Executive Whitepaper

Unbundling and Wholesale in GPON Networks

Unbundling GPON networks for multi-provider access

In broadband-access market, wholesale business models are a reasonable response to unreasonable investments into a parallel first-mile infrastructure (copper or fibre). In order to promote effective competition among the service providers (SPs) to the benefit of industry and consumers, the regulation requires network operators/providers (NPs) with a significant market power to introduce these models.

Regardless of specific legislative requirements related to the structural separation, several distinctive wholesale-broadband models have emerged: local-loop unbundling (LLU), virtual unbundled local access (VULA), and bitstream access (BSA).

The network operators and service providers need a clear understanding of all economic aspects of each of these models, as well as of technological specifics or limitations related to the practical implementation of their next-generation access (NGA) network.

Summary

The whitepaper focuses on wholesale in GPON-based next-generation networks: it outlines the three wholesale models, describes the specific implementation and applicability of LLU, VULA and BSA in GPON next-generation access networks, and considers their economic implications.

Local-loop unbundling (LLU) gives SPs full control over everything: the first mile, the services and QoS, and the home gateways. Nevertheless, LLU introduces the highest additional investment – due to OLT co-location and due to multiplication of passive optical infrastructure

Virtual unbundled local access (VULA) avoids this additional investment, yet it introduces another one into dual-box CPE needed for a clear delineation of responsibilities between the NP and SPs. With VULA, the SPs keep control over home gateways, but loose some independence with regard to QoS assurance and multicast IPTV.

Bitstream access (BSA) is able to avoid the additional investment completely, and offer the SPs a similar level of control as VULA. However, this comes at the cost of somewhat less clear delineation of responsibilities for device management and troubleshooting.

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Local-Loop Unbundling

Local-loop unbundling (LLU) allows competitive SPs to physically take over the NP's passive first-mile infrastructure, while the SPs need to provide their own active access equipment with co-location.

In point-to-point (P2P) optical architecture, LLU is simple and straightforward: if an alternative SP requests access to a subscriber, a full path can be sold or leased on a per-fibre basis.

A replication of P2P-style LLU is not feasible for GPON technology since GPON uses a shared physical medium – specifically, the feeder fibres between the OLT and last-hop splitters, and the splitters themselves.

LLU with co-location for P2P

Although multiplication of GPON trees is possible inside existing ducts and splitter cabinets, it does not make much economic sense since it implies the multiplication of costs as well.

LLU with co-location for GPON
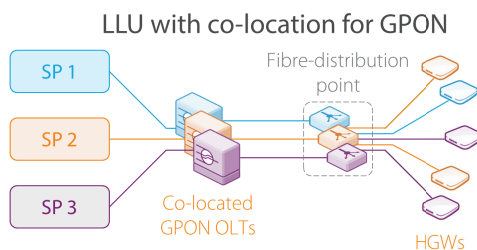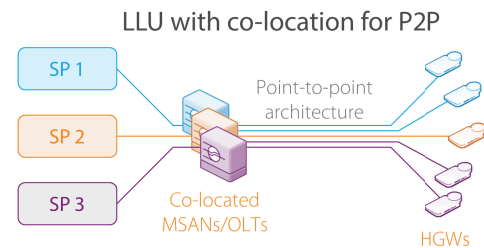
However, LLU can be implemented with GPON by multiplying only the feeder fibres and last-hop splitters located at a fibre-distribution point. This increases the cost of passive fibre distribution and makes LLU in GPON environments economically less appealing; on the other hand, it avoids the multiplication of fibres from the fibre-distribution point to customer premises.

Advantages:

- The SPs control and differentiate their services, including the control over bandwidth and QoS.
- The SPs fully control the first mile.
- Home gateways are owned and controlled by the SPs, independent of NP.

Weaknesses:

- Higher investment due to co-location of GPON active equipment (OLTs).
- Higher investment due to partial multiplication of passive optical infrastructure.

Virtual Unbundled Local Access

Virtual unbundled local access (VULA) physically reuses the NP's passive first-mile infrastructure, but it avoids investment into SPs' own active access equipment by providing connectivity over NP's OLT, giving SPs a dedicated (virtual) link to their customers.

VULA makes wholesale services possible for some NGA infrastructures (such as GPON), where LLU wholesale model cannot be applied due to technological or economical specifics or limitations.

Unlike LLU, VULA avoids co-location at the central office and the multiplication of passive infrastructure, yielding a lower investment.

Dual-box VULA for GPON

At customer premises, VULA is typically implemented as a dual-box solution, with SPs' HGWs connected to a simple, single-port ONT under NP's control.
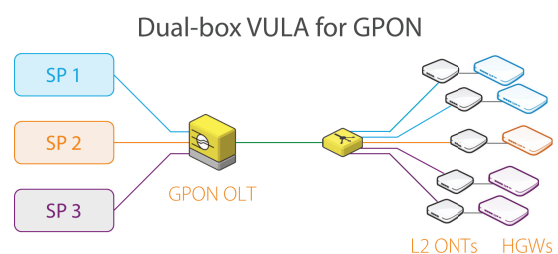
Since a single, NP-controlled OLT is used, the interoperability with the ONT must be assured: an uncontrolled mix of GPON OLT and ONTs may prevent the functional operation of the low-level OMCI management protocol between the OLT and ONTs. Since the NP needs to assure connectivity and manageability, it needs to control the choice of ONTs, in effect reducing the choice to verified and interoperable ONTs.

Advantages:

- Lower investment since it avoids co-location of active equipment (OLTs), and the multiplication of passive optical infrastructure.
- Home gateways can be owned by and under full control of SPs, if technically possible, and independent of the NP who owns and controls the L2 ONTs.
- The separation of responsibilities between the NP (connectivity) and SPs (services) is clear.

Weaknesses:

- Somewhat higher investment, since two boxes are required at customer premises.
- The SPs need to agree with the NP on the use of traffic classes and QoS assurance.
- For multicast IPTV, the SPs and NP may need to agree on multicast group addressing.
- While VULA is advantageous in VDSL (control over physical-line parameters), the distinction between VULA and BSA is not clear in GPON networks.

Bitstream Access

Bitstream access (BA) enables non-exclusive lease of the NP's passive infrastructure and active equipment, effectively sharing the NP's resources (equipment and bandwidth) among the SPs.

In BSA, an NP makes the first-mile connection available to SPs to lease. With BSA, the available bandwidth on GPON OLT ports and on passive optical infrastructure is shared among the SPs: the bandwidth is logically divided and allocated to alternative SPs. This type of access does not give SPs the control over the first mile, but allows them to use the NP's access node (OLT) and broadband CPE.

At customer premises, BSA can be implemented as a single-box or a dual-box solution.

Single-box BSA for GPON

Dual-box BSA for GPON

In the single-box solution, the NP prescribes a list of compatible HGWs to assure interoperability of the low-level OMCI management protocol, and to be able to manage the connectivity for all SPs. The SPs configure the HGWs to provision the services; they perceive the NP's network as a transparent traffic pipe to customer premises.

In the (more common) dual-box solution, the NP provides the connectivity to customer premises as well as simple, single-port ONTs. Provisioning of services on the SPs' HGWs is similar to the VULA model. A possible alternative to a standalone, single-port ONT is the use of a GPON ONT SFP stick with the HGW.

Advantages:

- Lower investment since it avoids co-location of active equipment, and multiplication of passive optical infrastructure.
- Lower investment with a single-box solution.
- Both L2- and L3-service connectivity possible, with control of QoS slightly easier in the dual-box L3 connectivity.

Weaknesses:

- Higher investment with a dual-box solution.
- The SPs need to agree with the NP on the use of traffic classes and QoS assurance, as well as on multicast group addressing for multicast IPTV.
- The NP is involved in service troubleshooting.
- The delineation of management responsibilities maybe complex in the single-box solution.

About Iskratel FTTH solution

Iskratel provides point-to-point and GPON fibre-to-the-home solutions, which are suitable for all types of end users (residential, SME, enterprise), and are able to deliver all types of services for these users – from high-speed internet or premium IPTV to business VPNs or bandwidth-hungry services and apps from the cloud. The solutions inherently support physical and virtual unbundling, bitstream and open broadband access, which makes them applicable for all regulatory environments and business models.
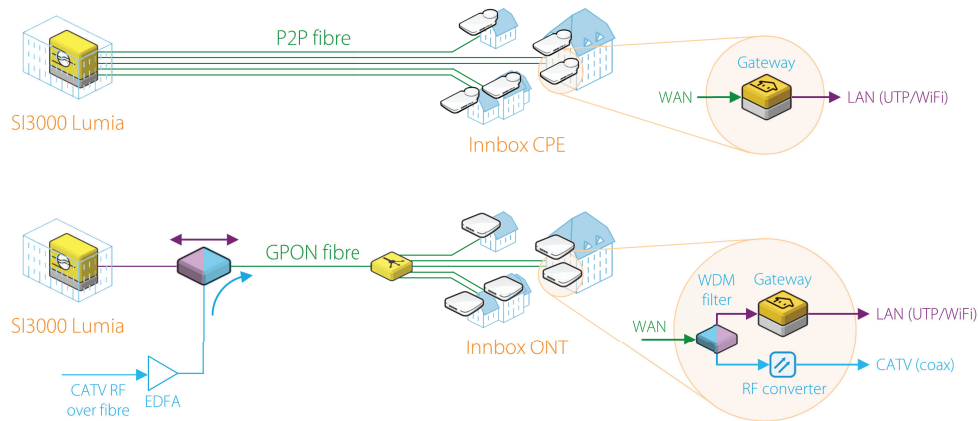
At the central office, SI3000 Lumia – a scalable multi-service broadband access and aggregation product – connects end users over all fixed-access technologies in a single, cost-effective platform. SI3000 Lumia is available for all deployment densities, from high-density urban to low-density rural areas. SI3000 Lumia is empowered with a unique, SDN-based awareness of services and apps that lets the operators justify their investment regardless of specific business models or regulatory requirements.

For customer premises, Iskratel provides an award-winning family of Innbox CPE products. The Innbox CPE family includes universal home gateways, home gateways for fibre and copper access, and fibre-termination units. A comprehensive range of Innbox CPE devices is available, spanning from low-end fibre termination to full-fledged, high-end home gateways.

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