equipment at the End User Premises attached to an AVC populates the Remote-ID field, the NBN Co Network will strip this field.

5.3 Access Components

Access Components comprise all UNI and AVC Product Components required to deliver a Customer's retail service to an End User.

This may involve a single UNI-D, or a UNI-D and UNI-V, each with separate associated AVCs.

Each Access Component is delivered using two sets of Product Features:

- **configuration attributes** – provided through Configuration Templates
- **service attributes** – provided through per-End User orders

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

5.3.1 Configuration Attributes

The following tables detail all AVC and UNI Product Features which must be specified within a Configuration Template, for the delivery of the Access Components. These Product Features are for Product Components available for NFAS only.

Each Customer may freely construct its end-to-end NFAS from a combination of these configuration attributes and service attributes provided with 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 Configuration Template. These details cannot be tailored between each specific Ordered Product. The Configuration Templates will be constructed through a joint consultation between NBN Co and the Customer during the solution definition phase, as part of the on-boarding process in accordance with the Wholesale Broadband Agreement.

Note that Configuration Templates apply to the Access Components only. They encompass UNI/AVC components that, when combined with per-Ordered Product service attributes provided at time of order, are required to fulfil an Ordered Product.

5.3.1.1 UNI Configuration Attributes

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

Table 16 UNI Configuration Attributes (NFAS)

Component	Configuration Attribute	Configuration Attribute Options
UNI	UNI Type	UNI-D
		UNI-V
	VLAN Mode	Default-Mapped (UNI-D only)
		DSCP-Mapped
	Child AVC List	AVC ID (Single AVC only for NFAS)

5.3.1.2 AVC Configuration Attributes

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

Table 17 AVC Configuration Attributes (NFAS)

Component	Configuration Attribute	Configuration Attribute Options
AVC	AVC Type	1:1 (UNI-D only)
		N:1 (UNI-V only)
	UNI Parent	UNI ID (Single UNI only)
	Supported Bandwidth Profiles	Refer Section 5.3.2.6
	~~Access Loop Identification Active~~	~~TRUE/FALSE~~

These templates define the AVC and UNI attributes that must be specified at time of the solution definition phase. A combination of UNI/AVC Product Components, each defined with these attributes, will constitute an order for Access Components.

5.3.2 Service Attributes

This section details the service attributes that are required to be supplied for each Access Component, at time of order. Note that the number and type of service components will be determined by the Configuration Template.

5.3.2.1 NTD Unit Type

Note that ~~a~~ Customer cannot directly order an NTD. The provision and operation of the NTD is the responsibility of NBN Co. By default, an internal NTD will be provided unless NBN Co determines that an external NTD is preferable in the circumstances or an End User indicates a preference for an external NTD during installation and agrees to any additional charges that may apply.

~~Customers are~~Customer is able to order individual UNIs on an NTD.

5.3.2.2 ~~UNI-V Service~~Access Component Attributes

The following service attributes must be specified at time of order for each ~~UNI-V~~AVC and UNI Product Component:

Table 18 Service Attributes for ~~UNI-V~~Access Service

Component	Service Attribute	Specification (Provided by Customer)
~~UNI-V~~Access Service[16]	~~FTP Username~~Service Restoration SLA	~~Username~~Standard (Default)
		Enhanced-12
	Priority Assist	No (Default)
		Yes

5.3.2.3 UNI-V Service Attributes

The following service attributes must be specified where UNI-V Functional Specification version 2.0 applies to the UNI-V:

Table 19 Service Attributes for UNI-V

Component	Service Attribute	Specification (Provided by Customer)
UNI-V	NTD UNI-V Port Number	0: Assigned by NBN Co (default)

The following service attributes must be specified where UNI-V Functional Specification version 1.0 applies to the UNI-V:

[16] Refer to the Service Levels Schedule section of the WBA Product Catalogue for details of supported service options

Table 20 Service Attributes for UNI-V (FTP Configuration Only)

Component	Service Attribute	Specification (Provided by Customer)
UNI-V	FTP Username	Username
	FTP Password	Password
	Configuration Filename	Filename

~~5.3.2.3~~5.3.2.4 UNI-D Service Attributes

The following service attributes must be specified at time of order for the UNI-D:

Table 21 Service Attributes for UNI-D

Component	Service Attribute	Specification (Provided by Customer)
UNI-D	NTD UNI-D Port Number	0: Assigned by NBN Co (default) 1 – 4: Request Specific UNI-D Port on NTD (if available)
~~UNI-D~~	Physical Interface	AUTO (Speed)/AUTO (Duplex)
		100Mbps/AUTO (Duplex)

~~5.3.2.4~~5.3.2.5 AVC Service Attributes

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

Table 22 Service Attributes for AVC

Component	Service Attribute	Specification (Provided by Customer)
AVC	CVC ID	CVC ID
	C-VID at NNI (1:1 AVC only)	0 – 4000[17]
	Bandwidth Profile (1:1 AVC only)	Specified from list of supported AVC Bandwidth Profiles in Table 23
	Access Loop Identification Active	TRUE/FALSE

~~5.3.2.5~~5.3.2.6 Supported AVC Bandwidth Profiles

This table shows the valid combinations that may be used to populate the Bandwidth Profile (upstream and downstream) for an AVC. 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.

Table 23 Supported AVC Bandwidth Profiles

Profile Number	AVC_TC-4 (DOWNSTREAM) (Mbps)	AVC_TC-4 (UPSTREAM) (Mbps)	~~5.3.2.5.1.1.1.1~~ AVC_TC-1 (UPSTREAM, DOWNSTREAM) (Mbps)	~~5.3.2.5.1.1.1.2~~ NI Interface	UNI-D Supported Interface Mode[18]	
					Default-Mapped	DSCP-Mapped
1[19]	0	0	0.15	UNI-V	N/A	N/A
2	12	1	0	UNI-D	Y	Y
3	12	1	0.15	UNI-D	N	Y
4	12	1	0.3	UNI-D	N	Y
~~4~~5	25	5	0	UNI-D	Y	Y

[17] 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.

[18] Certain AVC Bandwidth Profiles have dependencies on the UNI-D operating mode.

[19] This profile is the only one available on the UNI-V, and not available on UNI-D. It is automatically provisioned by NBN Co when the UNI-V is ordered.

~~5~~6	25	5	0.15	UNI-D	N	Y
7	25	5	0.3	UNI-D	N	Y
8	25	5	0.5	UNI-D	N	Y
~~6~~9	25	10	0	UNI-D	Y	Y
~~7~~10	25	10	0.15	UNI-D	N	Y
11	25	10	0.3	UNI-D	N	Y
12	25	10	0.5	UNI-D	N	Y
13	25	10	1	UNI-D	N	Y
~~8~~14	50	20	0	UNI-D	Y	Y
~~9~~15	50	20	0.15	UNI-D	N	Y
16	50	20	0.3	UNI-D	N	Y
17	50	20	0.5	UNI-D	N	Y
18	50	20	1	UNI-D	N	Y
19	50	20	2	UNI-D	N	Y
~~10~~20	100	40	0	UNI-D	Y	Y
~~11~~21	100	40	0.15	UNI-D	N	Y
22	100	40	0.3	UNI-D	N	Y
23	100	40	0.5	UNI-D	N	Y
24	100	40	1	UNI-D	N	Y
25	100	40	2	UNI-D	N	Y
26	100	40	5	UNI-D	N	Y

Note the following:

- Certain AVCs will be restricted in what speed profiles they can support. For instance, a UNI-V is only allowed to support profile 1. This is enforced at the Configuration Template level.
- There are technical limitations which will restrict which Bandwidth Profiles can be deployed onto specific UNI/AVC types. These restrictions will be enforced at the solution definition phase of the on-boarding process, through the Configuration Template.

- NBN Co may limit the availability of Bandwidth Profiles with TC-1 capacities greater than 0.3 Mbps to certain CSAs where NBN Co does not, or considers it is likely to not, have sufficient capacity to provide all requested TC-1 capacity. Customer must utilise NBN Co's service qualification tool which will indicate the availability of Bandwidth Profiles for TC-1 capacities greater than 0.3 Mbps in relation to each premises.

5.4 Connectivity Virtual Circuit (CVC)

This section details 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 Connectivity Serving Area. 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 Connectivity Serving Area.

The CVC may be configured as a 1:1 VLAN, for 1:1 AVC services delivered using the UNI-D interface, or as an N:1 VLAN, for N:1 AVC services delivered using the UNI-V interface.

The NNI, and all CVCs delivered through it, are specific to a single Customer. It is possible that a Customer may have multiple CVCs delivered using a number of NNI at a given Point of Interconnect.

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

5.4.2 CVC Scalability

A single CVC can support up to 4000 1:1 AVCs, and is ~~delivered to~~able to deliver AVCs to any UNI within a single Connectivity Serving Area. Each of the 4000 1:1 AVCs is addressed using a single, unique C-TAG VID, locally significant to the CVC. The number of CVCs that a Customer may purchase to a given Connectivity Serving Area is limited only by the NNI resources that the Customer has purchased at the POI.

CVCs are isolated from each other on an NNI via the use of distinct S-TAG VIDs, and can each be individually dimensioned according to the service needs of each Connectivity Serving Area or UNI. CVCs using different service modes are able to co-exist on the same NNI.

Note that where a Customer requires access to more than 4000 AVCs on a given CVC, it is necessary to utilise additional CVCs.

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

5.4.3 CVC Interfacing

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

5.4.4 CVC 802.1P Discard

Any discard of CVC service frames arising from AVC:CVC contention will be in accordance with Section 4.

5.4.5 CVC Service Attributes

There is no Configuration Template required for a CVC. Each CVC order must specify each of the service attributes listed in Table 24 below.

Table 24 CVC Service Attributes

Component	Attributes	Attribute Description	Selectable Options
End-Point Identification	NNI Group ID[20]	Identification of the NNI that the CVC is to be terminated on.	NNI Group ID (Existing)
	B-END CSA	Identification of the CSA that the CVC is terminated on.	CSA ID
S-TAG Mapping	S-TAG (NNI)	~~A~~ 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)
Bandwidth Profile	Bandwidth Profile (Upstream and Downstream)	CVC_TC-1_CIR	Refer Table 25
		CVC_ TC-4_CIR	Refer Table 26
Installation Options	CVC Type	Type of CVC.	1:1
			N:1

5.4.6 Supported CVC Bandwidth Profiles

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

Table 25 CVC TC-1 Bandwidth Profile Capacities[21]

Profile Number	CVC_TC-1 (Mbps)
1	0

[20] Refer to Section 5.5 below.

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

2	5
3	10
4	20

Table 26 CVC TC-4 Bandwidth Profile Capacities[22]

Profile Number	CVC_TC-4 (Mbps)
1	0
2	100
3	150
4	200
5	250
6	300
7	400
8	500

5.5 Network-Network Interface (NNI)

The NNI defines the interface at which the Customer interconnects its backhaul infrastructure to NBN Co's network.

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

5.5.1 NNI Group

The NNI Group has the following attributes:

- Location

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

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

5.5.1.1 NNI Group Location

An NNI Group is provisioned at an NBN Co Point of Interconnect, which 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 POI location), it is necessary to purchase a new NNI Group in the intended POI location, and transition existing AVC/CVC services 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
- 10Gbps

The group interface rate is set through the selection of the first NNI Bearer (Single-Chassis mode), or pair of NNI Bearers (Chassis-Diverse 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 AVC/CVC services from the old NNI Group. Once completed, the previous NNI Group may be cancelled.

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)
- **Chassis Diverse** (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 Chassis-Diverse Redundancy Mode

When an NNI Group is configured in Chassis-Diverse 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, it is necessary to purchase a new NNI Group in the intended redundancy mode and transition existing AVC/CVC services 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[23]. All NNI Bearers within an NNI Group must be consistent with the group interface rate for that NNI Group[24] (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 one or more pair of NNI Bearers (Chassis Diverse 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 Chassis-Diverse, NNI Bearers must be ordered in pairs, with each NNI Bearer of the pair provisioned on different EFS.

For NNI Groups comprising of 1Gbps Ethernet interfaces, NBN Co will 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 comprised of 10Gbps Ethernet interfaces, NBN Co will 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.

[23] 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.

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

5.5.1.5 Layer 2 Functional Characteristics

5.5.1.5.1 TPID Setting

The NNI Group must be configured with a S-TPID that is common across all NNI Bearers within the NNI Group. This must be selected at time of order. S-TPIDs are described in section 3.6. Allowable settings are as follows:

- 0x88A8 (default)
- 0x8100

5.5.1.5.2 CVC Support

An NNI Group can support up to 4,000 CVCs, including any mix of 1:1 and N:1 CVC types.

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

5.5.1.5.3 Customer Network Restrictions

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

5.5.1.5.4 Layer 2 Frame Forwarding

The NNI implements forwarding of service frames as detailed in Table 27, providing all CVC VLAN tag conditions are met.

Table 27 NNI Frame Forwarding Details

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	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[25]	Tunnel	None

Note the following definitions:

- 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

[25] NFAS is agnostic to CFM Maintenance Associations and Maintenance Domains under normal operating conditions

5.5.1.5.5 *Class of Service*

The NFAS 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 will be discarded according to the priority as indicated at the CVC level.

5.5.1.6 NNI Group Orderable Attributes Summary

A summary of attributes that must be specified for each NNI Group order is shown in Table 28.

Table 28 NNI Group Orderable Attributes

Component	Attributes	Attribute Description	Selectable Options
Service details	Physical Location	Physical location of NNI	POI ID
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)
			Chassis-Diverse

Each successful NNI Group order will yield an NBN Co-supplied NNI Group ID.

5.5.2 NNI Bearer

5.5.2.1 NNI Bearer Types

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

- 1000BASE-LX
- 1000BASE-EX
- 10GBASE-LR
- 10GBASE-ER

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 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 in an administratively "down" state, and will be activated in co-ordination with the 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 29.

Table 29 NNI Bearer Service Attributes

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 ID
NNI Bearer	Type	Physical interface type.	1000BASE-LX
			1000BASE-EX
			10GBASE-LR
			10GBASE-ER

Each successful NNI Bearer order will yield an NBN Co-supplied NNI Bearer ID, which will indicate a physical port on the Optical Distribution Frame (**ODF**) located within the NBN Co POI, to which the NNI Bearer has been cabled.

Customer must separately acquire the necessary facilities access rights to connect the NNI Bearer to the Customer's rack or fibre service.

5.5.2.4 NNI Bearer Attributes

The optical interface parameters for each offered NNI Bearer are described in Table 30.

Table 30 Optical Interface Parameters (NNI Bearer)

Parameter	1000BASE-LX	1000BASE-EX	10GBASE-LR	10GBASE-ER
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)	-11.5	-4.5	-8.2	-4.7
Receiver Power (max) (dBm)	-3	-3	0.5	-1
Receiver Power (min) (dBm)[26]	-19	-22.5	-10.3 (-14.4)	-11.3 (-15.8)

Note that ~~the~~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~~, for instance where:~~.

- ~~NBN Co's physical Point of Interconnect is remote to the EFS~~
- ~~The optical characteristics of cross-connect may impact loss calculations~~

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

6 Network Attributes

This section details network level attributes and characteristics that are relevant to the delivery of end-to-end services by ~~Customers~~Customer.

6.1 Supported Layer 2 Frame Size

The NBN Co Network supports a maximum layer 2 Ethernet frame size of 2000 bytes at the NNI, inclusive of the S-TAG and C-TAG. This maximum frame size limitation may be referred to as the layer 2 Maximum Transfer Unit (**MTU**) of the NBN Co Fibre Network.

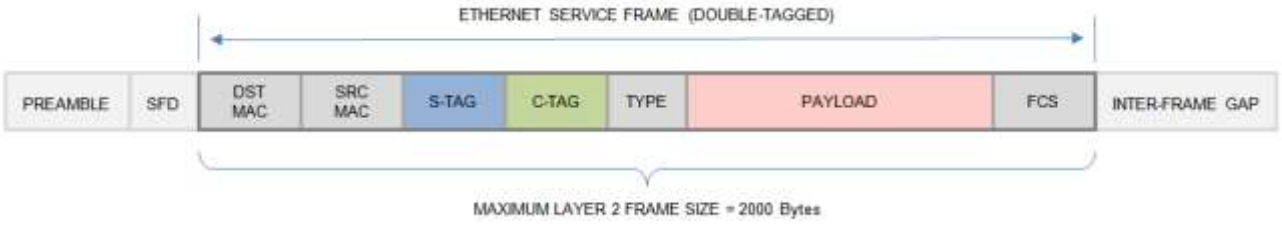


Figure 6 NNI Service Frame Definition (NNI Service Addressing Mode A)

For UNI-D configured as either Default-Mapped or DSCP-Mapped, the maximum layer 2 service frame length at the UNI-D is 1992 bytes. Any ingress service frame received at the UNI-D that exceeds this length will be discarded. Any ingress service frame received at the UNI-D that is less than 64 bytes (not including any VLAN tag applied by the Customer) will also be discarded.

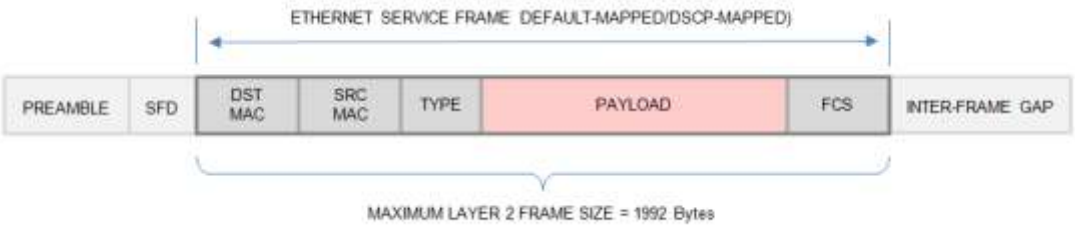


Figure 7 UNI-D Maximum Frame Size Definition (Default-Mapped/DSCP-Mapped Mode)

Note that any ingress service frame received at the UNI-D that is less than 104 bytes in length will be padded to 104 bytes (prior to the insertion of the S-TAG and C-TAG) as it traverses the NBN Co network.

6.2 Network Performance

The following information describes the performance of the NFAS Traffic Classes.

6.2.1 Traffic Class Performance Parameter Definitions

This section is provided to clarify NBN Co's traffic parameters, for the specification of CIR performance.

Table 31 Traffic Parameter Definitions

Parameter	Description
Frame Delay	Average, one-way propagation delay for a frame from UNI-D to NNI, where the delay is defined as the time elapsed since the start of transmission of the first bit of the frame at the frame source until the reception of the last bit of the frame at its destination. Commonly referred to as "latency". Note that Frame Delay guidance is provided for UNI-D to NNI distances less than 100km. In case of UNI-D to NNI distance > 100km, an extra allowance of 1ms latency per additional 200km fibre distance (or part thereof) is required. Note that services utilising the UNI-V are subject to additional performance-affecting processing which will impact end-to-end performance.
Frame Delay Variation	A measure of the average variation in delay between the arrival of pair of service frames, where the service frames belong to the same CoS instance or grouping. Provided in accordance with RFC3550. Commonly referred to as "jitter".
Frame Loss	A ratio of the number of service frames not delivered, divided by the total number of service frames transmitted during a specific and defined time interval.

6.2.2 Scope of Traffic Performance Targets

The stated traffic performance targets apply explicitly within the NBN Co Network, between the UNI-D and NNI.

These traffic performance targets do not account for any traffic contention applied by the Access Seeker through AVC/CVC dimensioning. The actual performance experienced by an End-User will depend upon the configuration of NFAS service components by the Access Seeker, as well as a range of additional factors outside of the NBN Co service boundaries (such as the configuration and performance of the Access Seeker's network and cabling and customer equipment on the End-User's side of the network boundary).

6.2.3 Traffic Performance Targets – Fibre (GPON)

NBN Co will use reasonable endeavours to manage its internal network resources to implement the following performance figures, and these target performance figures may be reviewed periodically by NBN Co in accordance with the Wholesale Broadband Agreement.

6.2.3.1 Traffic Class 1 (TC-1)

Traffic Class 1 is designed for applications that require strict performance characteristics, with low bit-rates (150kbps), and small frames (maximum ~~150~~250 bytes).

The minimum CIR performance for TC-1 is shown in Table 32 below.

Table 32 NFAS TC-1 Performance (CIR)

Traffic Class	Frame Delay	Frame Delay Variation	Frame Loss
TC-1	≤ 25msec	≤ 16msec	≤ 0.04%

These CIR performance attributes are dependent upon the following operating conditions, as maintained by the Access Seeker:

- TC-1 CVC capacity operating at ≤ 70% utilisation
- Periodic frame arrivals, every ~~10ms~~20ms
- Frame length maximum of ~~150~~250 bytes at NNI

6.2.3.2 TC-4 Traffic Performance Characteristics

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

NBN Co does not provide specific Frame Delay, Frame Delay Variation or Frame Loss targets for the TC-4 class.

7 Deployment Guidelines

7.1 Delivery Options

NFAS supports GPON access technology for delivery of last-mile connectivity to the End User Premises.

7.2 Network Termination Device (NTD)

NFAS is delivered to an End User Premises using a physical NTD.

The NTD is intended for residential deployments, primarily for single-dwelling premises.[27] However, it may be used for other types of deployment subject to NBN Co's confirmation of suitability.

The internal and external NTD variants are functionally identical, in the number of ports and services that they can deliver.

7.2.1.1 Physical Interfaces

The NTD has the following UNI ports:

- Four electrical 10/100/1000BASE-T Ethernet UNI-D ports
- Two UNI-V[28]

Figure 8 shows the arrangement of UNI-D and UNI-V ports on the internal NTD.

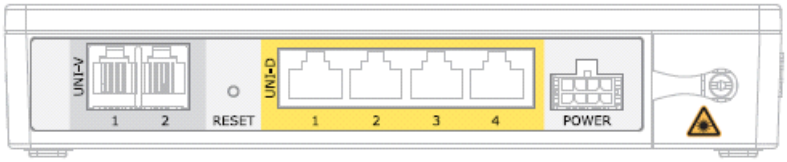


Figure 8 Internal NTD

7.2.1.2 Power Supply

The NTD is supplied with an indoor power supply unit that must be connected to a dedicated, standard 240V, 10A Australian General Purpose Outlet (**GPO**). The NTD should be installed within 3 metres of the power supply unit.

NBN Co will deploy a battery backup solution with each NTD that provides battery backup power supply capability in respect of the UNI-V ports only in the event of mains power failure at that End User Premises.

[27] NTD is also applicable for Multi-Dwelling Units where fibre access is deployed to each tenancy.

[28] Only a single UNI-V will be activated unless notified by NBN Co otherwise.