



Proximus Reference Offer for Bitstream Access

Covering the technology Fiber GPON

Annex 2: Technical Specifications

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Our reference: MSO & Servicing version

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1.Scope

The purpose of this document is to describe the technical specifications of the Bitstream Fiber GPON "Shared VLAN"¹ service.

To allow the Beneficiary to set up a service based on the above-mentioned service from Proximus, this document describes the interfaces.

The Beneficiary willing to offer features which require other technical characteristics than those implemented and supported by Proximus and described in the present offer can implement them but without commitment of Proximus on their correct functioning. Examples of such features are:

- non-tested protocols or protocols not supported by Proximus network equipment,
- burst sizes, delay or jitter requirements beyond the Proximus retail applications.

Proximus cannot guarantee, deliver support & be held liable regarding:

- the correct functioning of such features in its network (at whatever time),
- the future evolution of other (supported or non-supported) features than those implemented and supported by Proximus for its own services.

Any enumeration of supported or non-supported protocols or features listed in this document are not exhaustive and are based on the Proximus best knowledge available at this moment.

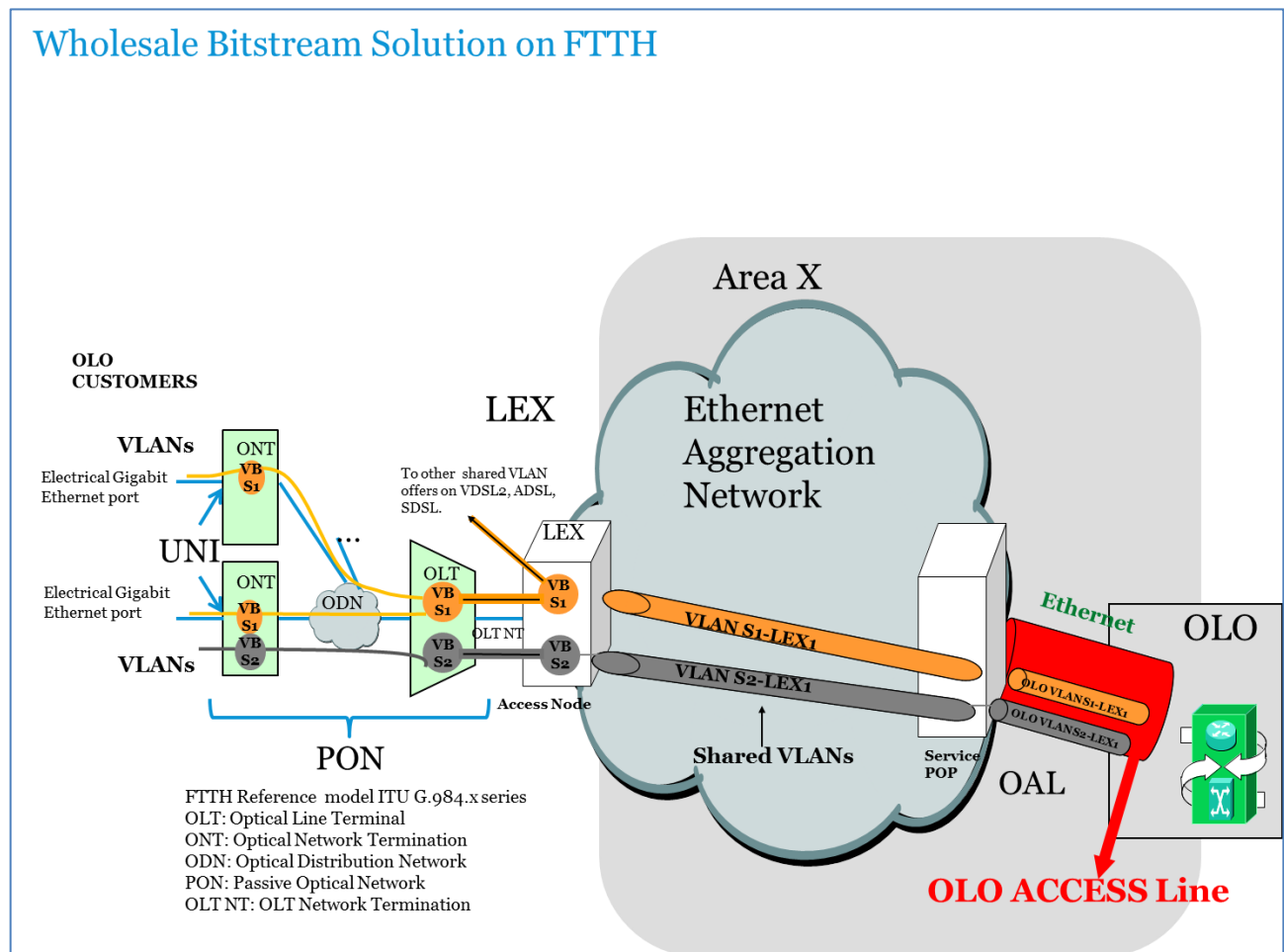
¹ Conditional to the availability of sufficient resources for IT and network implementation, the development of the Bitstream Fiber GPON "Dedicated VLAN" service in the Proximus network and systems is expected to be available with the October 2019 IT release. This timeframe does not contain a commitment of Proximus. The technical specifications of this new service will be detailed out at a later stage.

2. Abbreviations

	Description
DHCP	Dynamic Host Configuration Protocol
DS	Downstream
DSCP	Differentiated Services Code Point
Fiber GPON	Point-to-multipoint shared fiber using GPON (Gigabit Passive Optical Network) technology to serve multiple homes (FTTH – Fiber To The Home) and businesses (FTTB – Fiber To The Business)
GE	Gigabit Ethernet
GUI	Graphical User Interface
IPoE	Internet Protocol over Ethernet
LACP	Link Aggregation Control Protocol
LAG	Link Aggregation
LAN	Local Access Network
LEX	Local Exchange
MTU	Maximum Transmission Unit
OAL	<u>Q</u> LO (Ethernet) <u>A</u> ccess <u>L</u> ine
ODN	Optical Distribution Network
OLO	Other Licensed Operator (also mentioned in this document as “Beneficiary”)
OLT	Optical Line Terminal
OLT NT	Optical Line Terminal Network Termination
ONT	Optical Network Terminal (also referred to as Optical Network Termination in this document)
PON	Passive Optical Network
p-bit	Priority bit
PoP	Point of Presence
PPP	Point to Point Protocol
PPPoE	Point to Point Protocol over Ethernet
UNI	User Network Interface (the word UNI systematically refers to the UNI on the ONT)
US	Upstream
U2U	User to User (communication)
VDSL2	Very high speed Digital Subscriber Line transceivers 2 (ITU-T G.993.2)
VLAN	Virtual LAN
VULA	Virtual Unbundling Local Access

3. Overall Network architecture of Bitstream Fiber GPON with Shared VLANs

3.1 End-to-End view



Graph 1: End-to-end overview (Shared VLANs)

This **Bitstream Fiber GPON Shared VLAN** service offers an end-to-end Ethernet connectivity between one OLO Access Line and the ONT GE port at UNI installed at the End-User premises. Six service classes are defined on the Ethernet Network, differentiated by the Ethernet p-bit², two service classes for each p-bit²:

² Conditional to the availability of sufficient resources for IT and network implementation, the development of the service quality P=1 in the Proximus network and systems is expected to be available with the October 2019 IT release. This timeframe does not contain a commitment of Proximus. The technical specifications of this new service quality will be detailed out at a later stage.

- P=0 : best effort (P0 & P0bis)
- P=3 : medium priority (P3 & P3bis)
- P=5 : highest priority (P5 & P5bis), and better performance for jitter and delay sensitive traffic.

Each service class can carry Bitstream Fiber GPON traffic and Bitstream xDSL traffic.

Each Fiber GPON UNI can offer to the End-User one or none of the two P0 service classes, one or none of the two P3 service classes and one or none of the two P5 service classes. At least one service class needs to be configured on the Fiber GPON UNI.

The service quality P=5 has the highest priority in the network and is also designed to offer better performance for jitter and delay sensitive traffic (e.g. voice and real-time traffic). This performance is obtained with a reduced size of the buffers compared to other service qualities. The traffic sent on a VLAN with P=5 should take into account that this service quality is less tolerant to burst of data. It is advised to send traffic with an appropriate shaping to avoid packet losses. An appropriate shaping can be implemented as follows: for traffic with service quality P=5 the shaper shall be configured slightly below the ordered P5 transport bandwidth and the traffic shall be sent with a constant bitrate to avoid packet loss. For P5-traffic on a Shared VLAN the sum of the shaped bandwidths shall stay slightly below the ordered P5 transport bandwidth.

The VLAN-ID scheme on all Fiber GPON UNIs is common for all OLOs.

- VLAN-ID 10 = Best Effort traffic (P0 or P0bis).
- VLAN-ID 40 = Medium priority traffic (P3 or P3bis).
- VLAN-ID 21 = Highest priority traffic (P5 or P5bis).

The PON network works as a VLAN Ethernet bridge performing translation between the VLAN-ID on the ONT UNI, to a VLAN, dedicated for 1 service class and 1 OLO. This bridge is shared amongst all End-Users of the same service class of the same OLO.

E.g.: All Best Effort P0 traffic of OLO1 End-Users is bridged to VLAN 2200 on the OLT NT. All P0bis traffic of OLO1 End-Users is bridged to VLAN 2202 on the OLT NT.

Per service class, the VLANs of the End-User lines of a Beneficiary will be aggregated on LEX level in the Access node of the Ethernet Aggregation Network and transported in 1 VLAN to the Service PoP, where the standard OLO Access Line is connected. When a Multichassis-LAG OLO Access Line is used, two OALs are connected to the 2 different Service PoPs. There are 2 Service PoPs, located in 2 different buildings, per Aggregation Network, and 5 Aggregation Networks for whole Belgium. Each of the 5 Aggregation Networks covers 1 geographical Area.

When a standard OLO Access Line is used, the VLAN ends in 1 VLAN on the OLO Access Line.

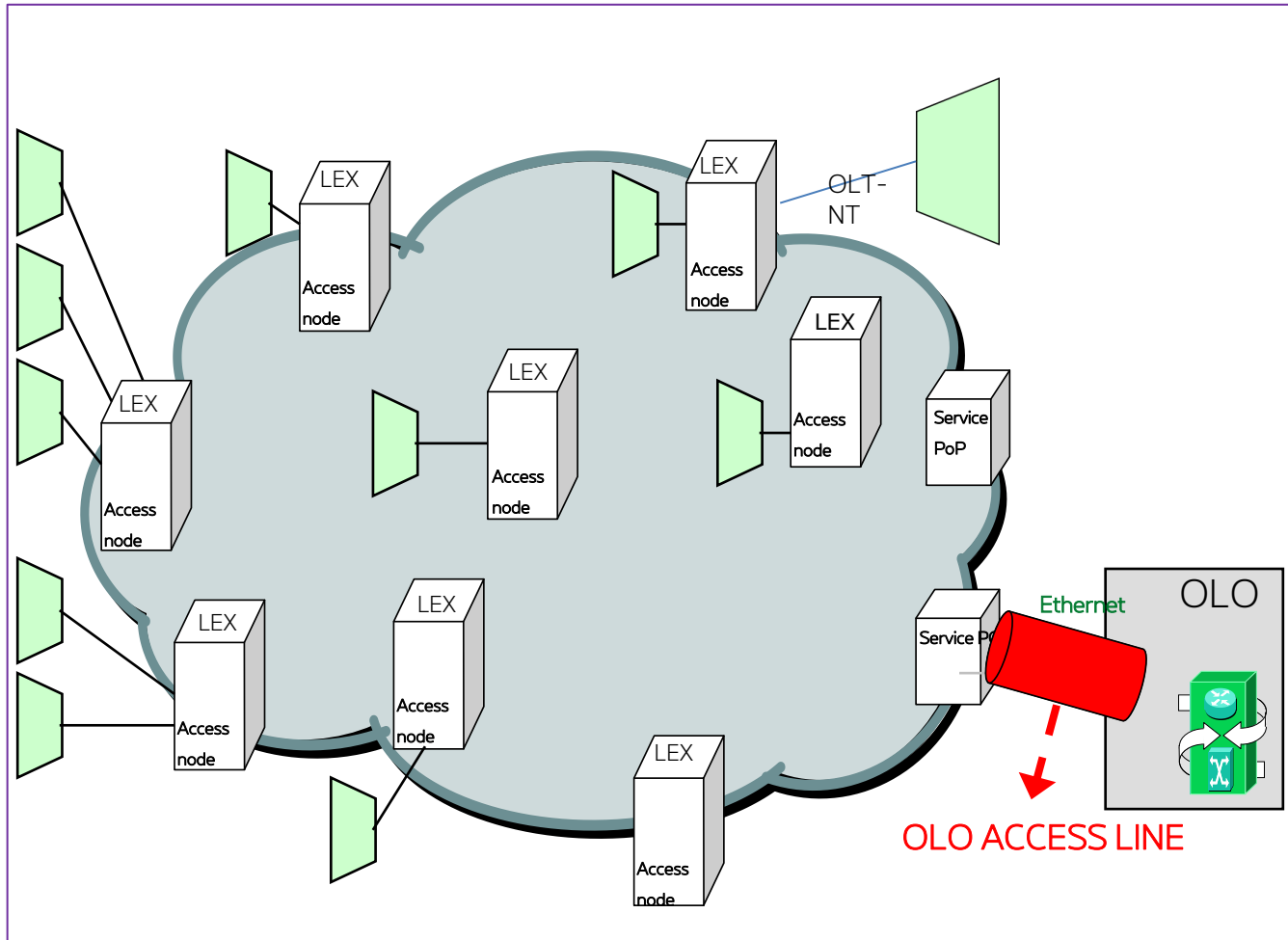
When a Multichassis-LAG OLO Access Line is used, one link is working and the other is standby. The VLAN ends in 1 VLAN on the working OLO Access Line.

Per service class and per LEX where the Beneficiary wants to be active, he will need to order 1 separate VLAN between the LEX and one of the 2 Service PoPs of the Aggregation Network to which the LEX belongs (in case of a Multichassis LAG OLO Access Line these VLANs will dynamically be terminated on the Service PoP with the working OLO Access Line). In this LEX, all End-Users of the Beneficiary with the same service class (e.g.: P0bis) will share this same VLAN separated from the VLAN (e.g.: P0) of the same OLO or any other OLO.

The OLO will connect the OLO Access Lines to his OLO Router or other equipment. When Multichassis LAG OLO Access Lines are used the OLO Router or other equipment must support multichassis LAG.

3.2 Aggregation Network structure

The Aggregation Network structure schematized in Graph 2 below is common to Bitstream Fiber GPON and Bitstream xDSL.



Graph 2: Aggregation Network Structure

The Optical Line Terminal Network Termination, OLT NT, is connected to one Access node. The VLAN is routed from the OLO Access Line to the Access node of the LEX.

Redundancy:

- Rerouting of the VLANs.
- The OLO Access Line redundancy is an option.
- The OLT NT is connected to its Access node via GE lines.

3.3 Aggregation Areas

The Bitstream Fiber GPON service shares the aggregation network defined in the document “Bitstream VDSL2 – Annex 2C – Technical Specifications”, sections “Aggregation Network structure”, “Aggregation Areas” and “VLAN characteristics”³.

Most important characteristics:

- Up to 6 bridges (p0, p3, p5, p0bis, p3bis, p5bis) in the Ethernet node in the LEX can be used for Bitstream Fiber GPON. These bridges are also used for Bitstream xDSL.
- Proximus connects the bridges in the “access nodes” to corresponding bridges in the IP-DSLAMs, GE-NT Aggregators and Fiber GPON OLT NTs.
- Shared VLAN connectivity per bridge, up to an OAL, ordered by the Beneficiary.

³ See Proximus Wholesale website at <https://www.proximus.be/wholesale/>, section “Regulated services”.

4. Interconnection at LEX level

In addition to the connection of the Beneficiary on Service PoP level as described in section 3, which allows the Beneficiary to use Bitstream services to connect End-Users of the whole Service Areas, the Beneficiary may also interconnect with Proximus at LEX level (VULA)⁴.

In case of interconnection of the Beneficiary on a LEX, the interconnection can only transport Ethernet frames of Bitstream connections serviced from that LEX.

In case of interconnection of the Beneficiary on a LEX, Proximus will provide, on behalf of the Beneficiary who will define their dimensioning, types and protection types:

- One or several OLO Access Lines between the Customer Equipment and the Proximus Ethernet Service Switch, sited in this LEX.
- Bandwidth (VLANs) between the Ethernet Service Switch of this LEX and the OAL(s) connected to this LEX. These VLANs can be either shared between several End-Users of a Beneficiary in this LEX or dedicated per individual End-User.
- The OAL at LEX level cannot be of type "Multichassis LAG".
- The OAL at LEX level cannot be of type 10GE.

4.1 With Shared VLANs

This **Bitstream** service offers an Ethernet connectivity between the OLO Access Line connected to the LEX and the GPON lines in the same LEX.

For VLAN Bandwidths available in function of the service chosen by the OLO, reference is made to Table 1 of the Main Body of the present reference offer.

A Shared VLAN of a specific service in a LEX might be connected to an OAL in the same LEX, while another Shared VLAN of another specific service ending in the same LEX is connected to an OAL in the Service PoP. E.g.: Shared VLAN P0 in LEX x is connected to the OAL in the LEX x, while Shared VLAN P5 ending in the same LEX x is connected to the OAL in the Service PoP of the same Service Area.

4.2 With Dedicated VLANs⁵

This **Bitstream** service offers an Ethernet connectivity between the OLO Access Line connected to the LEX and the GPON lines in the same LEX.

⁴ In case a firm request is received from a Beneficiary, the creation of the Bitstream local access in the Proximus network and systems will be targeted to be executed within a timeframe of 1 year.

⁵ Conditional to the availability of sufficient resources for IT and network implementation, the development of the Bitstream Fiber GPON "Dedicated VLAN" service in the Proximus network and systems is expected to be available with the October 2019 IT release. This timeframe does not contain a commitment of Proximus. The technical specifications of this new service will be detailed out at a later stage.

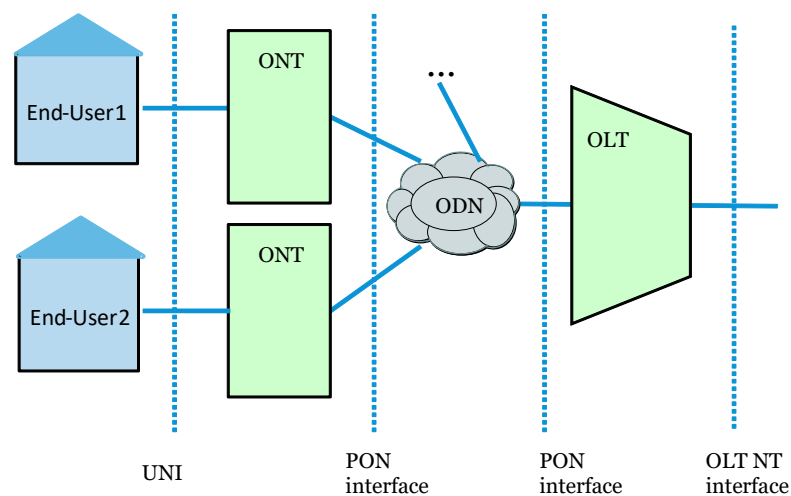
5.UNI

5.1. Physical Transport (Layer 0)

The Proximus Fiber GPON solution is a shared fiber solution, i.e. shared amongst a number of End-Users from Beneficiaries and from Proximus: it is an ITU-T G.984x based Gigabit Passive Optical Network (GPON) solution composed of the following elements:

- One or more Optical Line Terminal(s) in the LEX and OLT NT interfaces to the Ethernet Access node(s) in the LEX.
- A shared fiber: Optical Distribution Network (ODN).
- An Optical Network Termination box, installed by Proximus at the Beneficiary's End-User premises. 230V AC supply must be available.
- UNI: a Gigabit Ethernet interface on the ONT, for connecting the Beneficiary's End-User LAN and / or Service Box.
- The UNI is the network demarcation point, which is the Ethernet port on the ONT box.

Fiber GPON reference model



Reference model ITU G.984.4
 OLT: Optical Line Terminal
 ONT: Optical Network Termination
 ODN: Optical Distribution Network
 PON: Passive Optical Network

Graph 3: Fiber GPON reference model ITU G.984.4

Gigabit Ethernet specifications: Port 8P8C type RJ45, wiring compliant with T568B.

5.2. Port speed at UNI (Layer1)

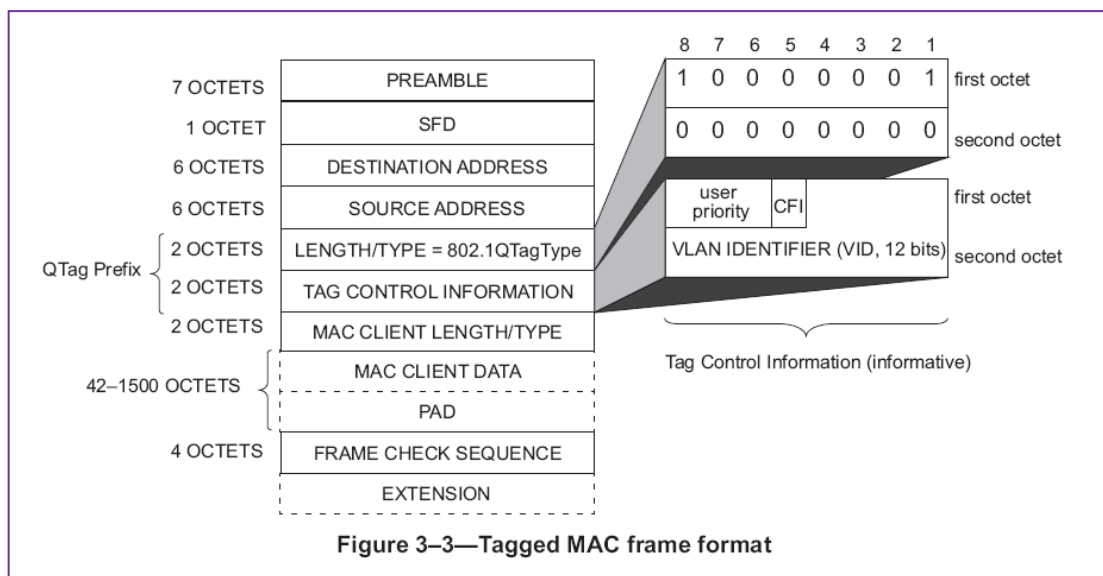
Gigabit Ethernet specifications:

- 1000 Base-T ports, IEEE 802.3-compliant.
- Full duplex.

5.3. Ethernet Format on Fiber GPON

Ethernet format on the UNI GE port:

- Frame format



Graph 4: Tagged MAC frame format

- IEEE 802.1Q also called “Tagged format” (see Figure 3-3 from IEEE 802.3 – 2005)

Ethernet MTU size: 1522 octets⁶ at End-User Demarcation point, including the C-tag VLAN. In this document, the MTU size is defined as the “Ethernet MTU size” and the number 1522 octets includes the following fields (cf. Figure 3-3 from IEEE 802.3-2005):

- Destination Address: 6 octets
- Source Address: 6 octets
- Qtag (is Ctag): 4 octets
- Mac Client Length/Type: 2 octets
- MAC Client Data +PAD: 1500 octets (equal to IEEE 802.3-2005)
- Frame Check Sequence: 4 octets
- Total: 1522 octets

On the UNI GE port, only single tagged Ethernet Frames with pre-defined VLAN ID (cf. section 5.5 VLAN ID allocation and QoS at UNI) are accepted. Classification and marking are based upon the VLAN ID.

⁶ Octet: a unit of digital information that consists of eight bits.

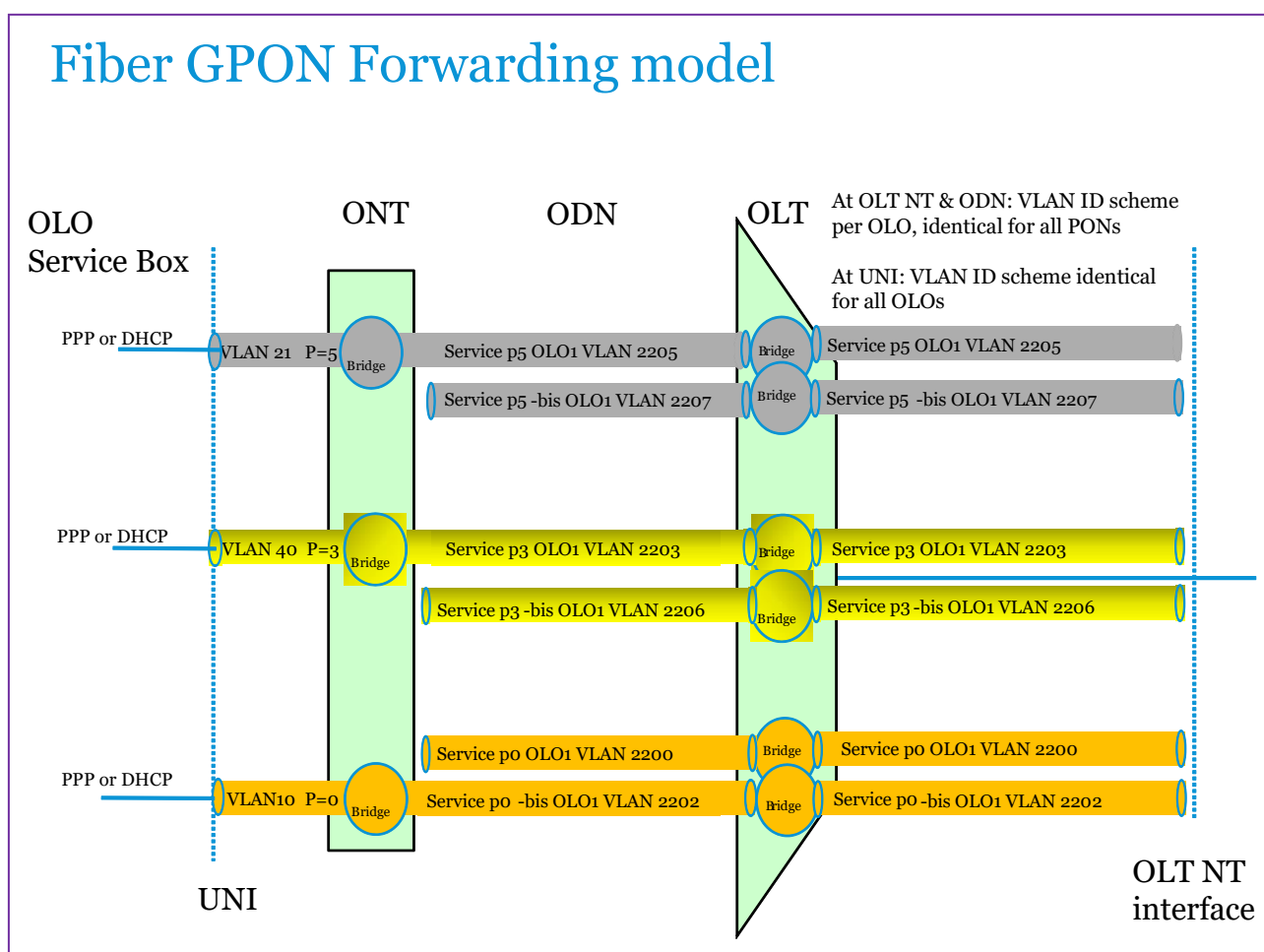
5.4. Ethernet Forwarding mechanism

The forwarding model for Fiber GPON with Shared VLANs can be considered as a L2 bridge with additional security features. Within this mode it is possible to associate different logical ports to one Virtual LAN. In the upstream direction, frames are forwarded from a VLAN at the user side to a service VLAN at the network side, with a MAC learning process. In the downstream direction, the frames are forwarded based on the MAC address, with a check on the correctness of the VLAN ID/MAC address usage.

Each subscriber's VLAN/Service on the UNI is mapped to the Service VLAN(s) of the respective OLO at the Fiber GPON ODN & OLT NT with VLAN Translation in the ONT.

No multicast Ethernet packets are allowed in the OLO Shared VLANs!

Graph 5 shows an example of an OLO, connecting one UNI to its services: pObis, p3 and p5.



Graph 5: Ethernet Forwarding Mechanisms on Fiber GPON (Shared VLANs)

5.5. VLAN ID allocation and QoS at UNI

On UNI it is possible to provision up to 3 VLAN IDs.

p-bit	0	3	5
VLAN id =	10	40	21

Table 1: Mapping p-bit and VLAN ID

This VLAN ID scheme is identical for all Beneficiaries.

Rate limiting per VLAN at UNI

A rate limiting is applied in upstream and downstream, on the flows of the UNI, as described in Table 2 below. The burst size of the rate limiter on the UNI-interface for the P5 service class is 22500 octets of contiguous packets in the upstream.

Profile ⁷ In Mbps	P0 Max DS/Max US	P3 Max DS/Max US	P5 Max DS/Max US
Type 1 ⁸	110/10	65/2 (Unicast)	4/4
Type 2 ⁸	250/30	65/2 (Unicast)	4/4
Boosted Type 2 ⁸	500/50	65/2 (Unicast)	4/4
Type 3	350/50	65/2 (Unicast)	4/4
Type 4	500/100	65/2 (Unicast)	4/4
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Table 2: Rate limiting types

⁷ Conditional to the availability of sufficient resources for IT and network implementation, the development in the Proximus network and systems of the profiles marked in grey is expected to be available with the October 2019 IT release. This timeframe does not contain a commitment of Proximus. The definitive characteristics of these profiles as well as the prices will be communicated by Proximus in due time.

⁸ The Type 1, Type 2 and Boosted Type 2 are only available in FTTH zones. Type 1 and Type 2 are targeted to be available in FTTB zones as from the June 2019 IT release.

No data volume limitation is applied on the different profiles and service quality⁹.

Upstream QoS at UNI: Priority treatment based on the VLAN ID.

Downstream Scheduling at UNI:

Hierarchical scheduler:

- P=0: best effort.
- P=3: medium priority.
- P=5: highest priority.

Strict priority queuing for P5.

Weighted Fair Queuing for P3 and P0.

⁹ Conditional to the availability of sufficient resources for IT and network implementation, the development of the service quality P=1 in the Proximus network and systems is expected to be available with the October 2019 IT release. This timeframe does not contain a commitment of Proximus. The technical specifications of this new service quality will be detailed out at a later stage.

5.6. Line Identification

Reminder: this section relates to a Shared VLAN topology.

Line identification will be enabled for both PPPoE and IPoE (DHCP) on each service VLAN of the OLO.

IPoE:

For IPoE access, per service VLAN a layer 2 DHCP relay function is implemented on the PON as described within DSL Forum TR-101. The DHCP packet format is specified in RFC 2131. The DHCP Relay Agent Information option (option 82) format is specified in RFC 3046.

In upstream, the access loop identification will be encoded within the “Agent Circuit ID” sub-option 1 of DHCP Option 82 during the DHCP session setup.

In downstream, the PON will remove DHCP option 82.

PPPoE:

For PPPoE access, per service VLAN the PPPoE Intermediate Agent function is implemented on the OLT as described within DSL Forum TR-156.

In upstream, the access loop identification will be encoded within the “Agent Circuit ID” sub-option 1 of the PPPoE vendor specific tag in the discovery messages (PADI, PADR, PADT) of the PPPoE protocol.

Format agent circuit ID for IPoE and PPPoE:

<Access_Node_ID> eth< Rack/Frame/Slot/Port/ONU/OnuSlt/UNI:Q-VID

Example:

F03BRM00001 eth 1/1/01/01/16/1/1:10

<Access_Node Identifier >eth< Rack>/<Frame>/<Slot>/<OLT Port>/<ONU>/<OnuSlt>/<UNI>:Q-VID

Where:

- Access_Node_ID = the nickname of the OLT (e.g F64LAL00001, F11TRU00001, etc)
- Rack = 1 (fixed value)
- Frame = 1 (fixed value)
- Slot = LT board position in the OLT, from 01 to 16 (leading 0 used)
- OLT Port = GPON port on the LT board, from 01 to 16 (leading 0 used)
- ONU = logical ID of the ONT, from 1 to 128 (no leading 0)
- OnuSlt = 1 (fixed value)
- UNI = from 1 to 4 (no leading 0)

- Q-VID = VLAN ID at UNI

5.7. Security

Reminder: this section relates to a Shared VLAN topology.

- No U2U communication.
- Prevention of Broadcast storms:
 - o Downstream:
 - Broadcast frames are dropped.
 - Ethernet frames with unknown destination MAC@ are dropped.
Ageing timer bridge = 900s (=> application shall send a message upstream at start up and every x sec, x<900, in order to remain joinable from the network)
 - o Upstream:
 - Rate limiting control plane (DHCP, IGMP, ARP...).
 - Discard control frames (STP, Pause frames...).
 - Multicast blocking.
- Maximum number of MAC@ per UNI port=16
- MAC anti spoofing.

Protocol limitations:

The Bitstream Fiber GPON service is intended for transport of IP packets by Ethernet frames (IPoE or PPPoE). Some protocols do not transparently pass, as described in Table 3 below. Therefore, Proximus does not guarantee their correct functioning. Known limitations related to the current GPON equipment firmware R.5.6.02x are mentioned in Table 3 below.

Protocol	Limitation ¹⁰
802.1x	Blocked
ARP	Policed
RIP	Transparent
CFM	Transparent ¹¹
ICMP	Transparent
DHCP	Policed
IGMP	Policed
PPPoEDiscovery	Policed
PPP LCP	Transparent

¹⁰ For security reasons, parameters will not be publicly shared. Beneficiary shall contact Proximus if he has the need to receive the information.

¹¹ This is valid for the ONTs installed and activated at End-User's premises but still needs to be confirmed for the new ONT version that will soon be deployed by Proximus. Beneficiary shall contact Proximus if he has the need to receive further information.

PPP control	Transparent
PPP LCP termination ack	Transparent

Table 3: Known protocols limitation related to the OLT

The list provided here above is indicative and non-exhaustive.

The Beneficiary has the opportunity to request on a project mode basis for ad hoc testing to check the transparency of any specific protocol in the context of the Bitstream Fiber GPON service.

5.8. Service aspects

The Bitstream Fiber GPON service does not allow a simultaneous transport of data and classical voice services¹² over the same network.

¹² Classical voice services = PSTN & ISDN services on copper.

6. Service Box

The network interface of the OLO Service Box must comply with the UNI specifications, i.e. trunked Ethernet interface, no native Ethernet interface.

7. Power requirements

The ONT is powered by 230V AC.

Current ONT version:

- Power Idle (ranged and no Eth connections): **4.8 W**
- Power max (UNI running traffic): **7 W**

New ONT version expected to be deployed as from November 2018 at the earliest:

- Peak Power consumption: **4.24 W**
- Minimum power consumption: **2.94 W**

8.OLO Access line

The technical specifications of the OLO Access line are detailed out in the document “Bitstream VDSL2 – Annex 2C – Technical Specifications”, section “OLO Access Line”¹³.

End of document

¹³ See Proximus Wholesale website at <https://www.proximus.be/wholesale/>, section “Regulated services”.