25 and 50G Optical Access Network Deployment Forecasts using Bi-Logistic curves

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Abstract: Different forecast scenarios for the 25G-PON and 50G-PON Globally for both ONT/ONU markets are presented based on modeling by a Bi-Logistic function with reference to GPON existing data.

1. Contexts beyond 10G PON

With the publication of XGS-PON and NG-PON2 standards by ITU-T in November 2016 a new standards roadmap was released [1]. There were a set of key requirements to be met in order to enable successful and cost efficient deployment of future optical access network (F-OAN) technologies, namely in terms of spectral efficiency (SE), flexibility, extended reach, open access and heterogeneous service convergence.

Residential was not the focus for the 10G-PON technology, but the longer-term effects of the pandemics on society, such as changes to individuals' working habits, reduced international travel, and the rebalancing of business activity towards digital products and channels are posing opportunities for the 10G-PON. The pandemics has highlighted the importance of home broadband, and operators should work with governments to deliver the necessary new infrastructure. The enterprise market has been permanently altered, and operators need to re-position their product portfolios to support changed working practices and business priorities.

In the end of 2019, ITU-T released the ITU-T G.9804.1 that defines the requirements for the Higher Speed Passive Optical Networks (HSPON) [2]. The specifications of the physical medium dependent (PMD) layer for 50G single channel PON systems, G.hsp-50Gpmd [3] stills under study, but it is already generating splitting on the PON industry, where the downstream bandwidth is not gathering consensus and a division is emerging between those in the 25G camp and opponents favoring 50G [4], [5]. The basic architectures of higher speed PON (HSP) systems can be split between TDM/TDMA based, and PtP based. In a 50G TDM PON, the OLT is a special case of a higher speed multi-channel PON system with just one channel in each direction [2]. A new PON-based 5G Mobile FrontHaul (PON-MFH) was included as services categories supported in higher speed PON scenarios. [2].

In October 2020 the signing of a 25G symmetric PON multi-source agreement (25GS-PON MSA) with the goal of promoting and accelerating the development of 25GS-PON. The MSA Group has defined the 25GS-PON specification needed to address the gap between 10G XGS-PON and 50G PON in the ITU-T. The MSA was created after the ITU-T SG15/Q2 group did not reach consensus to standardize 25GS-PON, which is seen as a crucial technology by many of the world's top operators and vendors [5]. The 25GS-PON MSA Group created a specification for 25GS-PON which includes optical specifications based on the IEEE 802.3ca 25G EPON standard, along with a Transmission Convergence (TC) layer that is an extension of XGS-PON [5]. A 25G TDM PON ONU shall be able to support the maximum service rate of approximately 25 Gbit/s in downstream and a symmetric nominal line rate of 25 Gbit/s in upstream. It will be also possible the support of an asymmetric 10 Gbit/s in the upstream.

The 25G-PON can benefit from the already optical technology employed in data-centers what leverage the best cost solution, high capacity and fastest time-to-market and simplest evolution path compared to the 50G-PON that will require a massive technology jump or long time to mature.

2. Forecasting the 25G-PON and 50G-PON

Early models of technology diffusion used the metaphor of the spread of epidemics to represent the process of diffusion [6], [7] [8]–[10]. The evolution of a technology in the marketplace is compared with the spread of a

disease in the population. The diffusion of innovations in the past has followed a certain regularity, regardless of their nature. The logistic model, assumes that the rate of change of the process is proportional to both the fraction of the market penetrated by the technology and the fraction that remains to be penetrated [11]. This process is analogous to the diffusion of a new and technically advanced product. In the logistic model, the initial sales of a new technology are challenging despite its potential and the size of the potential market. In early stages there may be institutional barriers and survival of technology and its supplier is uncertain. Adoption implies significant risk. As applications diversify, so does the overall knowledge of the technology and its benefits. The support infrastructure improves. From this point, penetration grows rapidly. At some stage, beyond 50% of penetration, further market diffusion becomes increasingly more difficult, thus the rate of penetration slows down. This can be clearly observed on the historical GPON market data, in early stage the uncertain evolution of the legal and regulatory framework of the FTTH network as well as the overall knowledge of the fiber networks, GPON technology, and uncertainty of the optical market presented significant risk.

The behavior of many dynamic real phenomena shows different phases, this is, two phases of logistic growth [12][13]. For the sake of validation, a Bi-logistic model was applied to the analysis of the data of the Global GPON ONT/ONU market, showing two phases of logistic growth. This system with two logistic growth pulses, existing simultaneously or in succession, it is named ―Bi-logistical by Meyer P. in [12]. The case of a system with two well-defined Logistic growth curves, it is possible to split the time-series data set in two and model each set with a separate Logistic function.

2.1. Modeling GPON as a basis to forecast the 25G-PON and 50G-PON

OMDIA market share 2Q20 [14] presents the units for ONT/ONU – 2.5G GPON for Global level from 2008 till 2019 years. This data was modelled to a Bi-Logistic [12] curve using a non-linear regression, Fig. 1 (right).

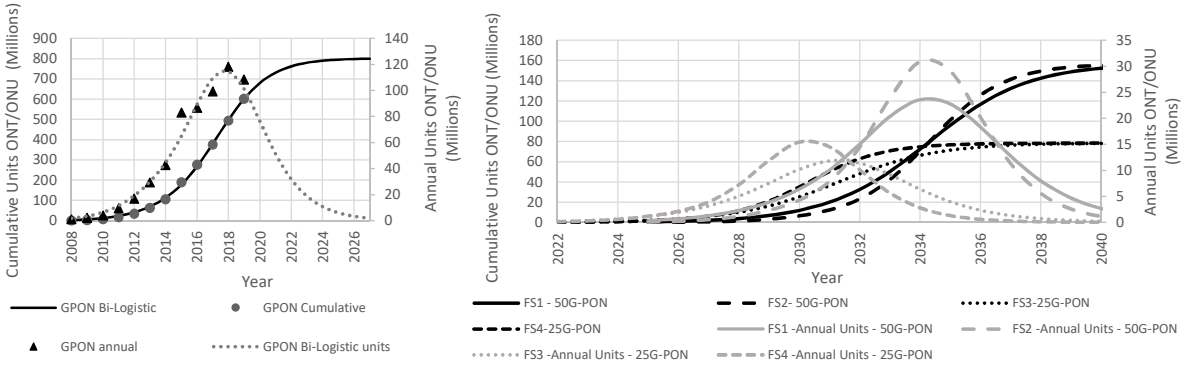

Fig. 1 – Right- Bi-Logistic fit to the global vendor units for ONT/ONU-2.5G GPON. Left – Forecast Scenarios for the 25G-PON and 50G-PON.

For GPON an *r square* of 0,999 was obtained. On this model was possible to identify two phases of the market: the first logistic curve that presented an market penetration of 37 million units, a characteristic duration (time to growth from 10% to 90%) of 5.8 years and an inflection point in the middle of 2012 (4.6 years); and a second component of the function, with a characteristic duration of 7 years and an inflection time in end of first quarter of 2017 (9.3 years). The total GPON market is forecast to 802 million units. In Fig. 1 (right) is also possible to observe the number of GPON selling/deployed units per year. By using the historical behavior of market diffusion of GPON and assuming that the future 25G-PON and 50G-PON ONT/ONU markets will have similarities, different forecast scenarios where defined, Table 1. The expect time frame of 25G-PON would be around the year 2022, as some firms presented already commercial solutions, and for 50G-PON 2025 [15].

Table 1. Forecast Scenarios

Forecast Scenario	**Market potential 1st curve**	**Characteristic duration 1st curve**	**Inflection time 1st curve**	**Market potential 2nd curve**	**Characteristic duration 2nd curve**	**Inflection time 2nd curve**
FS1– 50G-PON	10% of the total	Same as found for GPON market		20% of the total	Same as found for GPON market	

<table>
<tr><td>FS2–
50G-PON</td><td>GPON</td><td>20% higher growth, 4.63 years</td><td>Same as GPON market</td><td>GPON</td><td>20% higher growth, 5.35 years</td><td>Same as GPON market</td></tr>
<tr><td>FS3–
25G-PON</td><td rowspan="2">5% of total GPON</td><td colspan="2">Same as found for GPON</td><td rowspan="2">10% of the total GPON</td><td colspan="2">Same as found for GPON</td></tr>
<tr><td>FS4–
25G-PON</td><td>20% higher growth, 4.63 years</td><td>Reaches inflection time one year earlier.</td><td>20% higher growth, 5.35 years</td><td>Reaches inflection time one year earlier.</td></tr>
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The forecast scenarios presented in Table 1 and Fig. 1 (left) were defined based on the assumptions that the 10Gbit/s market is widely expanding beyond 2021, the use of 25G-PON to support 5G wireless will start to gain market share beyond 2022, but the competition with the 50G-PON beyond 2025 will make market splitting and consequently a decrease on market share for the 25G-PON. Taking into account that GPON was mainly use for residential applications and due to the widespread of this technology worldwide and with the upcoming 10Gbit/s market starting to spread, a market potential of 5% for 25G-PON and 10% for 50G-PON in the first phase can be considered a good market approach. The 25G-PON will still compete with the 10Gbit market on the first phase, having as clear disadvantage against the 10Gbit optics price. The delay and squeeze of the 5G investment plans by several operators will benefit the 50G-PON technology. The 25G-PON can be considered as middle step towards a higher speed PON since it leverages existing technologies. The second phase of the 25G-PON happens in the first phase of 50G-PON, and the 50G-PON will suffer on the first phase of the high cost of optics. But as the optics cost starts to decrease and taking into account the widespread of fiber to cell sites and the support of PON-MFH by this standard, a 20% of market potential on the second phase should be considered.

25G-PON and 50G-PON technologies do not have the residential customers as target, as so, the market potential was diminished, because such technologies aimed the X-Haul connections and Enterprises. As they will benefit of the already installed FTTH/B infrastructures the growth was defined to happen faster and consequently the inflection time.

3. Conclusions

Different forecast scenarios for the 25G-PON and 50G-PON Global ONT/ONU market were presented based on the historical behavior of the GPON market and on the future possible market due to the target of such technologies. The final market forecast for the 50G-PON market is bigger than the 25G-PON because the 25G-PON will compete with the 10Gbit/s market, as well as the inherent support of the 50G-PON of PON-MFH. The 25G-PON will benefit from the already 25G Ethernet optical technology that will allow a faster and earlier time to market, but with smaller market potential, mainly on EMEA and NA.

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