



Role of photonics integration for Fiber To the Home

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Orange Innovation Networks – WNI/FAN

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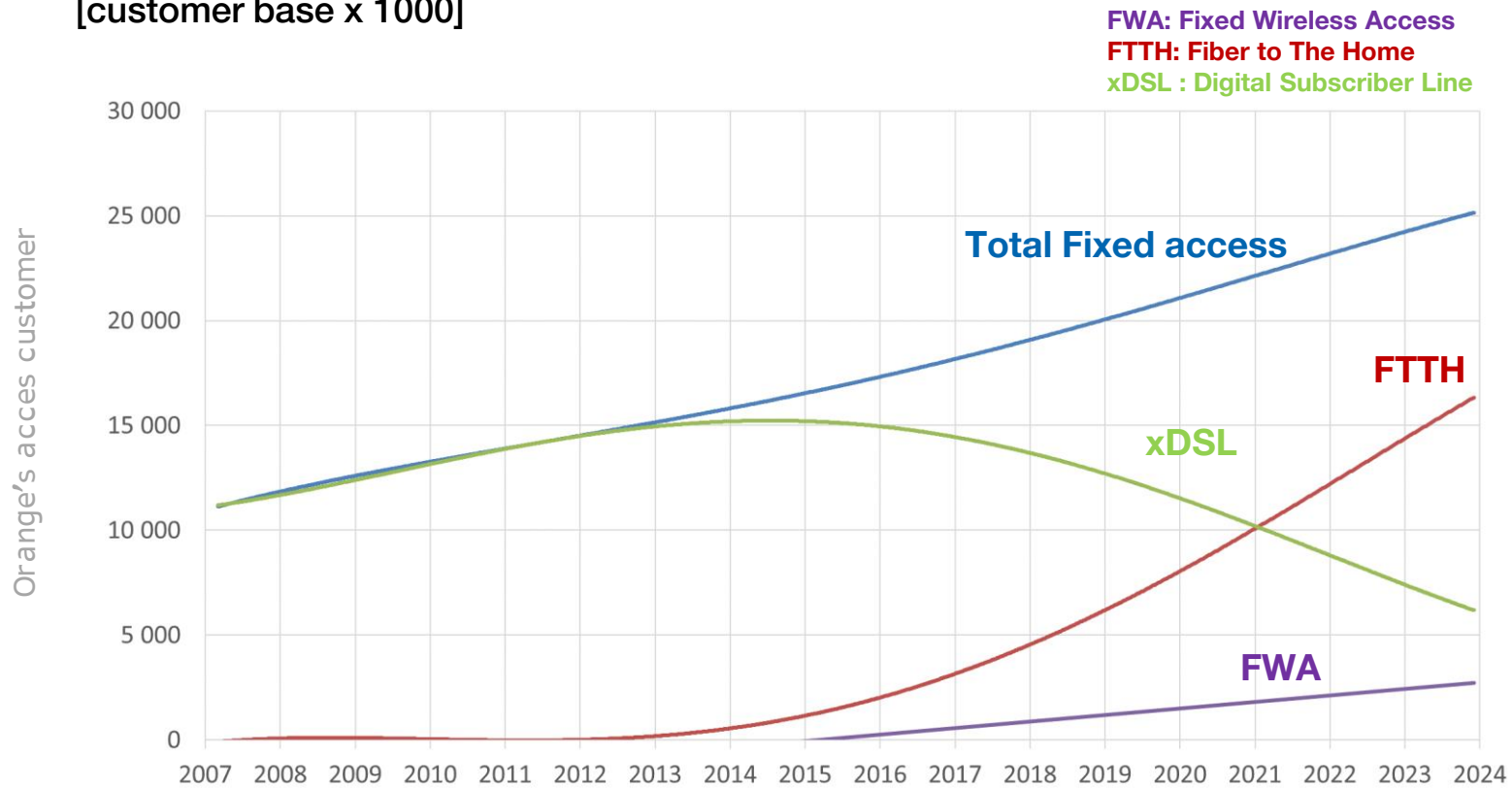
OCTAPUS

Optical circuit switched time sensitive network architecture for high-speed passive optical networks and next generation ultra-dynamic and reconfigurable central office environments
HORIZON-CL4-2021-DIGITAL-EMERGING-01-06 Advanced Optical Components



Orange's Fixed accesses customers

[customer base x 1000]



Orange Fixed operations around the world



~ 25M
Broadband internet customers

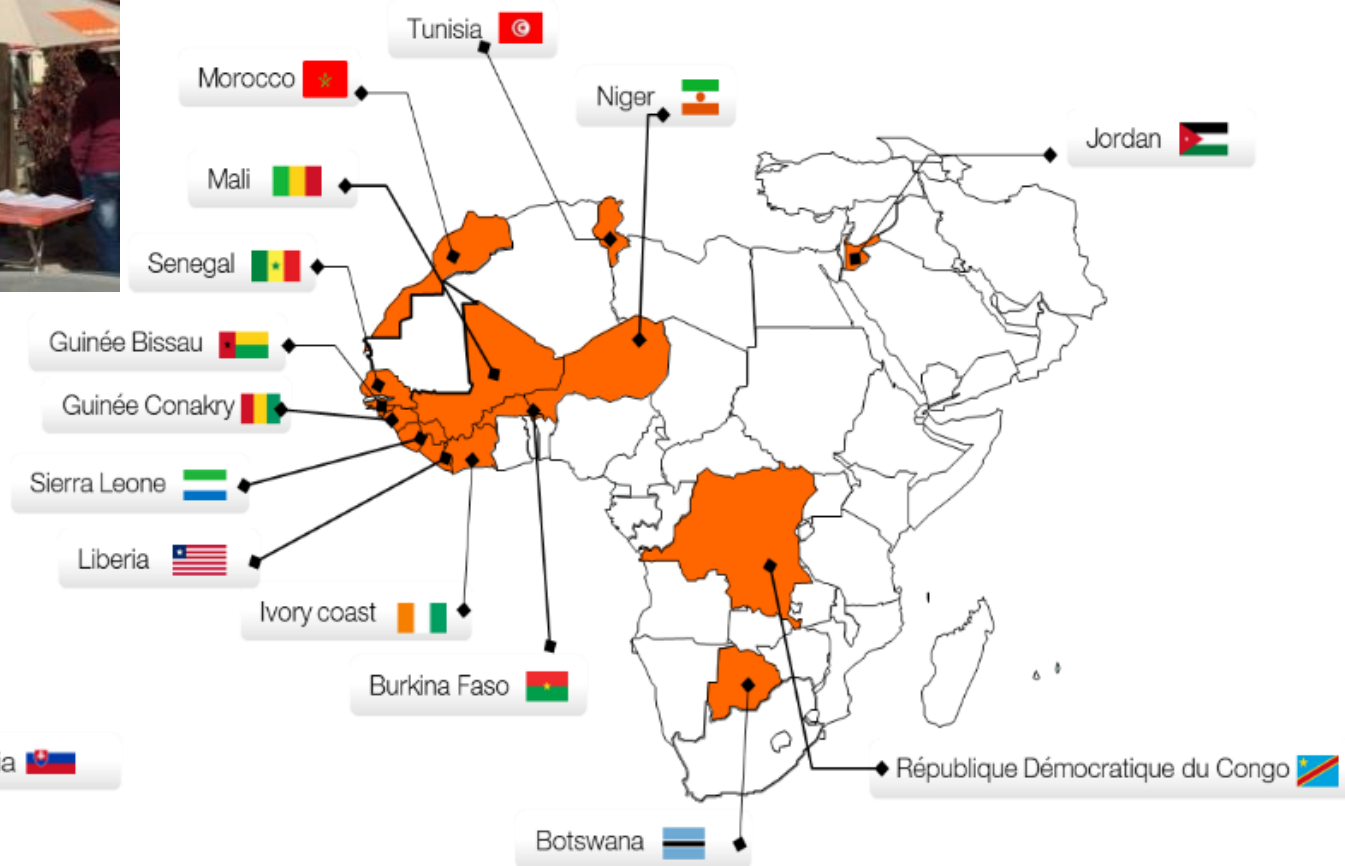
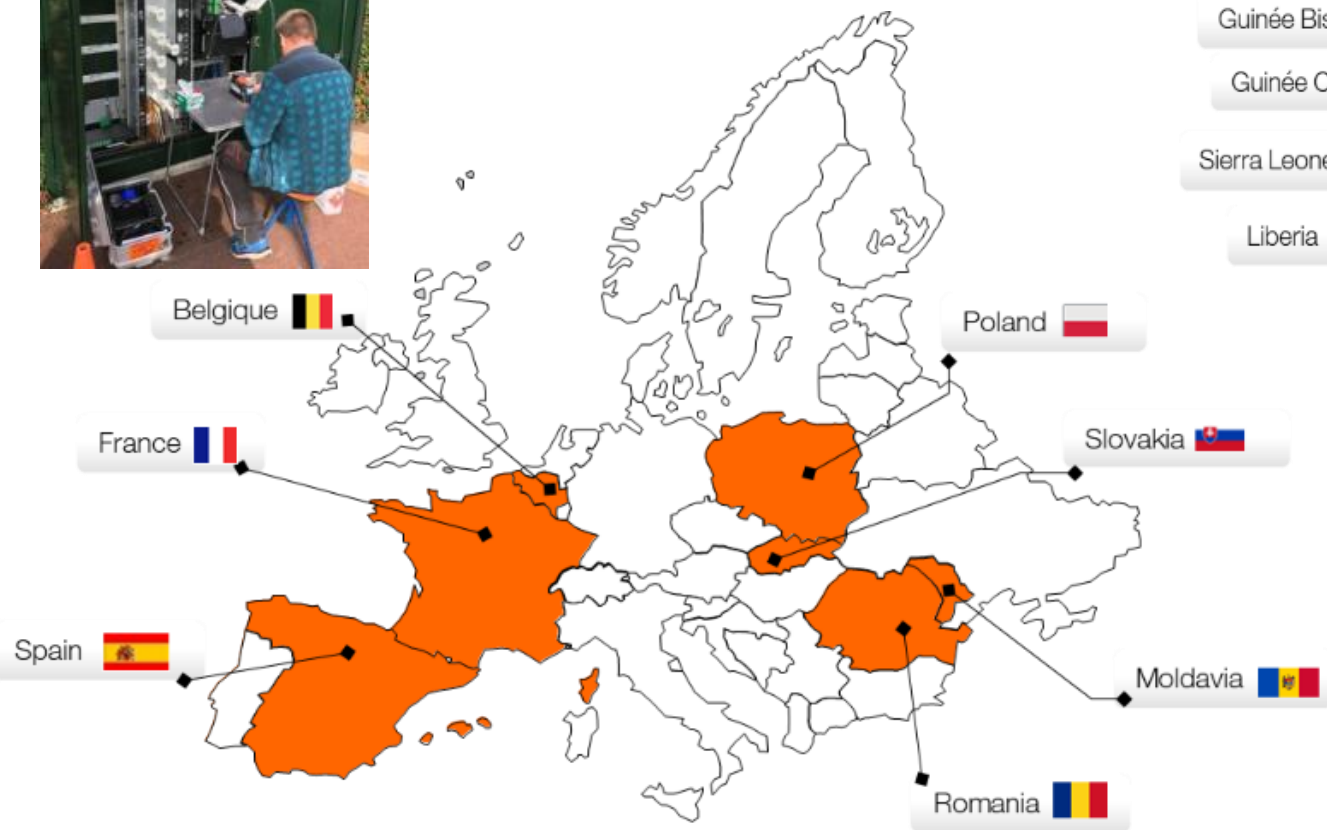
~72M
FTTH Home Passed

~17M
FTTH customers

17
FTTH networks in Europe (8) and MEA (9 and counting...)

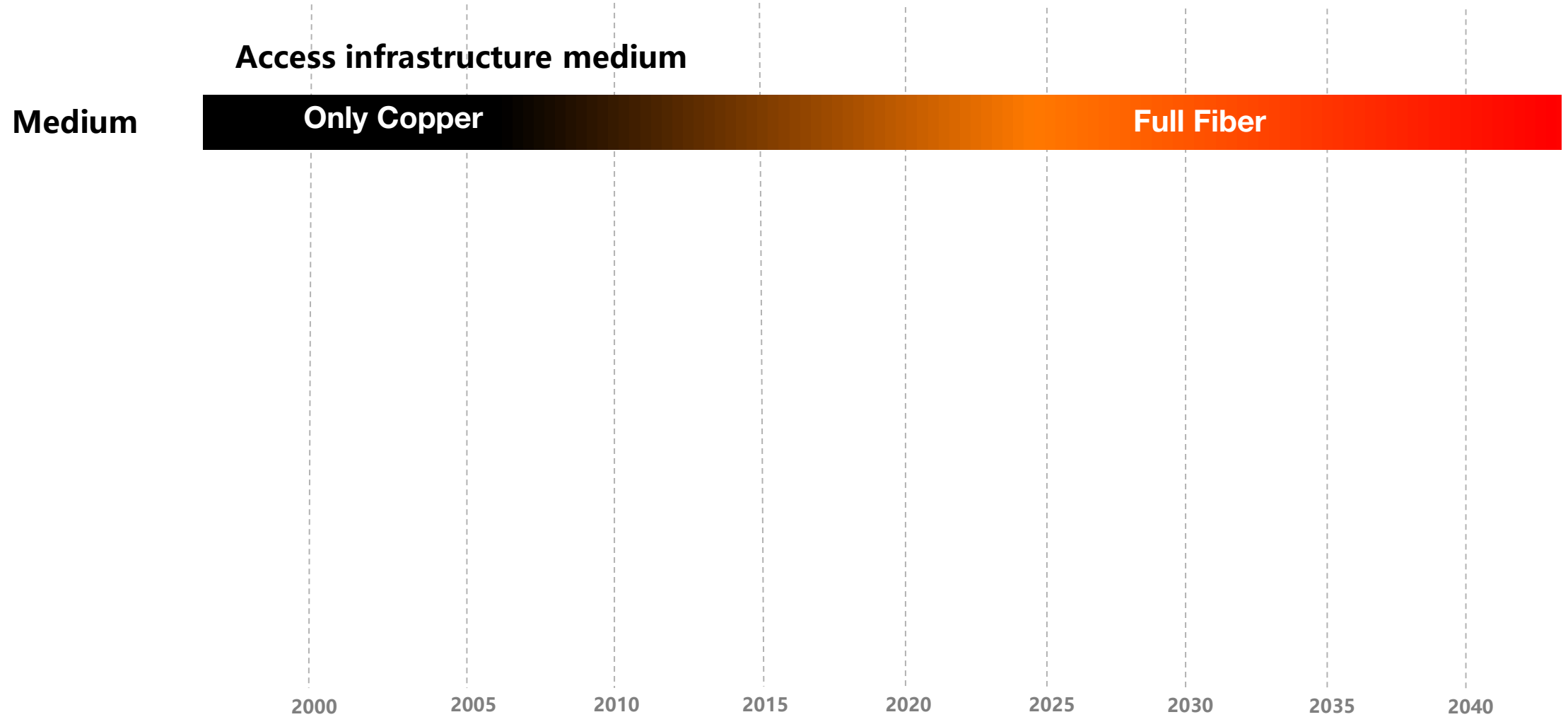


ORANGE's countries



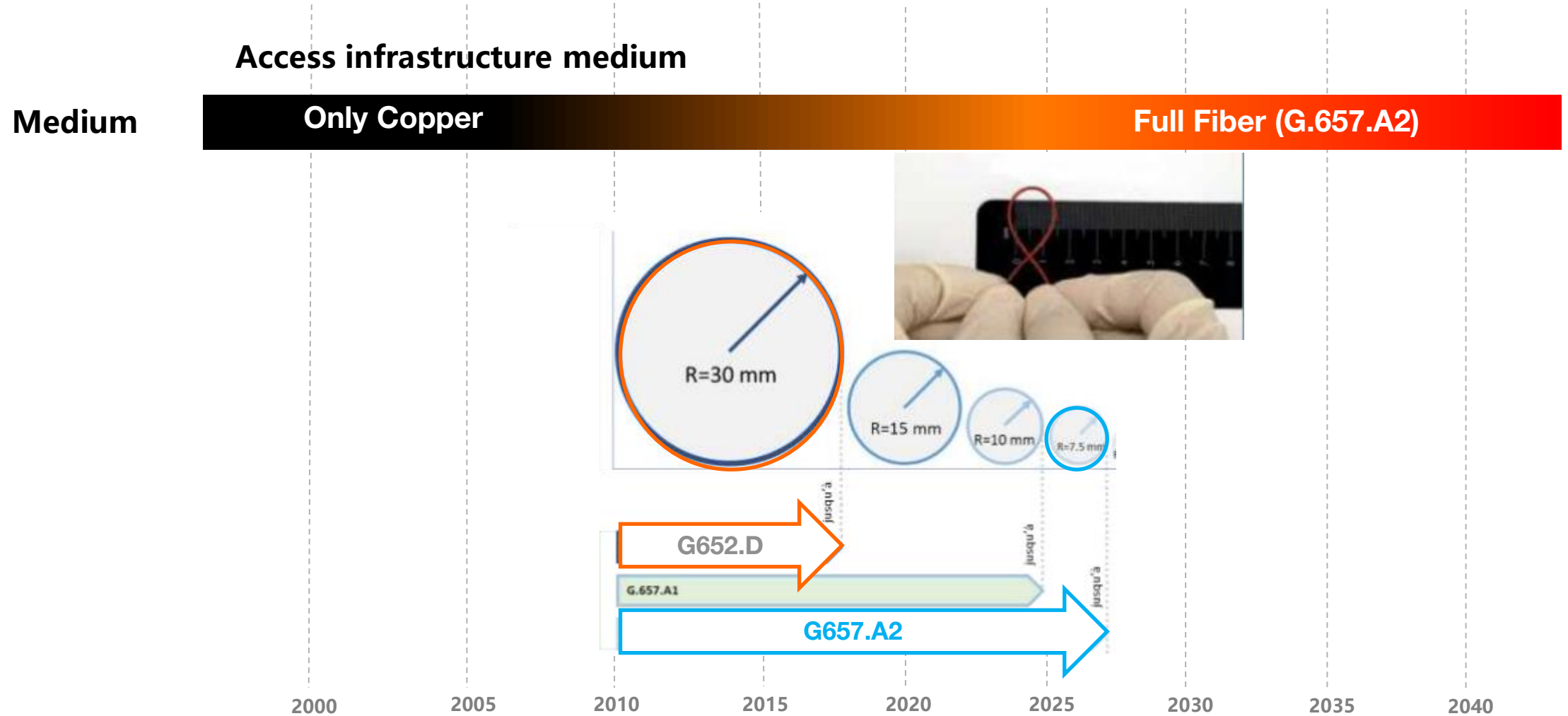


The right medium to maintain high quality fixed access network (FTTx)



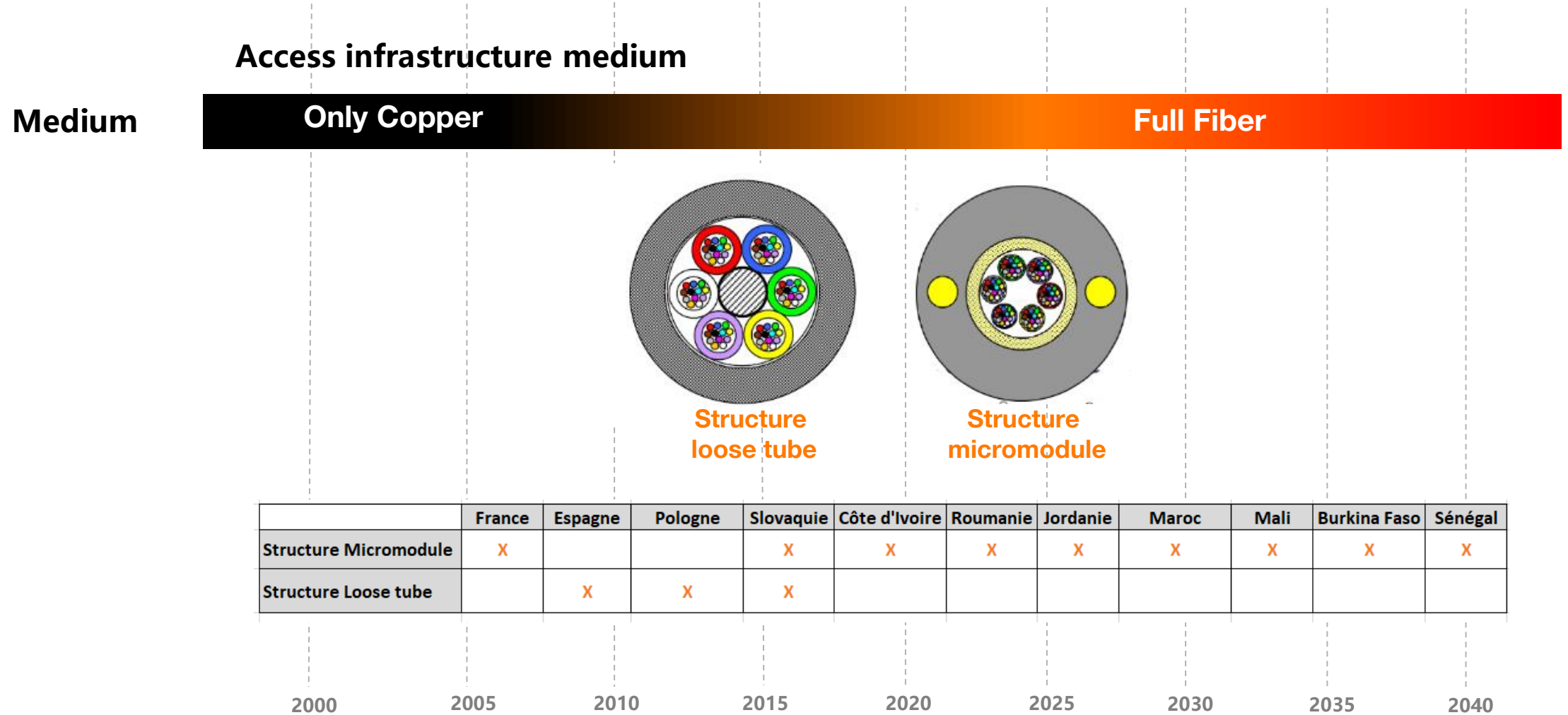


The right medium to maintain high quality fixed access network (FTTx)





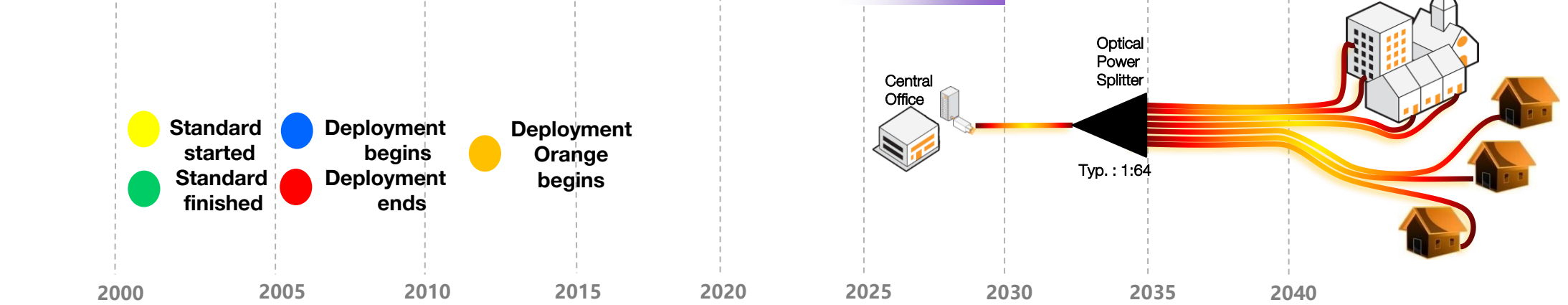
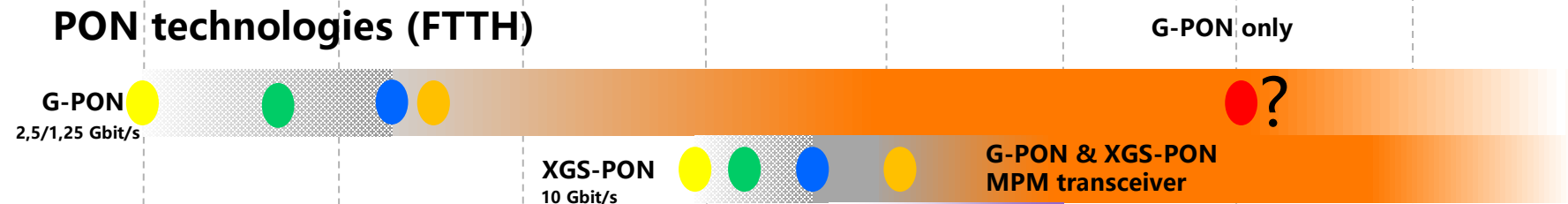
The right medium to maintain high quality fixed access network (FTTx)





The right technology to maintain high quality fixed access

Access infrastructure medium



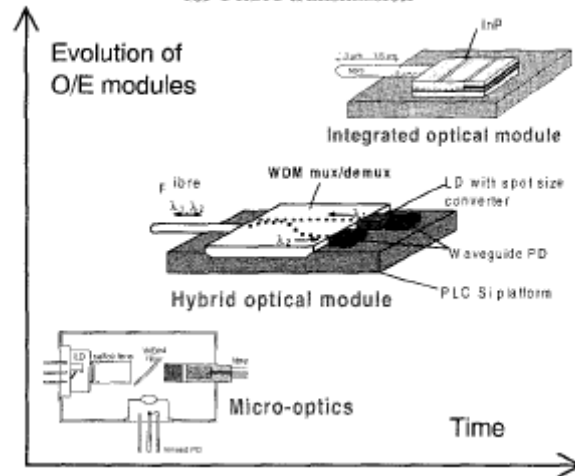


The role of photonic integration for PON technology (FTTHome)



1998 : Evolution of integration for FTTH transceivers

Fig. 2: Possible O/E modules technologies for 1 fibre transmission



D. Lecrosnier, G. Destefanis, A. Gnazzo, B. Jacobs, M. Pousa,

« Optical enabling technologies for access networks: requirements and challenges an overview from FSAN and EURESCOM »

24th European Conference on Optical Communication - ECOC '98

Where are we right now?



The role of photonic integration for G-PON technology (FTTHome)

Access infrastructure medium



PON technologies (FTTH)

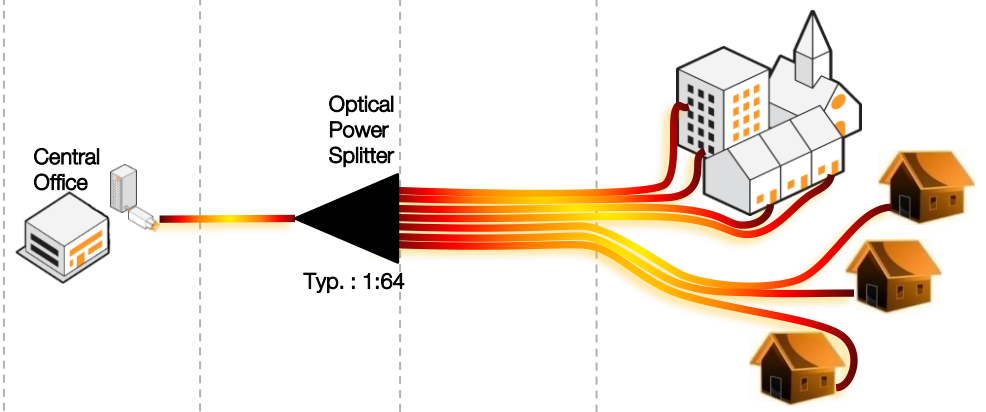
G-PON
2,5/1,25 Gbit/s



Standard started
Standard finished

Deployment begins
Deployment ends

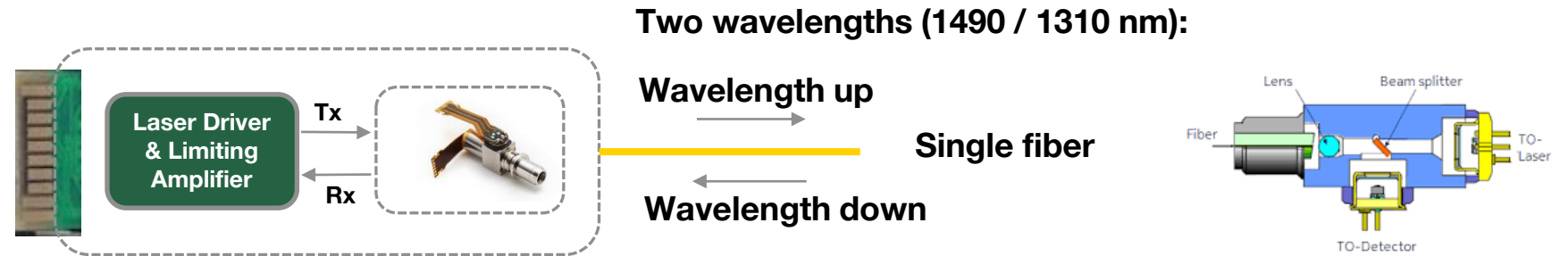
Deployment Orange begins





The role of photonic integration for G-PON technology (FTTHome)

G-PON



- **Transceiver characteristics defined the class of optical budget**
 - **The trend is to increase the optical budget**
 - **2003 : classes A, B, C (max. 20, 25, 30 dB) based only on photonics performance (Tx/Rx)**
 - **2006 : class B+ (28 dB) with the introduction of FEC (Down) is the most common**
 - **2008 : class C+ (32 dB) with the introduction of FEC (Up and Down)**



Role of photonics integration for ONU

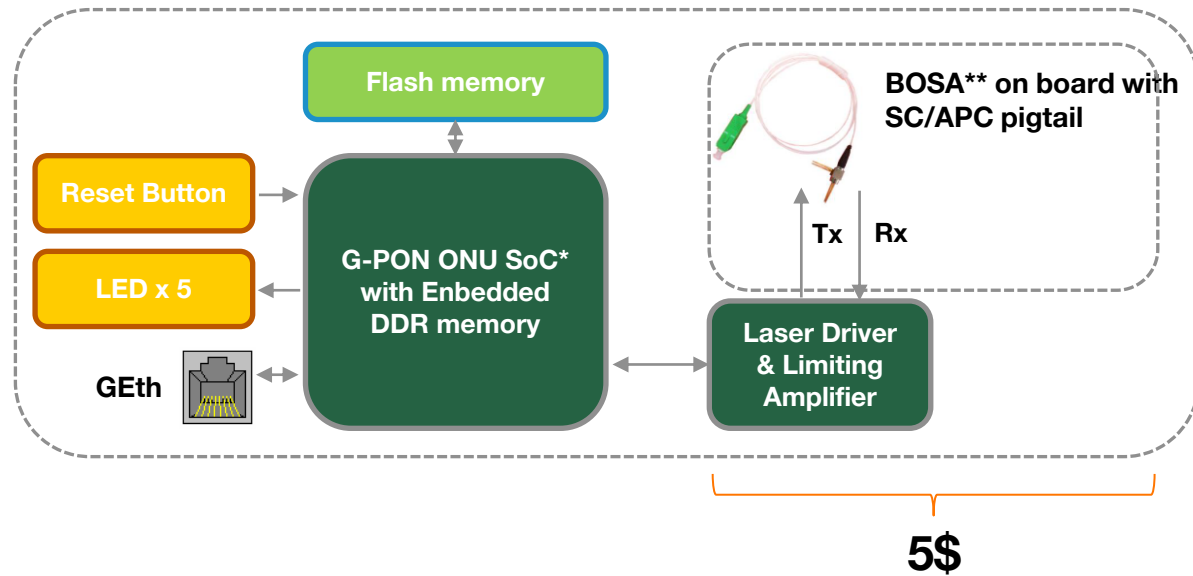
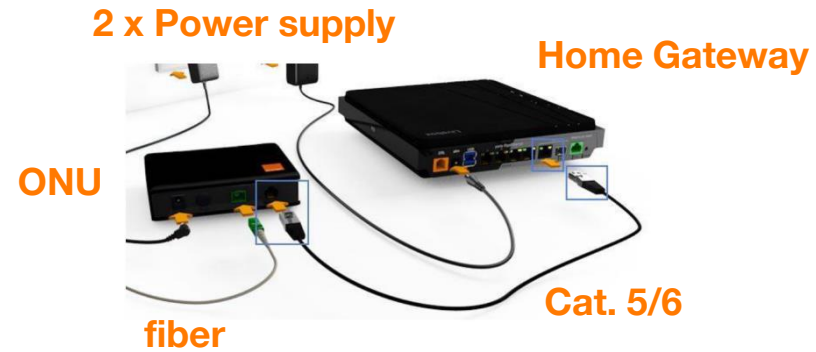
- **Two boxes: ONU + Home Gateway**





Role of photonics integration for ONU

➤ Two boxes: ONU + Home Gateway





Role of photonics integration for ONU

- **Two boxes: ONU + Home Gateway**
- **One Box: Home Gateway + SFP (ONU)**





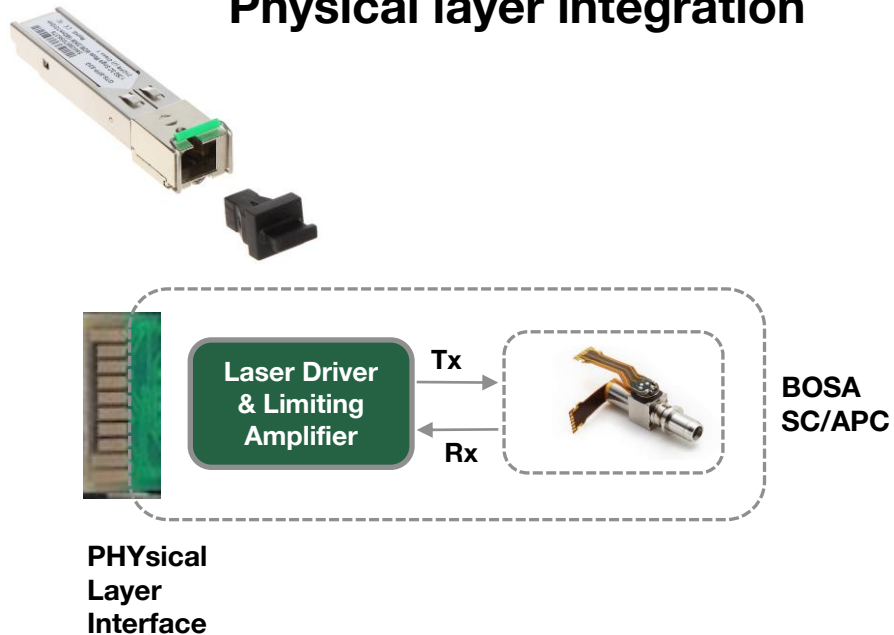
Role of photonics integration for ONU

- Two boxes: ONU + Home Gateway
- **One Box: Home Gateway + SFP (ONU)**



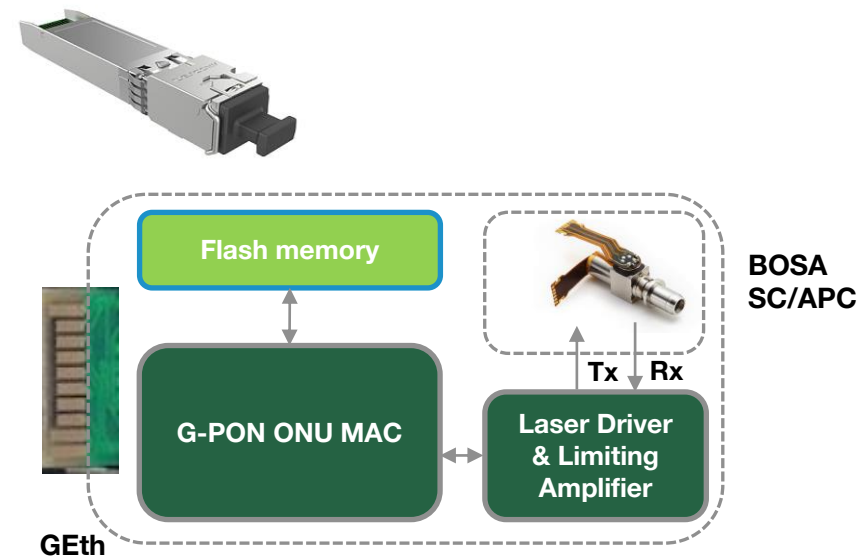
SFP ONU G-PON

Physical layer integration



SFP ONU G-PON

MAC & Physical layer integration



Low market appetite & unstable performance



Role of photonics integration for ONU

- **Two boxes: ONU + Home Gateway**
- **One Box: Home Gateway + SFP (ONU)**
- **Optical Box: Home Gateway with BOSA on board**





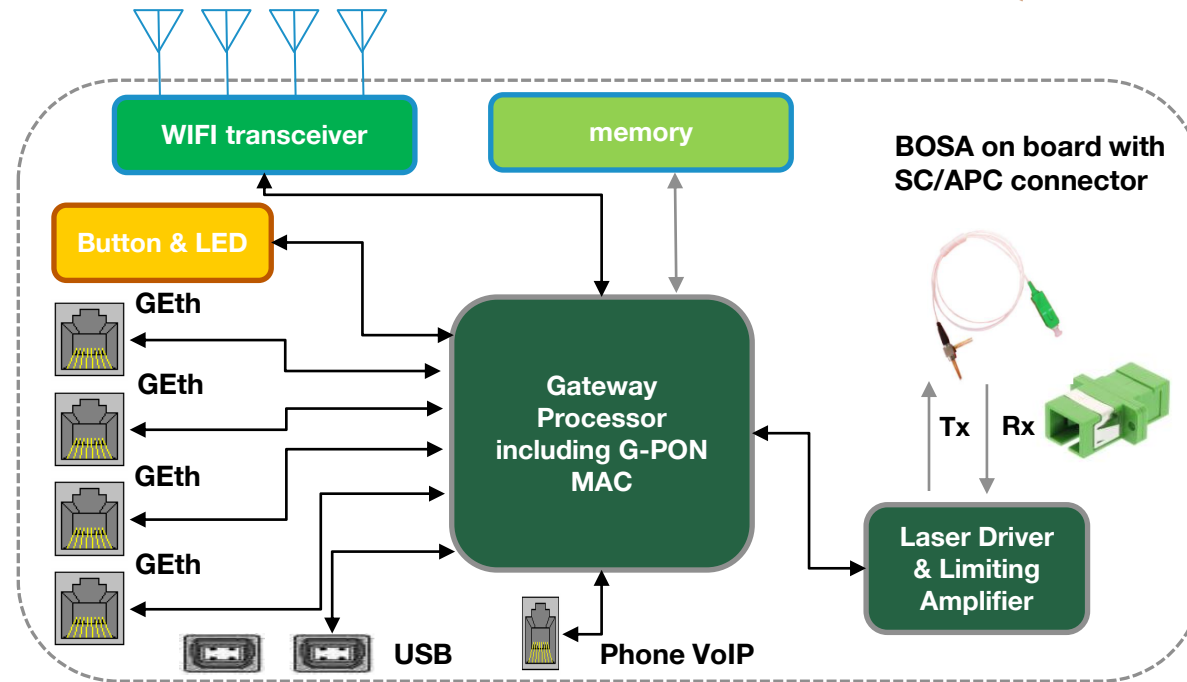
Role of photonics integration for ONU

- Two boxes: ONU + Home Gateway
- One Box: Home Gateway + SFP (ONU)
- Optical Box: Home Gateway with BOSA on board



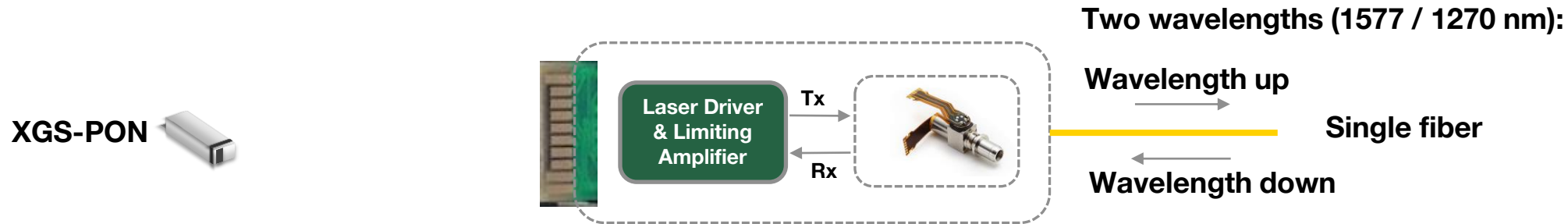
BOSA G-PON on board

**Integration of G-PON
MAC inside gateway
processor**





The role of photonic integration for XGS-PON technology (FTTHome)

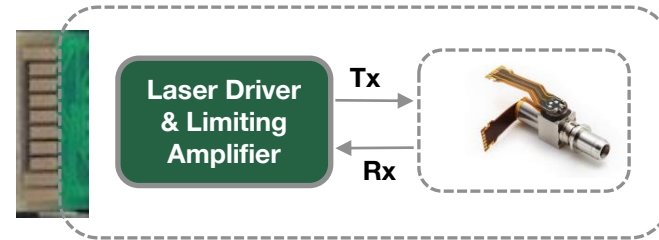


- **Transceiver characteristics defined the class of optical budget**
 - **2010: XG-PON first (10/2.5 Gbit/s)**
 - **Following by XGS-PON (10/10) in 2016 which is now the common solution due to photonics maturity of 10 Gbit/s Tx and Rx**
- **The trend to increase the optical budget continues**
 - **Classes B+ (28 dB) and class C+ (32 dB) due to progress on the photonics performance (Tx/Rx). FEC (Up and Down) is now mandatory**
 - **Class E2 (35 dB) for XGS-PON was declined to G-PON with class D**
- **1st Lesson learn : The maturity of photonics allows to increase optical budget in same time that line rate increase (2,5Gbit/s to 10 Gbit/s)**



The role of photonic integration for G-PON and XGS-PON technology (FTTHome)

G-PON



Two wavelengths (1490 / 1310 nm):

Wavelength up

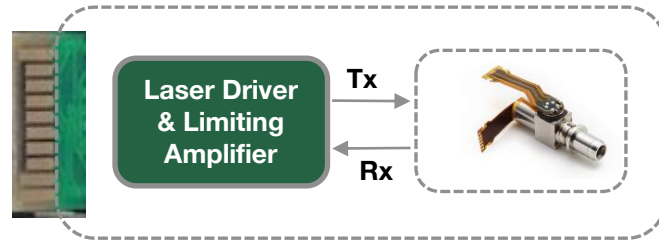


Single fiber

Wavelength down



XGS-PON



Two wavelengths (1577 / 1270 nm):

Wavelength up

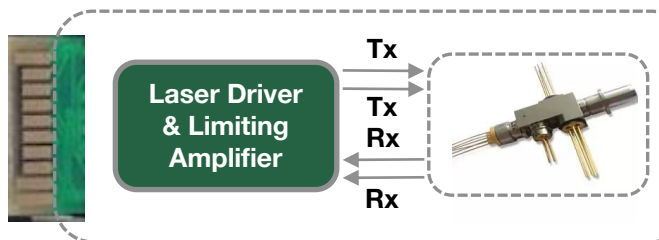
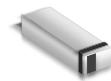


Single fiber

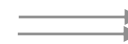
Wavelength down



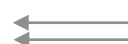
**Combo
G-PON & XGS-PON**



Four wavelengths (1577 / 1270 + 1490 / 1310 nm):



Single fiber





The role of photonic integration for G-PON and XGS-PON technology (FTTHome)

Livebox 7

A GPON or XGSPON compatible box, without the need for customer intervention when changing technology.



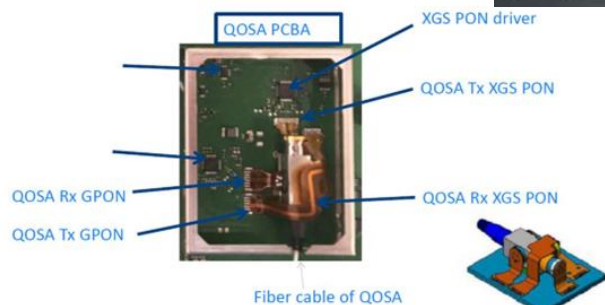
10G Ethernet port.



A single « fiber » port for G-PON and XGS-PON



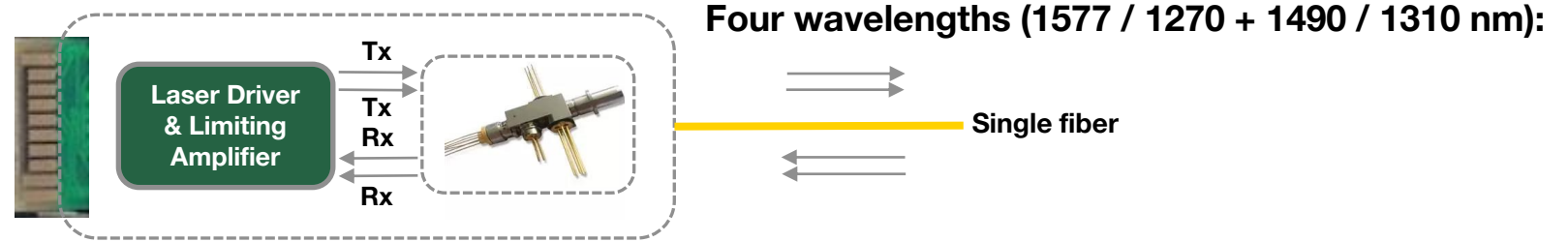
Multiple PON technologies gateway with automatic PON technology selection





The role of photonic integration for G-PON and XGS-PON technology (FTTHome)

Combo
G-PON & XGS-PON

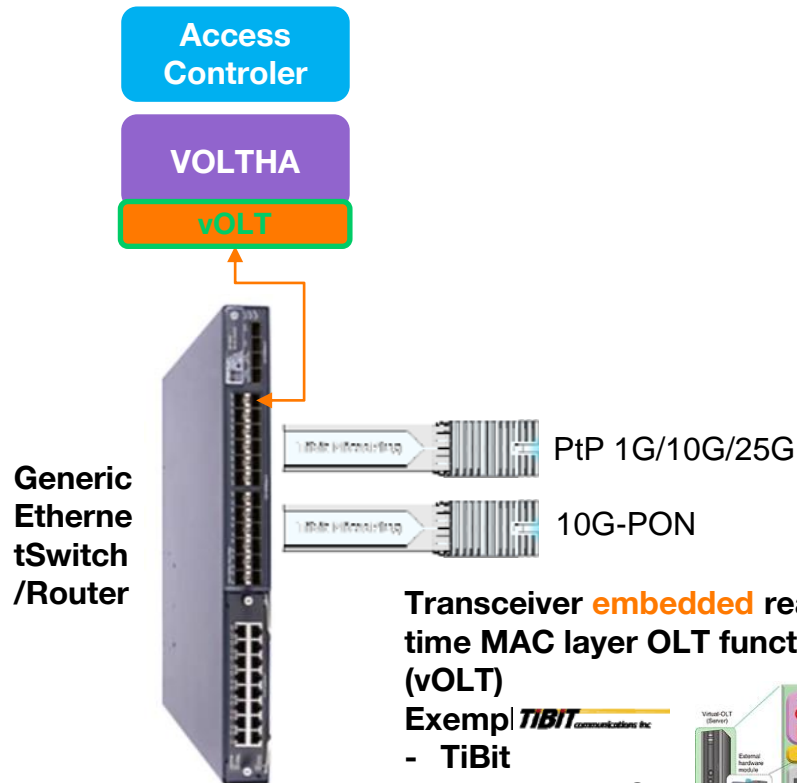


- **2nd Lesson learn** : The maturity of photonics integration allows to achieve bidi-rection single fiber with 2 x Tx, 2 x Rx and optical multiplexer based on micro-optics



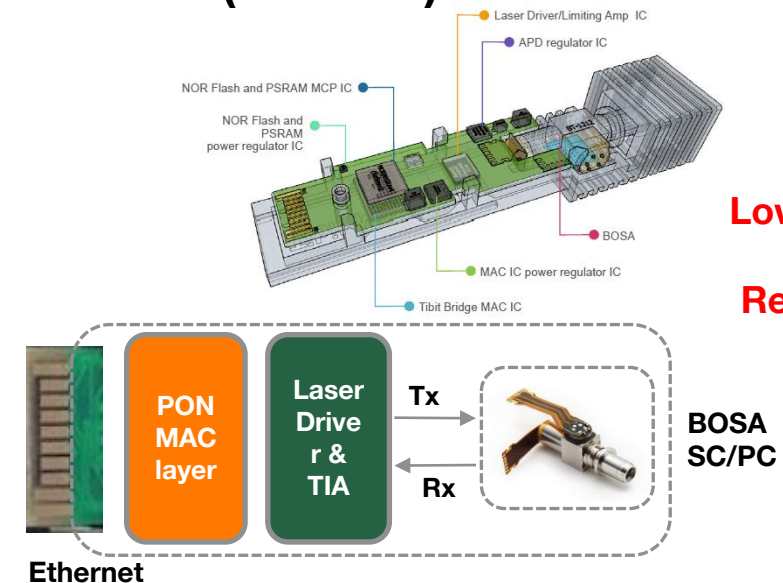
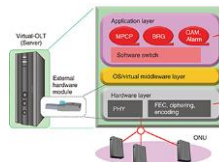
Role of photonics integration for OLT XGS-PON

- OLT transceiver defined the class of optical budget
- OLT Multi-PON module G- & XGS-PON (also named Combo)
- OLT made of generic hardware and « smart » transceiver (« vOLT »)



Transceiver **embedded** real time MAC layer OLT function (vOLT)

- Exempl **TIBIT** communications Inc
- TiBit
 - NTT with FASA*

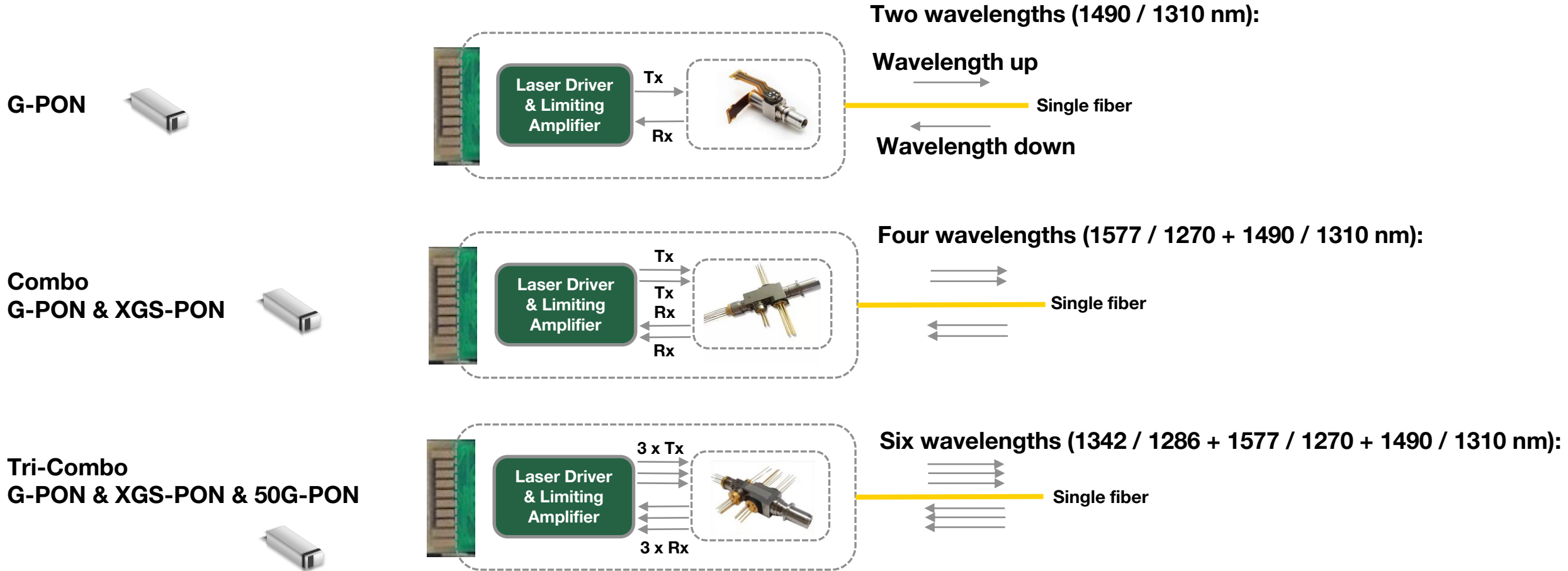


Low market appetite & Related to VOLTHA

- BOSA is the simplest solution to provide compact and enough space for integration of MAC chipset

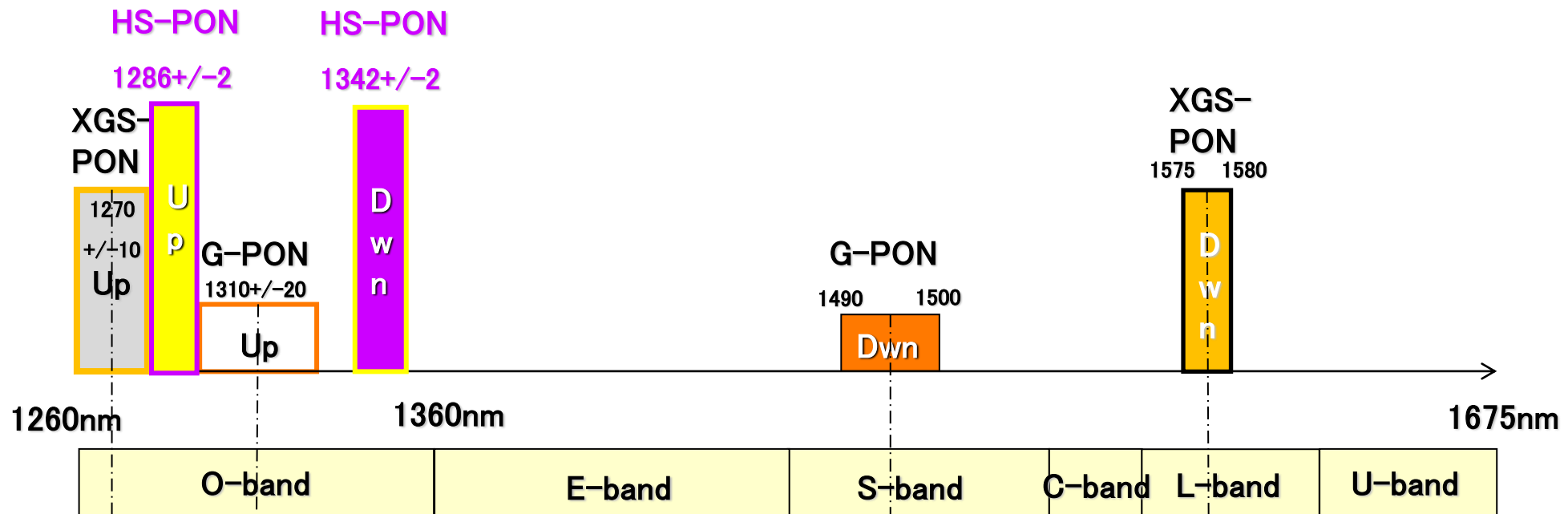
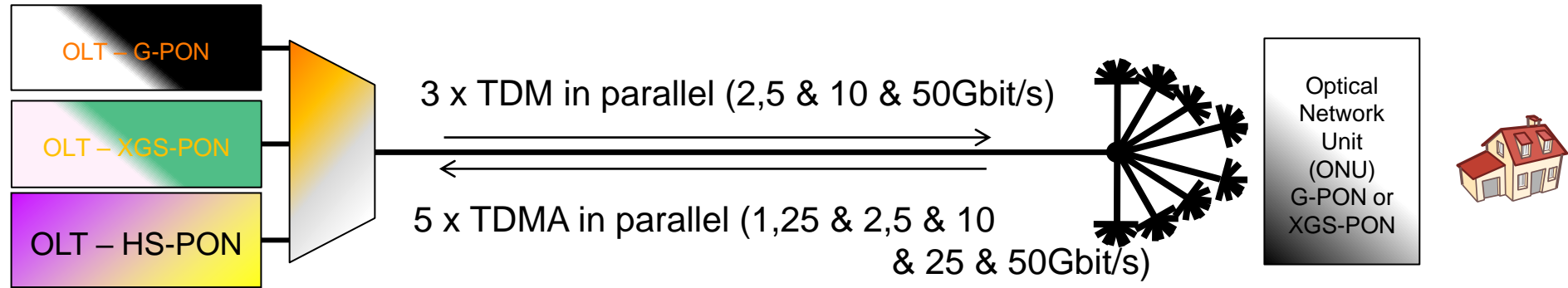


The role of photonic integration for G-PON, XGS-PON and 50G-PON technology (FTTHome)





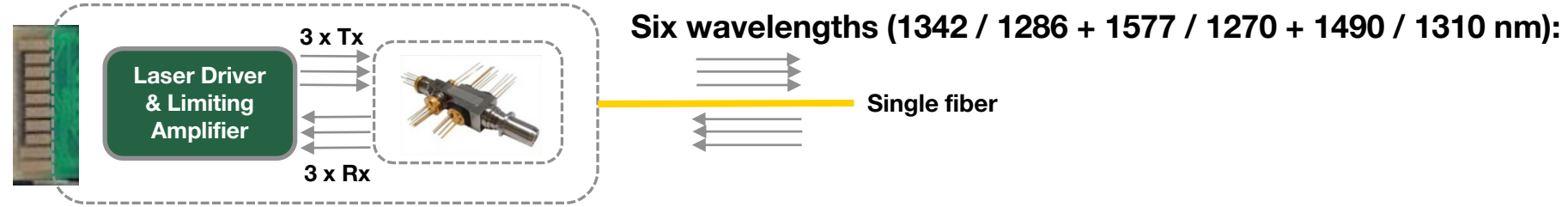
The right technology to maintain high quality fixed access





The role of photonic integration for G-PON, XGS-PON and 50G-PON technology (FTTHome)

Tri-Combo
G-PON & XGS-PON & 50G-PON

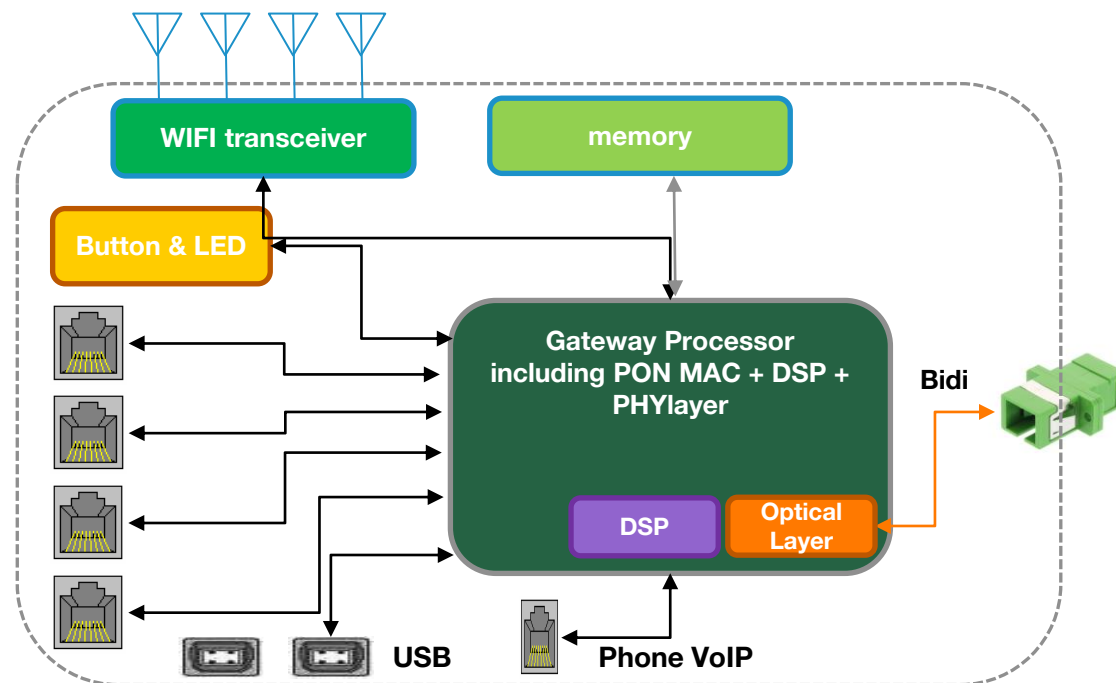
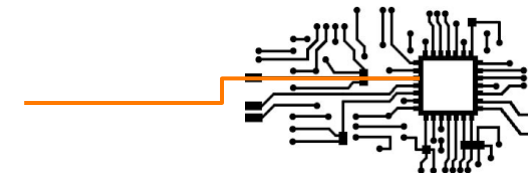


- 50G-PON was initialized with “Combo”. First with either G-PON or XGS-PON and now with the three technologies: G-PON, XGS-PON and 50G-PON.
- 50G-PON : this year, first commercial products are available
- The trend is to maintain the optical budget :
 - New FEC (LDPC) with more gain
 - First time that we use electronic equalizer (FFE 13 symbol taps)
 - Class C+ (32 dB) due to progress on the photonics performance (Tx/Rx) (Tx with EML + SOA)
- 3rd Lesson learn : The maturity of photonics allows to maintain optical budget in same time that line rate increase with a “combo” integration (2,5Gbit/s to 10 Gbit/s to 50 Gbit/s)



Conclusion and perspective of the role of photonics integration for FTTH

- **Two boxes: ONU + Home Gateway**
- **One Box: Home Gateway + SFP (ONU)**
- **Optical Box: Home Gateway with BOSA on board**
- **2030: Home Gateway chipset with Optical interface?**



Potential integration on processor chip:

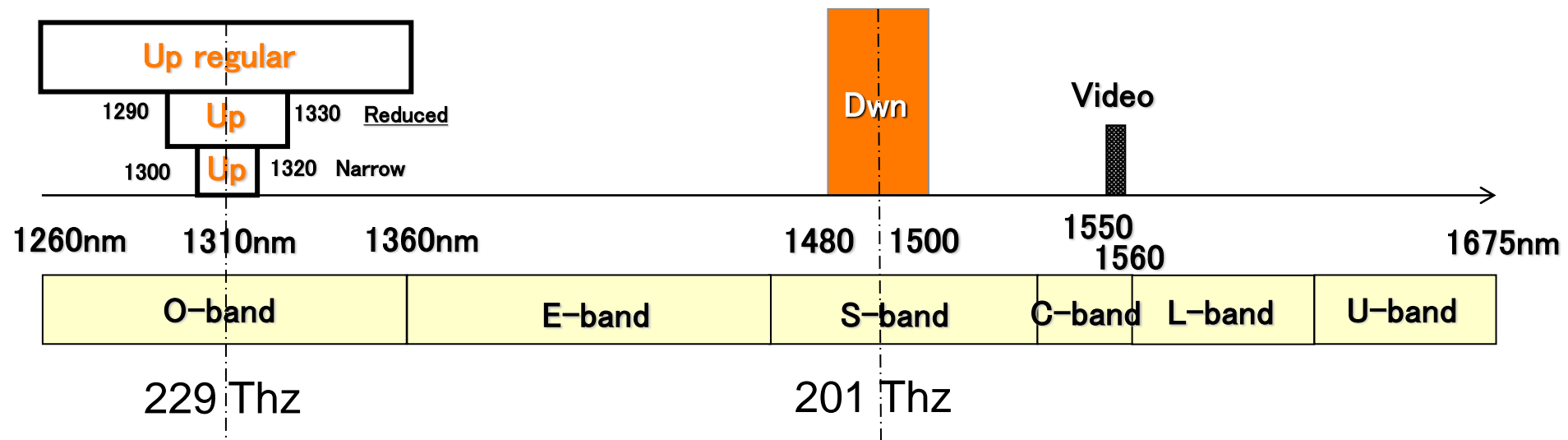
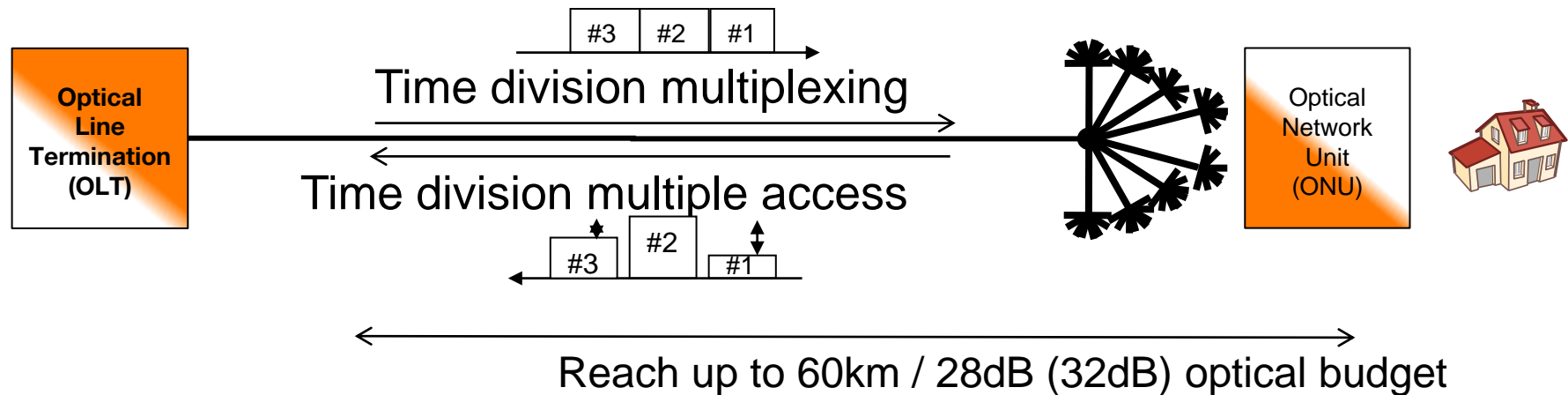
- **Silicon Photonics BOSA on chipset**
- **For 50G-PON and the future PON (200G) : with more Digital Signal Processing (DSP)**



Thank You



G-PON : Gigabit capable Passive Optical Network





XGS-PON : 10 Gigabit Symetrical capable Passive Optical Network

