FTTH Conference 2010

ITU-T Standardization: from G-PON to 10G XG-PON

Optical Access Transmission: XG-PON system aspects

Fabrice BOURGART,

France Telecom – Orange Labs.

Lisbon, 25 February 2010

Presentation Outline

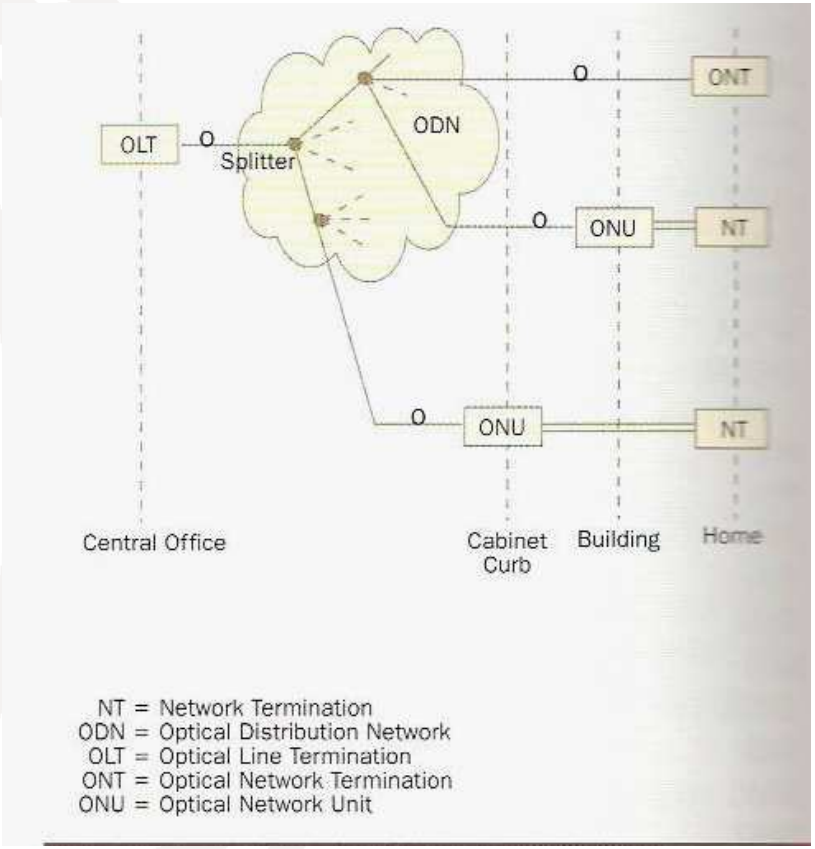
- PON Access Overview
- Migration from G-PON to XG-PON
- Architecture aspects for XG-PON
- Physical Layer specifications
- Trends.

PON Access Overview

- Optical access deployments happening worldwide, with regional customized flavors built on generic transmission
- Most cost effective transmission solutions found to be PON
  - Since sharing the opto-electronics in the central office
  - Sharing part of the fibre infrastructure through passive splitters
  - Thus featuring an energy efficient solution
- G-PON is a well established technology
  - Featuring 2.5 Gbit/s downstream
  - 1.2 Gbit/s upstream
- Defined by the G.984 series ITU-T Recs.
- G-PON has demonstrated advanced interoperability
- Mainstream deployments undergoing are based on classB+ (13-28dB optical budget) passive optical plant

PON Access Overview

- G-PON features:
  - 64 way passive split
  - 20km reach
  - various architectures options
- G-PON extensions enable:
  - up to 60km reach
  - class C+ optics feature up to 32dB
  - Reach extenders enable full capability in distance and split

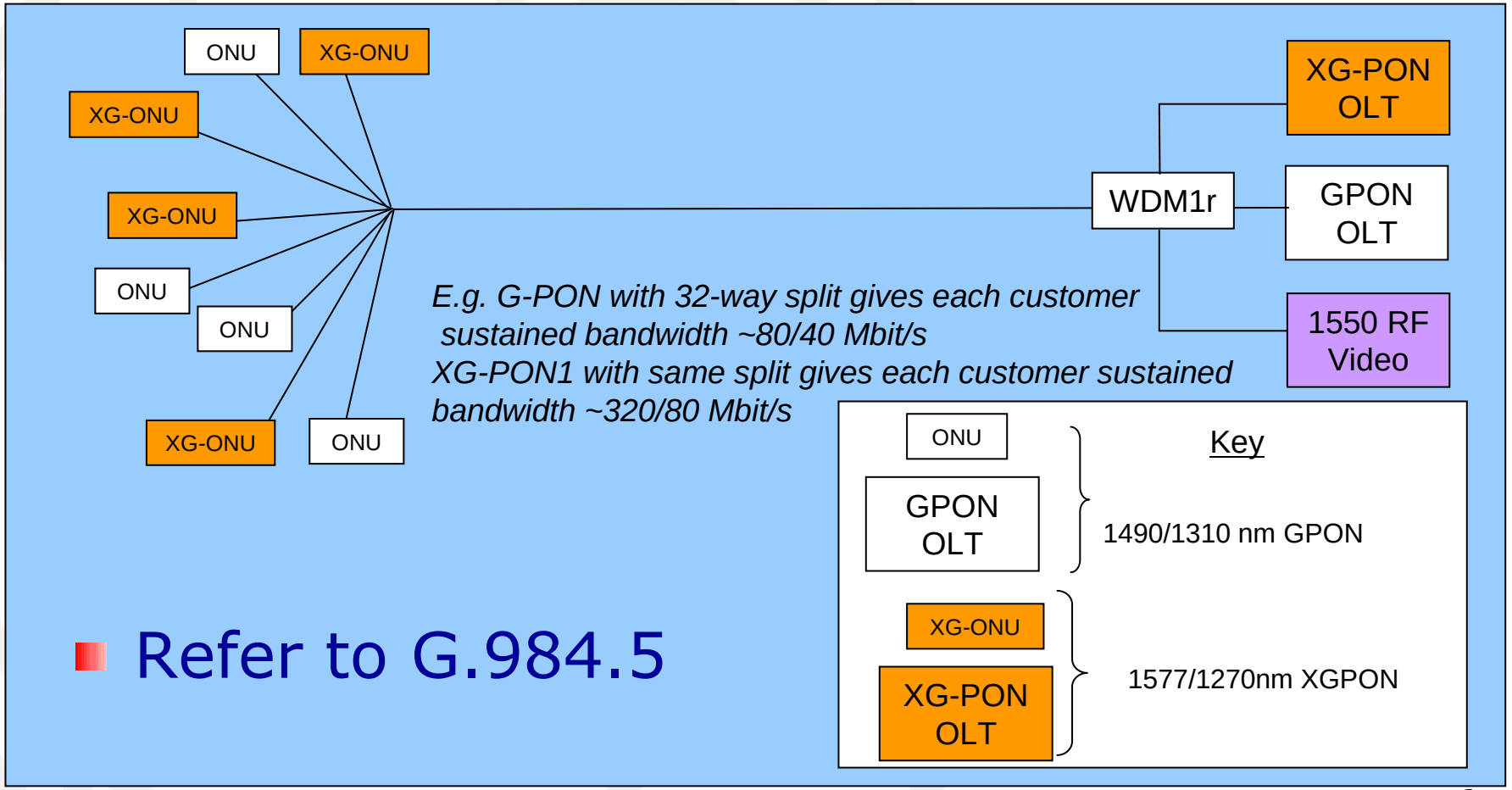


PON Access Overview

- Operators and vendors need to ever improve their return on investments:
  - Further features added to G-PON
  - Improve G-PON applicability
  - Assure future proof of plant investments
- But anticipating increasing demand for bandwidth
  - Higher line rates necessary => XG-PON
  - Under affordable migration conditions
  - Include G-PON optional extensions

Protection of G-PON & Overlay

- G-PON anticipated migration through ONU embedded filter and US window narrowing

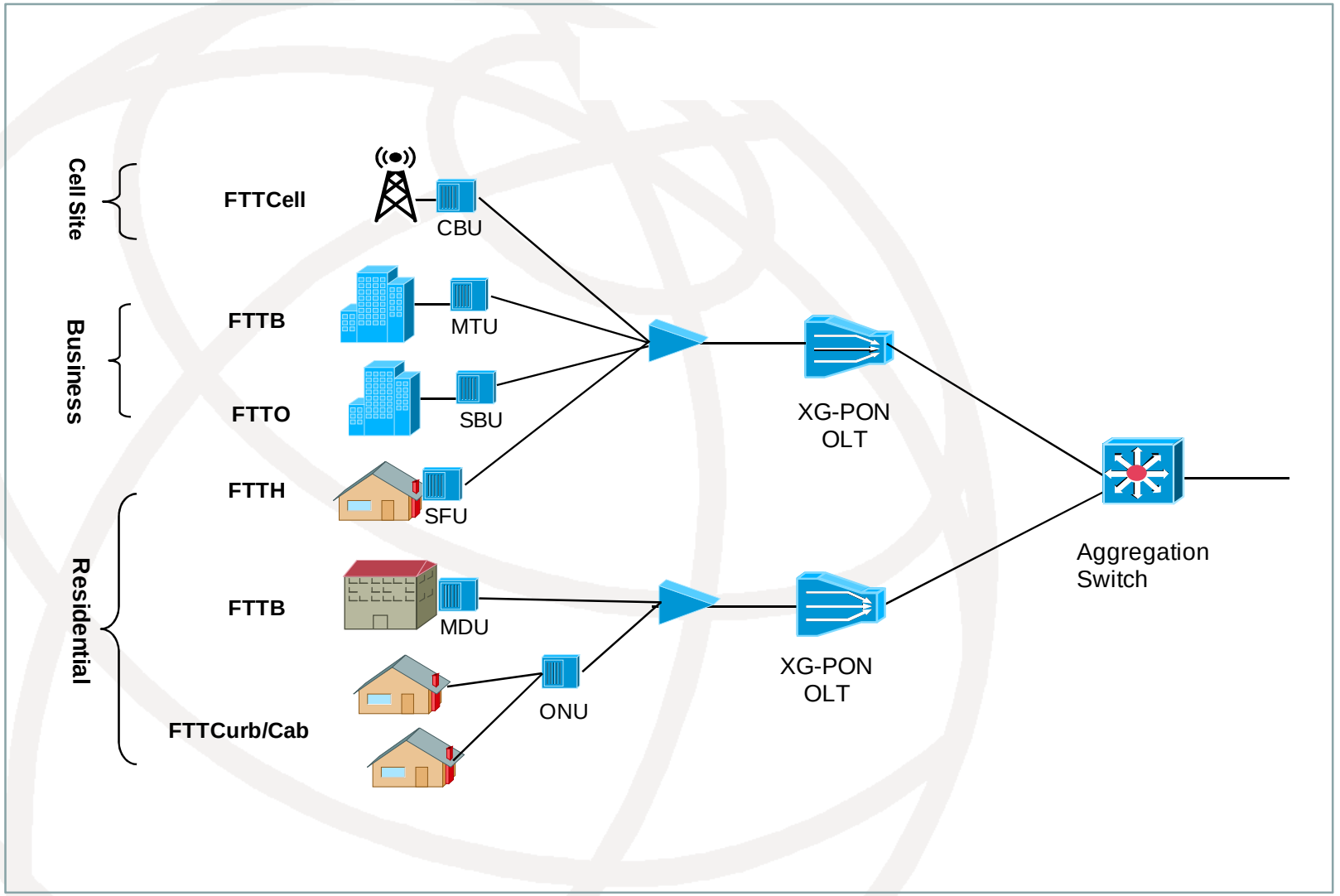


- Refer to G.984.5

XG-PON General features - G.987.1

- XG-PON conceived to inherit from G-PON:
  - TC layer principles
  - Dynamic bandwidth allocation
  - QoS and traffic management
  - Remote operation of ONU through OMCI (G.988)
- Integrate and improve G-PON options:
  - Enhanced security mechanisms
  - Enhanced power saving options
  - Synchronizing options enabling mobile backhauling applications
  - Enhanced ODN and performance monitoring

Architectures with XG-PON G.987.1



Transmission capabilities of XG-PON

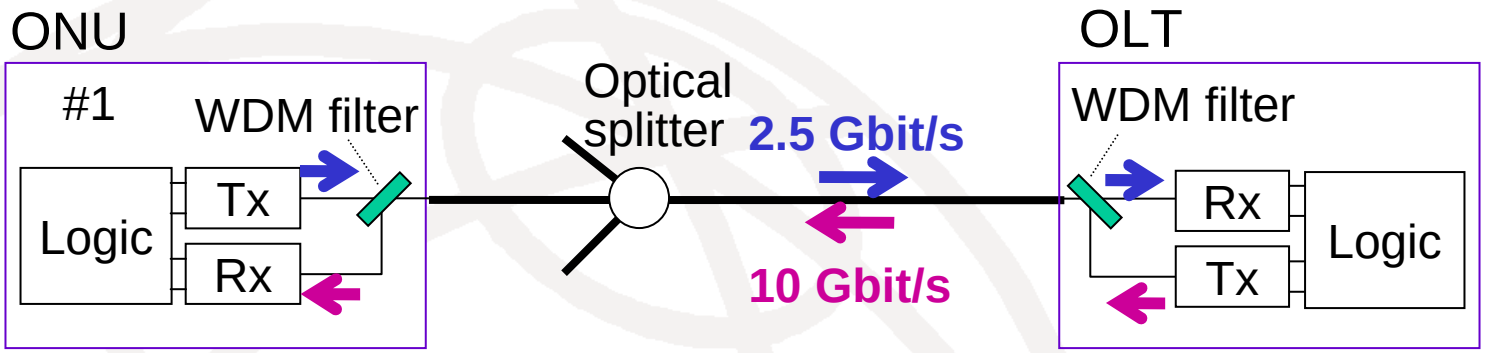
Item	Requirement	Remark
Upstream speed	2.5 Gbit/s XG-PON1	10 Gbit/s aka XG-PON2 is for future study.
Downstream speed	10 Gbit/s	
Multiplexing method	TDMA (up) / TDM (down)	
Loss budget	29 dB to 31 dB (Nominal class)	Extended class 33dB under study
Split ratio	1:64 (1:256 in the logical layer)	
Fiber distance	20 km (60 km in the logical layer)	Reach extender under study
Coexistence	• With G-PON (1310/1490 nm) • With RF-video (1550 nm)	

Physical layer of XG-PON G.987.2

Item	Upstream	Downstream
Loss-budget	Nominal-1 class: 29 dB, Nominal-2 class: 31 dB	
	Extended class of 33dB is under study.	
Signal wavelength	1260 – 1280 nm	1575 – 1580 nm [1]
	Same as IEEE 10G-EPON / Enables co-existence with G-PON	
Linerate	2.488320 Gbit/s	9.953280 Gbit/s
Linecode	Scrambled non-return-to-zero (NRZ)	
Forward error correction (FEC)	A weak FEC code - RS(248, 232)	A strong FEC code – RS(248, 216)
	FEC support is mandatory for both upstream and downstream	

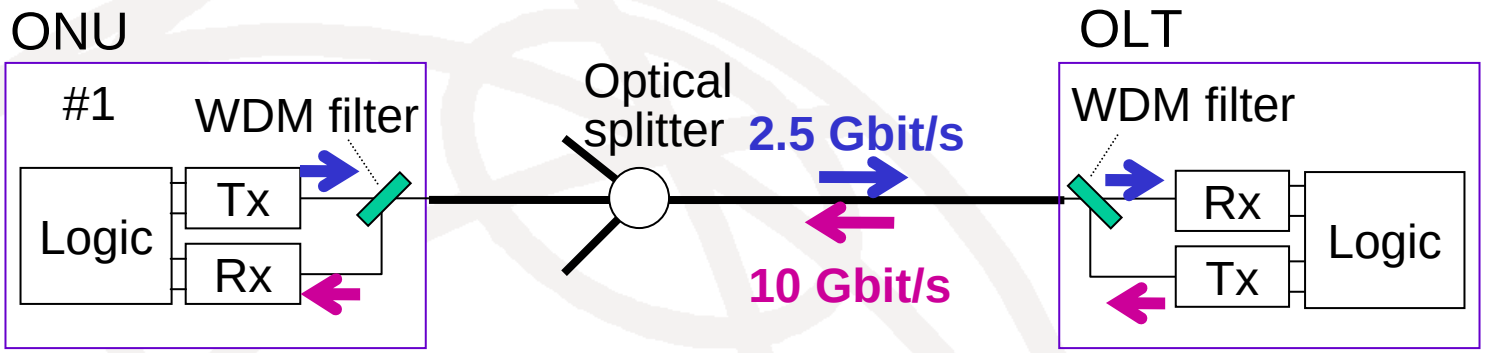
[1] In the case of outdoor OLT deployment, it is allowed for the operating wavelength to span between 1575 – 1581 nm.

Physical layer implementations: nominal 1 class G.987.2



Class	Direction	ONU	ODN	OLT
Nominal 1	2.5G US	Min Tx power: 2 dBm Directly Modulated Lasers (DML)	Max loss: 29 dB Path penalty: 0.5 dB	Min Rx power: -27.5 dBm APD receivers
	10G DS	Min Rx power: -28.0 dBm APD receivers	Max loss: 29 dB Path penalty: 1 dB	Min Tx power: 2.0 dBm Externally Modulated Lasers (EML)

Physical layer implementations: nominal 2 class G.987.2



Class	Direction	ONU	ODN	OLT
Nominal 2	2.5G US	Min Tx power: 2 dBm DML	Max loss: 31 dB Path penalty: 0.5 dB	Min Rx power: -29.5 dBm
	10G DS op.1	Min Rx power: -28.0 dBm APD receivers	Max loss: 31 dB Path penalty: 1 dB	Min Tx power: 4.0 dBm EML
	10G DS op.2	Min Rx power: -21.5 dBm Pin-PD receivers	Max loss: 31 dB Path penalty: 1 dB	Min Tx power: 10.5 dBm EML + Optical amp.

XG-PON work under way

- XG-PON recs targeted for June 2010:
  - G.987.3 TC layer and framing simplification
    - withdrawal of unused options (observed in G-PON)
    - Optimizing framing for lower power consumption
  - G.988 management applicable for G-PON, XG-PON, 1Gbit/s point to point and possibly GE-PON and 10GE-PON
  - Upgrade of RE G.984.6 rec. for application to XG-PON

Energy efficiency on XG-PON

Two main targets of PON power saving:

- Continuation of lifeline voice service(s) with backup battery for a longer time, e.g. ranging from 4 to 8 hours in case of mains outage.
- Power saving in nominal PON operation (adapted from G.sup45).

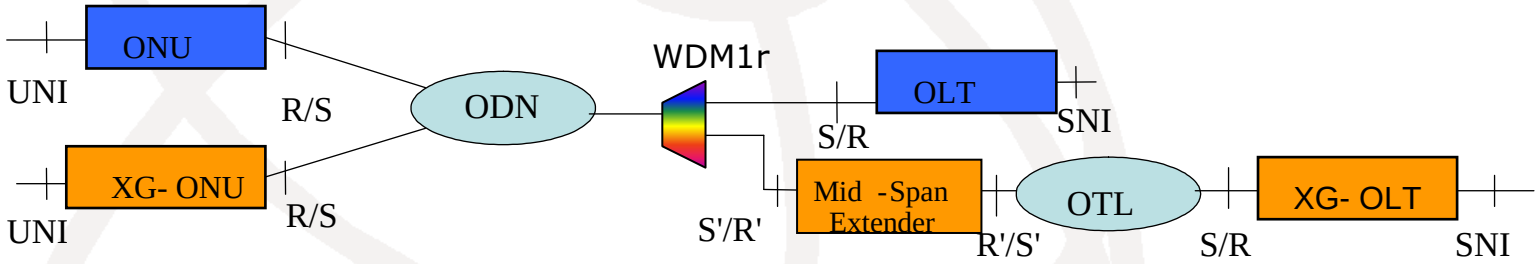
Four possible solutions to be further studied:

- Power shedding at UNI
  - Make unused user-network interfaces (UNIs) sleep.
- Dozing
  - Make the ONU transmitter sleep when no upstream traffic observed.
- Deep sleep
  - Make the ONU transmitter & receiver sleep when no traffic observed.
- Fast sleep/Cyclic sleep
  - Periodic wake up of ONU transmitter/receiver/logics when no traffic observed.

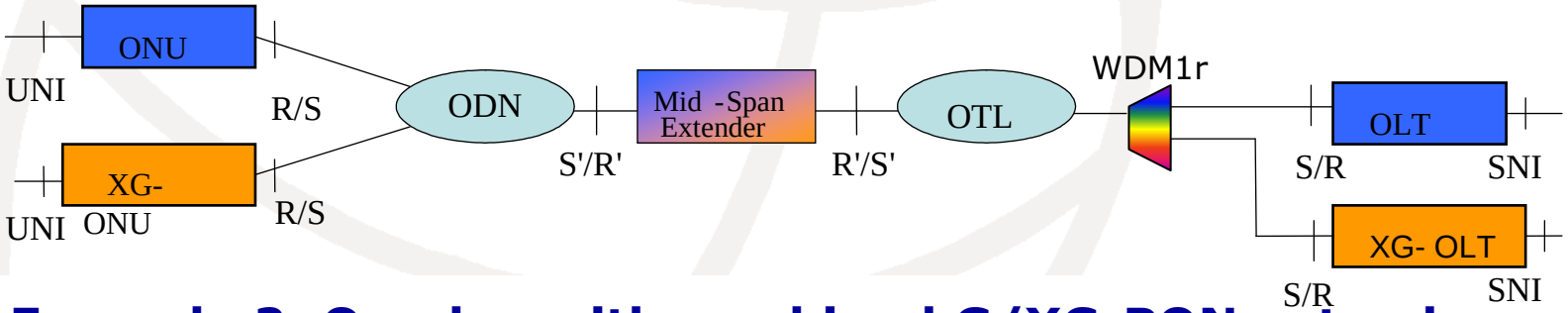
Service compatible parameters are now under discussion.

Reach Extending options for XG-PON

- RE to enable budget for full optical capability 60km and split
- RE to enable optimized OLT location in lower density areas
- RE to inherit from G.984.6 enable fibre saving in OTL section through TDM or WDM multiplexing (under study)



Example 1: Overlay with mid span XG-PON only extender



Example 2: Overlay with combined G/XG-PON extender

XG-PON G.987.1 further options

- Beyond June consent, G.987.1 listed additional topics that are for further study:
  - Evolution to more symmetrical XG-PON option XG-PON2
  - WDM stacking of G.987.3 XG-PON1 systems
  - Enhanced optical path protection including RE based architectures

Summary

- XG-PON G.987 series under way:
  - Provide good confidence that ClassB+ plants will be upgradable from G-PON to XG-PON when required by operators
  - G.987 with G.984.5 overlay provide a smooth migration path
  - XG-PON1 based systems will benefit from extensions consolidating the capability towards full fibre access

Acknowledgement

- Many thanks to those who made such progress possible:
  - All Q2/15 contributors with special dedication to the Rapporteur and Editors.
  - The FSAN community for their ever helpful contributions in ITU-T.

Thank you for your attention.

Any questions ?