

With 70 years of experience, Iskratel is the leading European provider of communications solutions, with its own R&D and manufacturing centres, 900 employees, and global footprint in more than 50 countries. Iskratel delivers integrated solutions across the telco, transportation, public safety, and energy industries.

Executive Whitepaper

Safe Migration to Next-Gen Optical Broadband Access

A gradual and controlled journey to **XGS-PON** and **NG-PON2**

PON (passive optical network) architectures are continuously evolving, further improving data rates and service availability. Several PON technologies are currently deployed, with GPON (gigabit PON) having the highest uptake rate. XG-PON1 (10-gigabit PON), the first standard 10 Gbps PON technology, drew the most attention in the early 2010's, but newer generations, dubbed XGS-PON (10-gigabit symmetric PON) and NG-PON2 (next-generation PON), are taking centre stage at present.

The long menu of technologies and options both attracts and confuses the operators. However, the opportunities that these next-gen technologies promise keep the operators on their toes and ready to jump on the bandwagon as soon as component prices drop – and as soon as they are confident they can make a gradual, cost-efficient and controlled transition, without any disruption to the services they offer.

Summary

Operators want a safe and **gradual migration** to XGS-PON and NG-PON2 technologies, which promise to unlock the full potential of the optical assets, and **generate new revenue** from multiple applications by exploiting the increased, symmetrical bandwidth and flexible wavelength plans.

In order to **protect past investments**, the new PON flavours must operate over the existing ODN (optical distribution network) without wavelength reassignment, coexist with GPON, and incur minimum or **no service disruptions**.

The migration is usually a **two-phase process**. The first phase upgrades the network to 10 Gbps PON (preferably XGS-PON, which has essentially displaced XG-PON1), while the second and final phase introduces 40/80 Gbps PON (specifically, NG-PON2).

Apart from the introduction of coexistence elements, the ODN remains unaffected. A forward-looking introduction of NG-PON2-compatible coexistence elements in the first phase keeps service disruptions to a minimum.

Customer-premises equipment of new XGS-PON/NG-PON2 end customers simply needs to be connected to the ODN. At the central office, the best option is to use existing PON shelves to host new XGS-PON/NG-PON2 blades, permitting a **pay-as-you-grow, gradual expansion** as needs develop and use cases dictate.

Universal next-generation PON blades, simultaneously supporting XGS-PON and NG-PON2, prolong the equipment lifecycle to a maximum, and arm the operators for **any migration scenario, any business need, and any service type**.

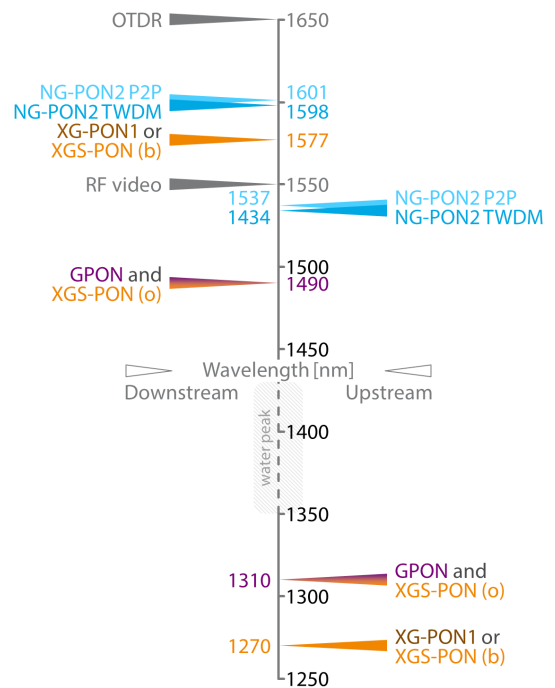
1 The flavours of multi-gigabit PON

Undoubtedly a market leader, **GPON** supports downstream/upstream (DS/US) data rates of **2.5/1.25 Gbps**, and split ratio from 1:16 to 1:128. Using additional wavelength multiplexers/triplexers, it optionally facilitates coexistence with RF (radio-frequency) video overlay of CATV (cable television), and/or with OTDR (optical time-domain reflectometry) equipment.

Standardised in 2010, **XG-PON1** was the first 10 Gbps PON technology, with DS/US data rates of **10/2.5 Gbps**, and split ratio from 1:32 to 1:256. Despite its improved data rates, its adoption implied business risks due to low component maturity, while newer generations of PON (specifically, NG-PON2) were already anticipated. Today, XG-PON1 has been mostly displaced by XGS-PON.

NG-PON2 (standardised in 2015) employs WDM (wavelength-division multiplexing) to create up to eight simultaneous, wavelength-separated instances of PON trees on the same ODN. Supported DS/US data rates are **four (up to eight) times 10/10 Gbps** (with service data rates up to 10/10 Gbps), while split ratio ranges from 1:16 to 1:256. To support new use cases (such as enterprise or mobile), NG-PON2 inherently supports both TWDM-PON (time- and wavelength-division multiplexing) with each wavelength shared among ONTs (optical network terminations) with TDM, and P2P WDM-PON for point-to-point connectivity using dedicated wavelengths per ONT.

XGS-PON (2016) combines high data rates of NG-PON2 with CAPEX efficiency of XG-PON1, and is often perceived as an intermediate step to NG-PON2. It supports symmetric DS/US data rates of up to **10/10 Gbps**, and split ratio from 1:16 to 1:256. XGS-PON reuses either XG-PON1 or GPON wavelengths (via “basic” or “optional” wavelength sets, respectively), allowing complete reuse of existing passive infrastructure (ODN, splitters, shelters, etc.), and coexistence with previously employed PON technologies.



Assignment of wavelengths to GPON, XG-PON1, XGS-PON, NG-PON2, RF video overlay and OTDR

2 Why bother at all: The promise of next-generation PON

NG-PON2 aims to resolve several challenges which were not sufficiently addressed by previous PON generations, such as:

- Increased bandwidth, resulting from the growing use of personalised or cloud-based services;
- Multiple applications (residential, business, mobile backhaul and fronthaul), supporting PON and P2P;
- Symmetry, low latency and reliability, vital for cloud services, business connectivity, and mobile backhaul;
- Functional separation (virtual unbundling and wholesale), enabled by utilising separate wavelengths;
- Improved resiliency and power saving, as well as better bandwidth utilisation.

3 Migration and coexistence of GPON, XGS-PON and NG-PON2

A gradual and controlled migration from existing GPON and ODN infrastructure involves a period of coexistence between different PON generations. NG-PON2 and XGS-PON were both designed to operate over the existing GPON ODN (including fibres, splitters and cabinets) in order to protect past investments. Therefore, no changes are required to the ODN when gradually upgrading to XGS-PON and/or NG-PON2, and operators can upgrade on a per-customer (per-ONT) basis as market opportunities arise.

In the process, no wavelengths have to be reassigned during migration or for the purpose of coexistence. Alongside this, service discontinuities affecting user experience can be kept to a minimum during migration

3.1 Coexistence of GPON with XGS-PON or XG-PON1

The first phase of the migration is a **gradual upgrade from GPON to 10 Gbps PON**: to XG-PON1 or XGS-PON. Given the current state of technology and price levels, upgrading to XGS-PON makes the most sense, offering four times more upstream capacity at a similar cost. It may be worth noting that although the XGS-PON standard assumes the possible use of two wavelength sets, the industry is clearly converging towards the use of the “basic” set, which allows conflict-free coexistence with GPON.

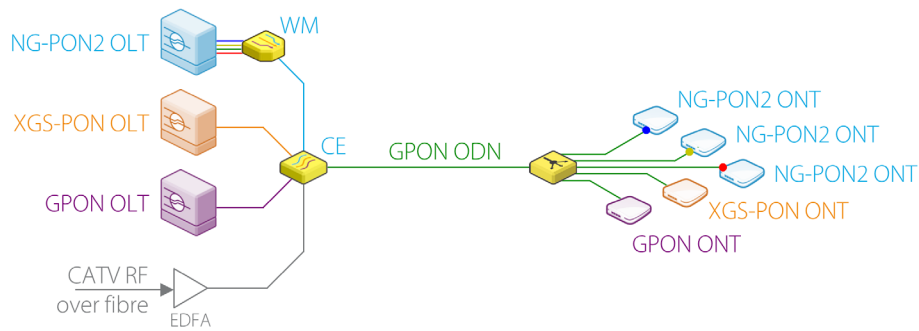
In order to coexist with GPON networks, a CE (coexistence element) is needed, replacing the legacy triplexer. Scheduling the replacement for low-usage hours will incur the least possible service disruption for existing GPON customers. Apart from the CE replacement, the ODN infrastructure remains unaffected. When introducing the new CEs, it is worth considering that whether an upgrade to NG-PON2 is anticipated in the future – which usually is the case – the CEs which are compatible with NG-PON2 wavelengths should be used, even at this stage. This will avoid additional service disruptions due to another CE replacement.

XGS-PON OLTs (optical line terminations) can be deployed as standalone equipment or (preferably) inserted as additional blades into existing OLT shelves. Technology permitting, the latter is a more cost-efficient approach to OLT upgrade, permitting a gradual, pay-as-you-grow expansion. New customers’ XGS-PON ONTs only need to be connected to the ODN, and can coexist with pre-existing GPON ONTs.

3.2 Full coexistence of GPON, XGS-PON, and NG-PON2

The second phase is the **introduction of 40/80 Gbps NG-PON2** on top of existing GPON/XGS-PON network. The NG-PON2 wavelengths do not overlap with other PON technologies, so no wavelength conflicts occur.

If the CEs installed in the first phase support all the wavelengths, they need not be replaced. However, additional elements are required: the wavelength multiplexers (WMs) at the NG-PON2 OLT location. The WMs combine all different NG-PON2 wavelengths (up to eight in either direction) and the corresponding physical OLT ports. Introducing the WMs does not cause service disruption to customers previously connected to the ODN. At the same time, the WMs allow operators to maintain a gradual, pay-as-you-grow expansion of NG-PON2, following the needs and use cases.



Full coexistence of GPON, XGS-PON and NG-PON2, with tunable receivers on NG-PON2 ONTs

Given that the most likely and cost-efficient approach is inserting new NG-PON2 blades into existing OLT shelves, new wavelengths can be assigned and combined as use cases dictate – from residential broadband and business connectivity to mobile backhaul and fronthaul. Furthermore, functional separation (in multi-provider environments) can be supported by utilising separate wavelengths per provider.

New customers’ NG-PON2 ONTs only need to be connected to the ODN, and can coexist with existing ONTs. In order to “tune” to individual wavelengths (up to eight of them), NG-PON2 ONTs use tunable transceivers, while a tuning mechanism on OLTs configures ONT wavelengths. The use of tunable ONT transceivers (with no specific wavelength defined in advance) reduces OPEX, and simplifies management of ONT inventory.

At the same time, the wavelength agility facilitates better bandwidth utilisation (by dynamically reassigning the wavelengths), improved service resiliency (by retuning to another wavelength in the event of a failure), and power saving (by retuning to a common wavelength during low-traffic periods).

About Iskratel's next-generation fibre broadband

Iskratel provides fibre-based broadband solutions, ideal for all kinds of end customers (residential, enterprise and mobile) and for all types of services, from high-speed internet or premium high-definition TV to business connectivity or bandwidth-hungry services and apps from the cloud.

Iskratel's flagship multi-service broadband access and aggregation product, **SI3000 Lumia**, connects end customers over all fixed-access technologies in a single, cost-efficient platform. By employing the top-of-the-line 16-port GPON blades, SI3000 Lumia perfectly serves all deployment densities, from low-density rural to high-density urban areas, providing from eight to 288 GPON ports from a single OLT.

The latest breakthrough that Iskratel brings to the market is the universal, 8-port multi-PON blade that simultaneously supports **NG-PON2 and XGS-PON**. The operators using Iskratel's multi-PON OLT can address any migration scenario with confidence, and rest assured that they can deal with any business needs and services in a cost-efficient and lucrative way, throughout the prolonged lifecycle.

Furthermore, SI3000 Lumia is the pioneering product of **software-defined access** (SDA), introduced to the market by Iskratel years before any SDA competitor followed. SI3000 Lumia features a unique awareness of services and apps that lets operators justify their investment regardless of specific business models or regulatory requirements.

Iskratel complements the solution with an award-winning family of **Innbox CPE** products, which includes fibre home gateways and fibre-termination units. A comprehensive range of Innbox CPE spans from low-end termination to fully-fledged, high-end home gateways. Innbox PON ONTs support the latest, standards-compliant PON technology of all generations.

For more information on Iskratel's solutions, please contact marketing@iskratel.si.



ISKRATEL

Iskratel, d. o. o., Kranj

Ljubljanska cesta 24a
SI 4000 Kranj, Slovenia
Phone +386 4 207 20 00
Fax +386 4 202 26 06

info@iskratel.si
www.iskratel.si

About the authors

Tomo Bogataj is responsible for strategic marketing of Iskratel's Telco solutions, and has twenty years of experience in telecommunications. He co-created Iskratel's software-defined access, establishing Iskratel as the first vendor to provide SDN-based broadband in 2010. Contact him at t.bogataj@iskratel.si.

Gregor Smolej is a solution manager, in charge of Iskratel's next-gen intelligent access. Earlier, he was a product manager of SI3000 Lumia, and head of Innbox development team. As forward-thinking innovation manager, he promotes solutions with superior value for providers and end users alike. Contact him at g.smolej@iskratel.si.