



Wholesale Bitstream & VUA Products Technical Manual

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Associated documents

Title	Location
Wholesale Bitstream and VUA Reference Offer	All available online at
Wholesale Bitstream and VUA Product Service Level Agreement	https://nbi.ie/industry/service-provider/
Wholesale Bitstream and VUA Product Process Manual	or from your NBI Account Manager

The products in this document relate to the set of Wholesale Bitstream and VUA Broadband products outlined in the Project Agreement between National Broadband Ireland (NBI) and the Department of Communications, Climate Action and Environment (DCCA) as signed on 19th November 2019. This product set includes the minimum Bitstream and minimum VUA product set and the additional required Bitstream and VUA product set

Glossary of terms

AF:	Assured Forwarding
API:	Application Programming Interface
BE:	Best Effort
BMC:	Bitstream Multicast (per PoH)
CIR:	Committed Information Rate
Co-Lo:	Co-Location
CPE:	Customer Premises Equipment
CSID:	Calling Station Identifier
DHCP:	Dynamic Host Configuration Protocol
EF:	Expedited Forwarding
E-NNI:	External- Network to Network Interface
FTTH:	Fibre to the Home
IBH:	In-building Handover
IGMP:	Internet Group Management Protocol
ISH:	In-Span Handover
LAG:	Link Aggregation
LER:	(MPLS) Label Edge Router
MAC:	Media Access Control
MPLS:	Multi-Protocol Label Switching
NBI:	National Broadband Ireland
NTU:	Network Termination Unit
ODP:	Optical Distribution Point
OLT:	Optical Line Terminal
ONT:	Optical Network Terminal
PE:	Provider Edge node
PoH:	Point of Handover
PON:	Passive Optical Network
PoP:	Point of Presence
SP:	Service Provider (also known as RSP – Retail Service Provider)
TPP:	Third Party Premises
UNI:	User Network Interface (as defined by MEF 13)
VLAN:	Virtual Local Area Network
VPLS:	Virtual Private LAN Service
VUA:	Virtual Unbundled Access
XGS-PON:	10Gb Symmetrical Passive Optical Network

1 Introduction

This Wholesale Bitstream and VUA Product Technical Manual provides a detailed description of the products that will be made available to Service Providers, focussing on the Fibre to the Home (FTTH) solution which will be used to deliver the service to the vast majority of End Users.

This schedule refers to and should be read in conjunction with the published Bitstream and VUA Standard Service Agreement, which is published on the NBI website or can be obtained via NBI Service Provider Account Manager where applicable.

The Products are called 'Wholesale Bitstream and VUA Broadband Products', and for convenience are referred to as 'Bitstream and VUA products' in this manual. The Bitstream and VUA products provide an access service from an End User premises back to the Service Provider's network via a nominated national or regional Point of Handover (PoH).

Any Service Provider specific technology mentioned in this document is current as at the date of issue and is for guidance purposes only. All changes to this Product Technical Manual will follow the NBI change management process.

NBI reserves the right to adapt the technology used to deliver the products through the change management process at any time subject to the notification and timelines agreed for this product set.

2 Product Overview

This section provides a high-level overview of the Bitstream and VUA products available to Service Providers which are within the Intervention Area (IA). The two product ranges that are available to Service Providers are:

- Bitstream
- Virtual Unbundled Access (VUA)

The products have connection, rental and other associated charges, which are applied at Service Provider level. These charges are outlined in the published Bitstream and VUA Price List available in the Bitstream and VUA Reference Offer.

2.1 Bitstream Product

The Bitstream product provides Ethernet access, with optional traffic-based Class of Service (CoS), from an End User premises back to the Service Provider's network via one of the national PoHs. The two national PoHs are located in Dublin (Citywest and Kilcarbery).

The Bitstream product utilises an XGS-PON fibre access technology to provide high speed broadband.

The Service Provider is required to have an InterConnect at one of the national Bitstream PoHs, where the aggregated traffic is handed over to the Service Provider's network.

The network is terminated at the RJ-45 port on the ONT at the End User premises. The ONT is a Nokia XS-010X-A ONT, which supports auto-negotiation with a 1 x LAN 100M/1G/2.5G/5G/10G Base-T interface with an RJ-45 connector, which will have a configured speed determined by the End User's product.

2.1.1 Bitstream Product Set

Table 1 below shows the Bitstream Products currently available:

Table 1: Bitstream Products		
Product Name	Downstream	Upstream
Consumer Standard	150 Mbit/s	30 Mbit/s
Consumer Premium	300 Mbit/s	50 Mbit/s
Consumer Elite	1,000 Mbit/s	100 Mbit/s
Business Standard	150 Mbit/s	50 Mbit/s
Business Premium	300 Mbit/s	75 Mbit/s
Business Enterprise	1,000 Mbit/s	200 Mbit/s

2.1.2 Bitstream Unicast

Unicast is communication between a single sender and a single receiver over a network.

The Bitstream Unicast service supports an individual connection for each End User. Aggregated End User traffic belonging to a Service Provider within the PoH area footprint is presented in a single VLAN at the PoH to the Service Provider.

Unicast traffic from each PoP within a regional PoH area footprint is assigned to a single Virtual Private LAN Service (VPLS) per Service Provider.

2.1.3 Bitstream Unicast Redundancy

Bitstream Unicast Redundancy allows the Service Provider to order multiple Bitstream Unicast logical connections to multiple InterConnects, to provide redundancy for the same Bitstream Unicast access traffic.

The VPLS is local to the PoH area and there are separate ethernet services pointing to different InterConnects. This protects against failure of either the Bitstream Unicast connection or the InterConnect.

2.1.4 Bitstream Multicast (BMC)

All Bitstream products support multicast traffic, which is available as an add-on to the Unicast product.

Multicast is communication between a single sender and multiple receivers.

Where Bitstream multicast is required, a dedicated VPLS per Service Provider per PoH is set up to handle all multicast traffic. All VPLSs for a Service Provider are joined to a single Multicast VPN (MVPN). Multicast traffic will be presented on a dedicated NNI, specific to Multicast and separate from the Unicast NNI.

The default implementation of the Bitstream Multicast Service requires a Rendezvous Point to be specified by the Service Provider because the use of IGMPv2 requires Rendezvous Point and a PIM-SM (Protocol-Independent Multicast – Sparse Mode).

If a well-known source address is used (i.e. from 224.0.0.0 to 239.255.255.255), a static mapping (i.e. (*,G) -> (S,G)) can be implemented such that IGMPv2 can continue to be used, but PIM-SM can be replaced with PIM-SSM (PIM Source-Specific Multicast). A Rendezvous Point will therefore no longer be required.

In that case, when placing the Bitstream Multicast order, the Service Provider should specify the source address to which the (*,G) should be mapped instead of the Rendezvous Point. Multiple source address mappings (*,G) -> (S,G) can be supported if required.

2.1.5 Bitstream Multicast Redundancy

Bitstream Multicast Redundancy allows the Service Provider to order multiple Bitstream Multicast logical connections to multiple InterConnects to provide redundancy for the same Bitstream Multicast access traffic.

The VPLS service on the PoH area is connected to two separate national Bitstream PoH routers. This protects against failure of the Bitstream Multicast connection or the InterConnect. If both InterConnects are advertising the RP (Rendezvous Point) in BGP (Border Gateway Protocol), then IGMP joins will be forwarded based upon BGP best path selection.

The Service Provider can influence the best path by using the MED (MULTI_EXIT_DISCRIMINATOR (BGP4)). The MED is an optional attribute, which provides a dynamic way to influence a route where multiple options exist. Split horizon is applied to the VPLS to prevent routing loops.

2.2 VUA Product

The VUA product provides ethernet access with optional traffic-based Class of Service (CoS), from an End User premises back to the Service Provider's network via one of the regional PoHs. The VUA product is available at any of the regional NBI PoHs. To access the VUA product, the Service Provider must have an InterConnect at the regional PoH, where the aggregated traffic is handed over locally to the Service Provider's network.

The VUA product utilises XGS-PON fibre access technology over to provide high speed broadband.

The network is terminated at the RJ-45 port on the ONT at the End User premises. The ONT is a Nokia XS-010X-A ONT, which supports auto-negotiation with a 1 x LAN 100M/1G/2.5G/5G/10G Base-T interface with an RJ-45 connector, which will have a configured speed determined by the End User's product.

2.2.1 VUA Product Set

Table 2 below shows the VUA product offerings currently available:

Table 2: VUA Products		
Product Name	Downstream	Upstream
VUA Consumer Standard	150 Mbit/s	30 Mbit/s
VUA Consumer Premium	300 Mbit/s	50 Mbit/s
VUA Consumer Elite	1,000 Mbit/s	100 Mbit/s
VUA Business Standard	150 Mbit/s	50 Mbit/s
VUA Business Premium	300 Mbit/s	75 Mbit/s
VUA Business Enterprise	1,000 Mbit/s	200 Mbit/s

2.2.2 VUA Unicast

The VUA Unicast service provides an individual connection for each End User. Unicast traffic from each PoP within the PoH area is assigned to a single VPLS per Service Provider.

Aggregated End User traffic belonging to a Service Provider within that PoH area is presented in a single VLAN at the point of handover to the Service Provider.

2.2.3 VUA Multicast

All VUA products can support multicast traffic, which is available as an additional service. Where multicast is required, a dedicated VPLS per Service Provider is set up to handle all multicast traffic for End Users within the PoH. Multicast traffic will be presented on a separate VLAN, but will be presented on the same NNI as Unicast.

2.2.4 VUA Redundancy

VUA redundancy allows the Service Providers to order multiple VUA connections to multiple InterConnects in the same PoH, to provide redundancy for the same VUA access traffic. This protects against failure of the InterConnect and provides Service Providers with extra resilience.

- Broadcast traffic (e.g. DHCP Discover messages) is forwarded to both InterConnects
- Unicast traffic is forwarded to one InterConnect based on MAC learning in the VPLS
- LAG is supported on InterConnects as a load-balancing mechanism across a number of InterConnect Links. Split horizon is applied to the VPLS to prevent routing loops

3 Network Solution Overview

The Bitstream and VUA products are primarily delivered using FTTH (XGS-PON technology). However, in the exceptional case where FTTH is not feasible, an alternative technical solution may be provided. This solution will only be used where fibre feed costs of an FTTH solution are excessively prohibitive.

3.1 Pre-Order Infrastructure Element Requirements

Irrespective of the actual delivery solution to the End User premises, all orders for Bitstream and VUA products require Service Provider infrastructure elements to be in place before placing any End User Bitstream or VUA order. Detailed information on infrastructure setup is described in the InterConnect and Co-Location Product Process Manuals and Product Technical Manuals.

3.1.1 InterConnect Product

The Service Provider must purchase and build an InterConnect using one of the following NBI InterConnect Products to ensure connection between the NBI network and Service Provider's network:

- CSH – InterConnect product using Customer Sited Handover
- ISH – InterConnect product using In-Span Handover
- IBH – InterConnect product using In-Building Handover

Please refer to the InterConnect Product Description and other elements of the InterConnect Product Reference Offer published on the NBI website for further details

3.1.2 Building and Cabin Co-Location Product

The Service Provider may purchase the physical Co-Location product at a nominated PoH, if available. Once Co-Location is in place, one of the InterConnect products may be ordered.

Please refer to the Co-Location Standard Access Agreement and the other elements of the Co-Location Product Reference Offer published on the NBI website for further details.

3.1.3 Logical Elements (Unicast and Multicast)

A Service Provider must order a logical connection from each PoP (or OLT level) to their chosen InterConnect location. These logical links are specific to each Service Provider and carry the aggregated Service Provider specific traffic (unicast or multicast) from the Co-Location point across the network to the InterConnect location. This logical connectivity is mandatory to ensure effective service and is required to be completed before a Service Provider can place orders for Bitstream and VUA Products for its End Users.

Once the logical elements are built, the S-VLAN and Egress Domains are used to map the traffic to the appropriate Service Provider specific VPLS.

The logical element consists of:

- A mandatory unicast logical connectivity element required for the ordering of all products (Bitstream Unicast Identifier (BUlxxxxxx) and Egress Domain Identifier (XXXXX)). Unicast is communication between a single sender and a single receiver over a network
- An optional multicast logical connectivity element for ordering multicast features. Multicast is communication between a single sender and multiple receivers

3.2 Bitstream Network Solution

This section provides a high-level technical overview of how the Bitstream products are supported on the NBI network.

3.2.1 Bitstream Unicast Implementation

End User traffic presented at the ONT will be VLAN tagged with the VLAN ID 10 and 802.1p bits marked by the End User's CPE.

The OLT will swap VLAN ID 10 with an S-VLAN tag to identify the Service Provider (VLAN 1100 for Service Provider A and VLAN 1200 for Service Provider B above).

At the regional PoH, the VLAN acts as the service selector. The VLAN tag is replaced with the S-TAG nominated by the RSP in the Bitstream logical order and forwarded to the specific InterConnect Link. There will be a VPLS per Service Provider per Egress Domain, per POH for unicast traffic.

3.2.2 Bitstream Unicast: End User to InterConnect Traffic Flow

The following describes how unicast End User traffic is treated in the End User InterConnect direction for both single and multiple VPLSs.

1. End User traffic is presented to the NBI network at a physical Ethernet port on the ONT installed at the End User site. The traffic presented at the ONT is VLAN tagged (VLAN 10). The End User retail or wholesale CPE generates the Ethernet frames with a VLAN tag of 10 and 802.1p CoS markings.

2. The OLT swaps VLAN ID 10 with an S-VLAN tag to identify the Service Provider. The assigned S-VLAN ID is not visible to either the End User or the Service Provider. The 802.1p CoS markings are preserved.

3. The OLT forwards traffic to the NBI Regional PoH tagged with the S-VLAN ID. The OLT acts as a DHCP relay and inserts DHCP Option82 and DHCPv6 option18 information including the physical port that supports user identification and authorization.

4. The S-VLAN acts as the service selector at the PoH area to map the traffic to the appropriate VPLS.

5. The CoS profile is applied to End User traffic associated with the S-VLAN and the End User traffic is mapped to the appropriate Forwarding Class within the network. The S-VLAN tag is removed and the End User traffic is carried within a VPLS across the NBI network.

6. An S-VLAN tag that identifies the source PoH area is added to the End User traffic on the Egress Domain of the NBI network and the appropriate CoS profile is applied to the End User traffic.

7. The End User traffic is passed to the NBI managed NTU at the Service Provider PoH. The S-VLAN on the network-facing port is mapped to the Service Provider facing port on the NTU (interconnect port). The default is for NBI to assign the S-VLAN ID presented at the InterConnect.* The assigned S-VLAN ID will be in the range 100 - 4000.

*The Service Provider may optionally specify the S-VLAN ID presented at the InterConnect. If the Service Provider chooses to specify their own S-VLAN ID on a specific InterConnect, then the Service Provider will be responsible for specifying all S-VLAN IDs within the range 100 - 4000 on that InterConnect.

The S-VLAN ID is used to identify the NBI regional side PoH area associated with the Bitstream Unicast fibre access. The 802.1p bits marked by the End User's CPE are not preserved through the network because the S-VLAN is stripped off, however the CoS is preserved because the 802.1p bits on the S-VLAN at the InterConnect are marked according to the MPLS EXP bits i.e. CPE S-VLAN 802.1p bits 0, 2 and 4 map into MPLS EXP bits 0, 2 and 4, which in turn map to 802.1p bits 0, 2 and 4 on the S-VLAN at the InterConnect.

Where a Service Provider has more than one InterConnect, the Service Provider must specify which InterConnect is to be associated with each Bitstream Unicast connection.

3.2.3 Bitstream Unicast: InterConnect to End User Traffic Flow

The following describes how Service Provider unicast traffic is treated in the InterConnect to End User direction:

1. The default is for NBI to assign the S-VLAN ID presented at the InterConnect. The assigned S-VLAN ID shall be in the range 100 - 4000.

Optional: The Service Provider can optionally specify the S-VLAN ID presented at the InterConnect. If the Service Provider chooses to specify their own S-VLAN ID on a specific InterConnect, then the Service Provider shall be responsible for specifying all S-VLAN IDs within the range 100 - 4000 on that InterConnect.

The Service Provider must add this S-VLAN tag to their traffic and mark the S-VLAN 802.1p bits prior to presentation at the InterConnect. The S-VLAN tag is associated with the NBI regional PoH area connected to the destination OLT.

2. The CoS profile is applied to the traffic associated with the S-VLAN and the Service Provider traffic is mapped to the appropriate Forwarding Class (FC) within the NBI network. The S-VLAN tag is removed and the Service Provider traffic is carried within a Virtual Private LAN Service (VPLS) across the NBI network.
3. An S-VLAN is added to the Service Provider traffic and the appropriate CoS is applied. The assigned S-VLAN ID is not visible to either the End User or the Service Provider.
4. The local OLT forwards traffic to the End User ONT with the SVLAN tag.
5. The OLT swaps the S-VLAN tag that identifies the Service Provider with VLAN ID 10 and present the End User's traffic to the End User's CPE.

3.2.4 Bitstream Multicast (BMC) Implementation

The multicast service is delivered using a MVPN solution.

The End User's CPE sends an IGMP Join to multicast group 239.1.1.1 (IGMP v.2 is supported) to the End User ONT. The OLT swaps VLAN ID 10 with a dedicated multicast S-VLAN that identifies the Service Provider. The ONT snoops and forwards to the OLT.

When the Join is received at the OLT on VLAN 1101, the OLT sends the traffic towards the NBI PE node/ Aggregation Router. At the NBI PE Node the Service Provider's multicast traffic enters a multicast VPN within the NBI network.

The Service Provider Rendezvous Point address is configured as part of the MVPN so that IGMP joins from the OLT can be forwarded as PIM joins to the Service Provider. At the InterConnect a dedicated VLAN is configured to carry all multicast traffic.

For efficiency and scalability, a single copy of every multicast stream offered by a Service Provider is carried from the Service Provider's handover point, through the NBI network, to the OLT and PON connecting to the End User. At no point in this path is the channel data replicated unnecessarily.

The OLT takes advantage of the shared PON medium to transmit a single stream to all End Users. The multicast streams from the Service Providers are transmitted from the encoders as IP packets with multicast addresses. These are grouped into a VLAN and sent to NBI at the Service Provider handover InterConnect. NBI multicasts the streams across the network and a single copy of each stream is sent to every OLT. At the OLT a multicast VLAN is configured for each Service Provider such that there is clear separation of streams between Service Providers.

When an End User joins the multicast group for a stream, the OLT transmits a copy of that stream to the ONT port over the PON. The OLT uses a special multicast GEM (XGS-PON Encapsulation Method) channel on the PON to carry this data. The data is available to all users ---transmitted once on the PON and is available to any of the 31 other End Users should they join that multicast group.

While the multicast traffic is visible on the PON side of all 32 ONTs, the data is not forwarded to the End User's internal Gbit Ethernet port unless an IGMP join has been seen by the ONT.

Unlike Unicast traffic, Multicast traffic is not encrypted by the OLT. Through (Access Control List) filters, the OLT is configured with a set of group addresses for each Service Provider multicast VLAN. End User ONTs are then permitted access to subsets of these group addresses on a Service Provider multicast VLAN. This restricts End Users to receiving only those streams that are transmitted by their Service Provider.

There is no requirement to agree on the multicast address space used by each Service Provider because the multicast traffic is carried in an MVPN in the NBI network.

OLT Multicast Settings

To enable multicast support for an FTTH customer, a multicast user is associated with the ONT and bound to the multicast VLAN to create a multicast member.

The Access Node (OLT) controls the maximum number of multicast groups that can be joined from an individual ONT. For each subscriber, this is set to the maximum value of 32 (TV stations).

Quick-leave, also known as fast-leave/immediate-leave, is enabled on the OLT and is MAC based. When IGMP-Join messages are received by the OLT, the OLT generates a multicast group membership table that contains the multicast user and the MAC addresses of the multicast group members (i.e. the set-top boxes) of the multicast user.

When the OLT receives an IGMP leave message, it deletes the MAC addresses in the multicast group membership table and stops forwarding the multicast stream when all the MAC addresses associated with the multicast user are deleted so that the associated bandwidth is released immediately.

Multicast authentication is not enabled in the OLT so IGMP Join messages for any multicast group address will be proxied by the OLT to the Multicast VPN.

3.2.5 Bitstream Multicast (BMC): End User to InterConnect Traffic Flow

The following describes how Service Provider multicast traffic is treated:

1. The End User's CPE sends an IGMP Join specifying the IP Multicast Group it wants to join.
2. The ONT swaps VLAN ID 10 with the multicast S-VLAN tag that identifies the Service Provider (and the VPLS/MVPN instance if the Service Provider has more than one) and forwards to the OLT (The ONT performs IGMP snooping).
3. The OLT proxies the IGMP Join towards the NBI PoH Aggregation Router
4. The S-VLAN will act as the service selector at the NBI PoH Aggregation Router to map the traffic to the appropriate VPLS. There will be a VPLS for multicast per Service Provider at each OLT site. Real-Time (EF) CoS is applied to End User traffic associated with the multicast S-VLAN and the End User traffic is mapped to the appropriate EF Forwarding Class (FC) within the backhaul network. The S-VLAN tag is removed and the End User traffic is carried within a VPLS to the NBI National Bitstream PoH Router PE node.

5. The VPLS instance on the NBI PoH area is connected to each of the NBI PE nodes and is terminated directly onto an IP interface of a multicast VPN (MVPN). IGMP will be enabled on the IP interface to support multicast distribution.

6. The NBI PE Node receives the IGMP join from the OLT and forwards the message as a PIM join within the Service Provider MVPN. At the far end BGP is enabled on the NBI PE Node to exchange routing information with the Service Provider's edge router. These routes will be used to calculate the appropriate path back to the source (i.e. via the InterConnect). The NBI PE Node at the InterConnect forms a PIM adjacency with the Service Provider and a distribution tree is built on which the multicast traffic is forwarded to the receiver.

7. An S-VLAN tag that identifies the multicast traffic for that MVPN instance is added to the End User traffic on Domain of the NBI network and the appropriate service policy is applied to the End User traffic.

8. When the source tree is built from the receiver to the source, data flows down the source tree to the receiver.

3.3 VUA Network Solution

This section provides a high-level technical overview of how the VUA products are supported on the NBI network.

3.3.1 VUA Unicast: End User to InterConnect Traffic Flow

The following describes how unicast End User traffic is treated in the End User to InterConnect direction (applicable to both single and multiple VPLS)

1. End User broadband traffic is presented to the network at a physical port on the ONT installed at the End User site. It is VLAN tagged (VLAN 10). The End User CPE generates the Ethernet frames with a VLAN tag of 10 and 802.1p CoS markings.

2. The ONT swaps VLAN ID 10 with an S-VLAN tag to identify the Service Provider and the Domain Group. The assigned S-VLAN ID is not visible to either the End User or the Service Provider. The 802.1p CoS markings are preserved.

3. The OLT forwards traffic to the PoH tagged with the S-VLAN ID. The OLT acts as a DHCP relay and inserts DHCP Option82 and DHCPv6 option 18 information including the physical port that will support user identification and authorization.

4. The S-VLAN acts as the service selector at the PoH to map the traffic to the appropriate Egress Domain

5. The CoS profile/bandwidth is applied to End User traffic associated with the S-VLAN and the End User traffic is mapped to the appropriate Forwarding Class within the NBI network

6. An S-VLAN tag that identifies the source PoH is added to the End User traffic exiting the NBI PoH InterConnect port and the appropriate CoS profile is applied.

7. The default is for NBI to assign the S-VLAN ID presented at the InterConnect.* The assigned S-VLAN ID will be in the range 100 - 4000

*The Service Provider may optionally specify the S-VLAN ID presented at the InterConnect. If the Service Provider chooses to specify their own S-VLAN ID on a specific InterConnect, then the Service Provider will be responsible for specifying all S-VLAN IDs within the range 100 - 4000 on that InterConnect. Traffic from each VPLS instance will be presented on a different S-VLAN.

3.3.2 VUA Unicast: InterConnect to End User Traffic Flow

The following describes how Service Provider unicast traffic is treated in the InterConnect to End User direction:

1. End User traffic is presented to the NBI InterConnect optical port. By default, NBI assigns the S-VLAN ID presented at the InterConnect*. The assigned S-VLAN ID will be in the range 100 - 4000.

*The Service Provider may optionally specify the S-VLAN ID presented at the InterConnect. If the Service Provider chooses to specify their own S-VLAN ID on a specific InterConnect, then the Service Provider will be responsible for specifying all S-VLAN IDs within the range 100 - 4000 on that InterConnect.

2. The CoS profile is applied to the traffic associated with the S-VLAN and the Service Provider traffic is mapped to the appropriate Forwarding Class. The Service Provider traffic is carried via within a VPLS to the OLT connected port on the NBI PoH area.

3. An S-VLAN is added to the Service Provider traffic and the appropriate CoS is applied. The assigned S-VLAN ID is not visible to either the End User or the Service Provider.

4. The OLT will forward traffic from the NBI PoH area to the ONT with the SVLAN tag.

5. The OLT will swap the S-VLAN tag that identifies the Service Provider with VLAN ID 10

6. The ONT presents the End User's broadband traffic to the CPE

3.3.3 VUA Multicast: End User to InterConnect Traffic Flow

The following describes how Service Provider multicast traffic is treated:

1. The End User's CPE sends an IGMP Join specifying the IP multicast group it wants to join.

2. The ONT swaps VLAN ID 10 with the multicast S-VLAN tag that identifies the Service Provider and forwards to the OLT (The ONT performs IGMP snooping).

3. The OLT proxies the IGMP Join towards the NBI PoH area.

4. The S-VLAN acts as the service selector at the NBI PoH area to map the traffic to the appropriate VPLS. There is a VPLS for multicast per Service Provider at each NBI PoH area with connected PoPs. EF CoS is applied to End User traffic associated with the multicast S-VLAN and the End User traffic is mapped to the appropriate EF Forwarding Class. The End User traffic is carried within a VPLS to the logical port on the NBI PoH area associated with the InterConnect.

5. An S-VLAN tag that identifies the multicast traffic is added to the End User traffic on the Egress Domain and the appropriate service policy is applied to the End User traffic.

6. The S-VLAN ID is used to identify multicast traffic.

The default is for NBI to assign the multicast S-VLAN ID presented at the InterConnect.* The assigned multicast S-VLAN ID will be in the range 100 - 4000.

*The Service Provider may optionally specify the multicast S-VLAN ID presented at the InterConnect. If the Service Provider chooses to specify their own multicast S-VLAN ID on a specific InterConnect, then the Service Provider will be responsible for specifying all S-VLAN IDs within the range 100 - 4000 on that InterConnect.

7. The Service Provider's router receives the IGMP join.

8. In the reverse direction multicast traffic is forwarded by the Service Provider through the InterConnect to the receiver. The same traffic flow as above applies in reverse.

3.4 VLAN Management

The Service Provider is required to tag End User traffic with VLAN ID10 and the 802.1p bit markings.

At the OLT the VLAN ID is swapped with an S-VLAN that identifies the Service Provider and the specific service (unicast or multicast for Bitstream and VUA). If the Service Provider has multiple products (unicast and multicast) then these will have their own S-VLAN to ensure VLAN separation at local access. In addition each VLAN will have its own VPLS and aggregated PoH traffic is carried across the network in a separate VPLS. This same concept also applies where a Service Provider has retail agents. These retail agents will have their own specific VLANs and VPLSs for their specific offerings and their own Egress Domain for their specific local VPLSs. The Service Provider will have a single VLAN, per Egress Domain, per NNI.

All CoS markings are preserved, where the appropriate CoS product has been purchased by the Service Provider. CoS markings will be ignored if the Service Provider has not purchased the relevant CoS product.

3.5 MAC Address Limits

There is a limit of 5 MAC Addresses per ONT

3.6 Egress Domain

If a Service Provider has multiple logical connections from a single PoH (e.g. Unicast for Service Provider 1, Unicast for Service Provider 1-RetailAgent 1, Unicast for Service Provider 2-RetailAgent 2, Multicast for Service Provider 1) then each logical Unicast connection will be assigned its own “Egress Domain” Identifier (e.g. xxxx)

This Identifier is used on End User orders to identify which Egress Domain should be used for the Service Provider specific End User. The same Egress Domains are used across all PoHs.

3.7 Class of Service (CoS)

The network has three forwarding / service classes available:

- Best Efforts (BE) by default
- Expedited Forwarding (EF) on Consumer and Business products
- Assured Forwarding (AF) for Business Products

	EF	AF	EF	AF
	Downstream	Downstream	Upstream	Upstream
Default	0	0	0	0
Consumer Option	1 Mbit/s	0	1 Mbit/s	0
Business Option 1	10 Mbit/s	20 Mbit/s	10 Mbit/s	20 Mbit/s
Business Option 2	20 Mbit/s	40 Mbit/s	20 Mbit/s	40 Mbit/s

The End User CPE tags traffic with VLAN ID 10 and marks the 802.1p CoS markings in the S-VLAN header. Using 802.1p the Service Provider can choose which forwarding / service class certain traffic types travel through. This is performed using the 802.1p markings in the Ethernet frame headers on network ingress.

End User traffic is mapped to a forwarding class on ingress to the network. The marking scheme is as follows in Table 4 below:

Table 4: Forwarding Class and CoS Marking	
Forwarding Class	802.1p CoS marking
Expedited Forwarding (EF)	4
Assured Forwarding (AF)	2
Best Efforts Forwarding (BE)	0

Traffic with other 802.1p markings not specified above will be dropped. Please note that for multicast the traffic is automatically assigned to the EF class.

4 Installation

4.1 End User Premises Installation

The fibre from the Optical Distribution Point (ODP) on the pole outside the End User premises and into the End User premises will be delivered either via an overhead fibre cable or, where available, via fibre within an underground duct. Where possible, all premises will be surveyed as part of the network build in order to confirm the most suitable method of delivering service on a per premises/unit basis.

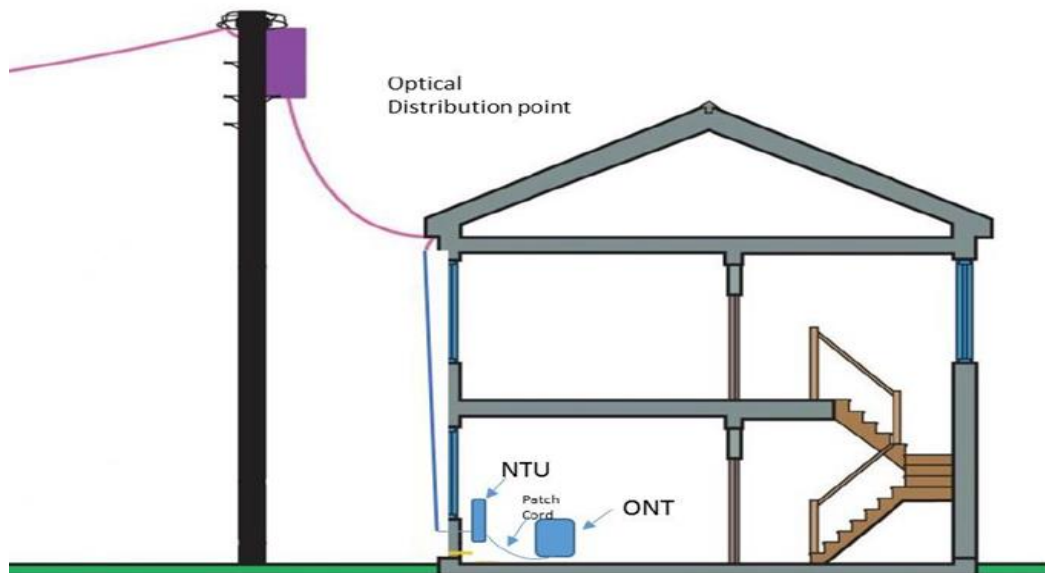


Figure 1: End User Connection

The default fibre drop point from the Optical Distribution Point (ODP) on the pole outside the End User premises into the End User premises is overhead as shown in Figure 1 - "End User connection".

In particular circumstances services may be provided via duct (using existing End User ducting if suitable) or if the End User provides ducting and signs the required wayleave. In this circumstance, however, this may carry an incremental associated charge if the delivery method differs to that from the initial premises survey. This is discussed in more detail in the Bitstream and VUA Product Process Manual.

The external fibre is brought to a suitable agreed point for entry at the external wall and close to an internal power supply. A ~10mm Ø hole is drilled through the wall and the cable threaded through to be terminated onto the NTU preferably within one meter of the hole.

4.2 Optical Network Terminal (ONT) & NTU

The Optical Network Terminal (ONT) RJ-45 port acts as the demarcation point for Bitstream and VUA service. The ONT is located in the fibre NTU for a neater installation and to minimise exposed cabling. The ONT and fibre NTU are connected using a 1m SC APC to SC APC fibre patch cord. The ONT requires mains power and will typically be wall-mounted near a power socket (power socket supplied by the End User).

The Technical Specification for the Nokia XS-010X-A ONT is as follows:

- Integrated XGS-PON optics on board (supporting 10G/10G symmetric. PON)
- Auto-negotiation with 1 x LAN 100M/1G/2.5G/5G/10G Base-T interface with an RJ-45 connector
- Network demarcation for all services
- Mux and demux functions to the PON
- Optical to electrical conversion
- Optics that support received signal strength indication (RSSI)
- FEC (Forward Error Correction) in both upstream and downstream connections
- FCS (Frame Check Sequence) error counter
- G.988 standards compliance for ONT management and provisioning
- Standards-based CMAC (OMCI/PLOAM)



Figure 2: NBI Optical Network Terminal (Nokia xs-010x-A)

5 Bitstream and VUA Ordering and Fault Handling

All ordering of Bitstream and VUA products is managed using the Service Portal or via the API functionality. Full details on all Ordering and Fault Handling processes are available in the Bitstream and VUA Product Process Manual. This document is available on the website or directly from the Service Provider's account manager.