10G - PON

By

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10G - PON

- There are several different 10G – PON (Passive Optical Networks) Standards / Architectures.
  - XG-PON1: 10 Gbps downstream and 2.5 Gbps upstream (fixed optics).
  - XGS-PON: 10 Gbps downstream and 10 Gbps upstream (fixed optics).
  - NG-PON2: 10 Gbps downstream and 10 Gbps upstream (tunable optics).
    - Also with PtP WDM (Point-to-Point Wavelength Division Multiplexing) with Up/Dwn Wavelengths with tunable optics.
  - 10G-EPON: 10 Gbps downstream and 10 Gbps upstream (fixed optics).

XG-PON1

- XG-PON1 = ITU-T G.987 series
  - 10 Gbps downstream and 2.5 Gbps upstream.
    - Line rate of 9.95328 Gbps downstream and 2.48832 Gps upstream.
  - Downstream occupies 1577 nm, Upstream occupies 1270 nm.
  - Downstream band 1575 nm to 1580 nm.
  - Upstream band 1260 nm to 1280 nm.
    - GPON: downstream = 1490 nm and upstream = 1310 nm.
    - RF Video = 1550 nm. RF return 1590 nm or 1610 nm
  - Coexists with GPON and RF video.

XGS-PON (aka XG-PON2)

- XGS-PON = ITU-T G.987 series
- The symmetrical version of XG-PON1.
- Sometimes referred to as XG-PON2.
  - 10 Gbps downstream and 10 Gbps upstream.
    - Line rate of 9.95328 Gbps downstream and 9.95328 Gps upstream.
  - Downstream occupies 1577 nm, Upstream occupies 1270 nm.
    - GPON: downstream = 1490 nm and upstream = 1310 nm.
    - RF Video = 1550 nm. RF return 1590 nm or 1610 nm
  - Coexists with GPON and RF video.

XG-PON1 & XGS-PON

- Must support minimum split ratio of 1 x 64.
- Will support legacy split ratios (1x16, 1x32 etc).
- OLT must be capable of supporting higher split ratios
  - i.e. 1 x 128 and 1x256.

XG-PON1 & XGS-PON

- **Differential fiber distance**: The absolute difference between the fiber distances of two particular ONUs (Optical Network Unit or aka ONT - Optical Network Terminal) connected to the same OLT (Optical Line Terminal) PON interface.
- **Fiber distance**: The overall length of fiber between the OLT and ONU.
- Must initially support a maximum fiber distance reach of 20 km.
- Needs to support a maximum fiber distance of 60 km.
- Needs to support the maximum differential subscriber distance of up 40 km in 20 km steps.

XG-PON1 & XGS-PON

- Optical Path Loss Classes

	Class N1	Class N2	Class E1	Class E2
Min Loss (dB)	14	16	18	20
Max Loss (dB)	29	31	33	35
Maximum differential optical path loss = 15 dB.				

NG-PON2

- NG-PON2 => ITU-T G.989 series (aka TWDM-PON)
  - **TWDM PON**: A time and wavelength division multiplexing passive optical network (TWDM PON) is a multiple wavelength PON solution in which each wavelength is shared between multiple optical network units (ONUs) by employing time division multiplexing and multiple access mechanisms.
- Multiple wavelength channel TWDM architecture.
  - 4 to 8 TWDM channel pairs (one downstream and one upstream).
- Downstream and upstream nominal line rates per channel:
  - 10 Gbit/s downstream and 10 Gbit/s upstream
  - 10 Gbit/s downstream and 2.5 Gbit/s upstream
  - 2.5 Gbit/s downstream and 2.5 Gbit/s upstream
- Coexist with GPON, XG-PON, XGS-PON, RF Video, and 10G-EPON.

NG-PON2 Cont'd

- Downstream Band occupies 1596 nm to 1603 nm.
- Upstream Band occupies 1524 nm to 1544 nm.
  - Several Upstream Options.
    - Wideband option: 1524 nm to 1544 nm.
    - Reduced band option: 1528 nm to 1540 nm.
    - Narrow band option: 1532 nm to 1540 nm.
- 8 PtP (Up/Dwn) Wavelengths: 1610 nm to 1625 nm.

  PtP WDM Ch. Rates -> 1G, 2.5G and 10G classes

10G-EPON

- 10G-EPON => IEEE 802.3av
- 10 Gbps downstream
  - Downstream band of 1575 nm – 1580 nm
- 10 Gbps or 1 Gbps upstream.
  - Upstream band of 1260 to 1280 nm for 10 Gbps.
  - Upstream band of 1260 to 1360 nm for 1 Gbps.
- Can coexist with GPON,RF Video, and NG-PON2.
- Can not coexist with XG-PON or XGS-PON. Uses the same Downstream and Upstream wavelengths as these standards.

Definitions.

- Coexistence Element (CE): special wave division multiplexer designed to multiplex the OTDR, GPON, XG/XGS-PON, RF Video, PtP, and NG-PON2 wavelengths onto a single fiber.
- Below is an example of a Coexistence Element parameters:

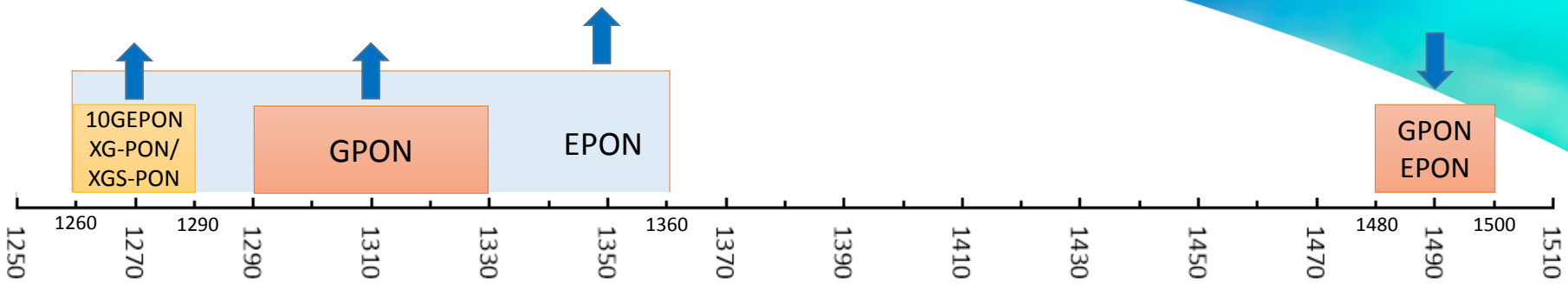
Parameters			Unit	Specifications
Operating Wavelength			nm	1260~1650
Channel Count			Ch	5
Channel Center Wavelength			nm	1570, 1590, 1610, Exp, 5% Test
Channel Passband	FSAN GPON	Min	nm	1290~1330&1480~1500
	XG-PON1	Min	nm	1260~1280&1575~1580
	NG-PON2（TWDM）	Min	nm	1524~1539&1596~1604
	RF	Min	nm	1550~1560
	PtP	Min	nm	1610~1625
Insertion Loss	FSAN GPON	Max	dB	1.00
	XG-PON1	Max	dB	2.20
	NG-PON2(TWDM)	Max	dB	1.90
	RF	Max	dB	1.30
	PtP	Max	dB	1.90

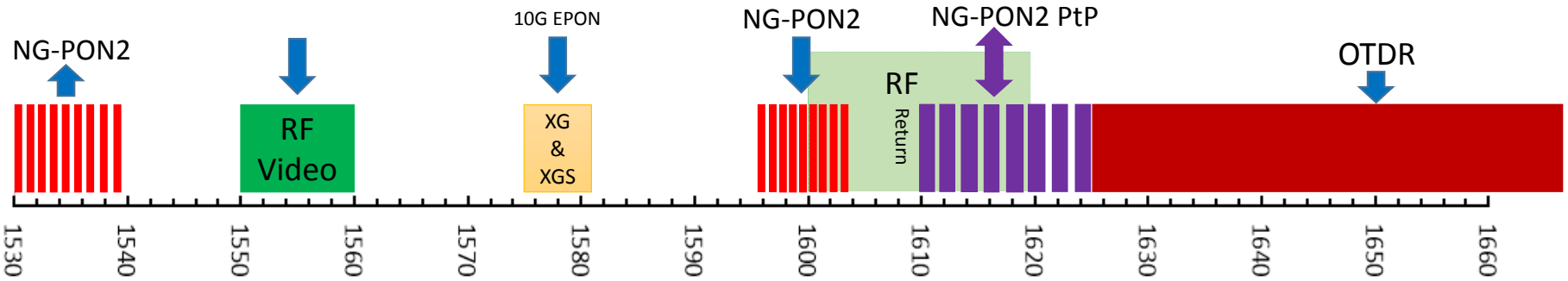
This example of a CE does not have an OTDR port. This is just one type of a CE. One can obtain a CE with the OTDR port.

The table is being provided to show the wavelengths and the insertion loss for the different systems being multiplex.

This is just one manufacturers CE. A different manufacturer may have different insertion loss values.

The Wavelengths



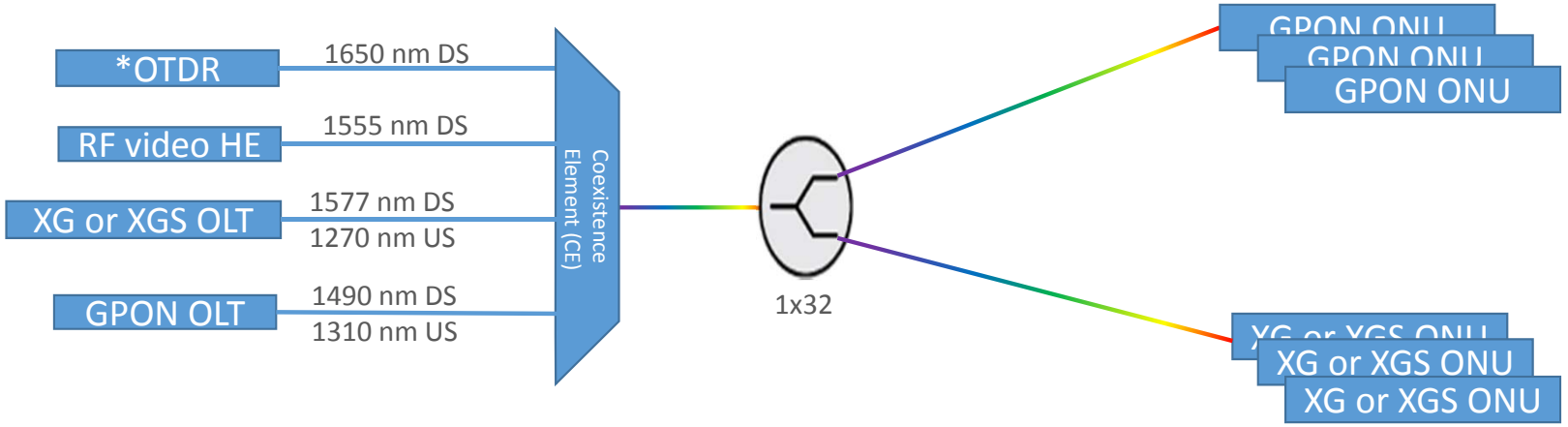


= Downstream; OLT to ONU

= Upstream; ONU to OLT

10G-PON Coexistence with Legacy Systems

- Initial 10G-PON deployment will most likely be an overlay onto an existing GPON system.
- XG-PON and XGS-PON optics will be available before NG-PON2 tunable optics.

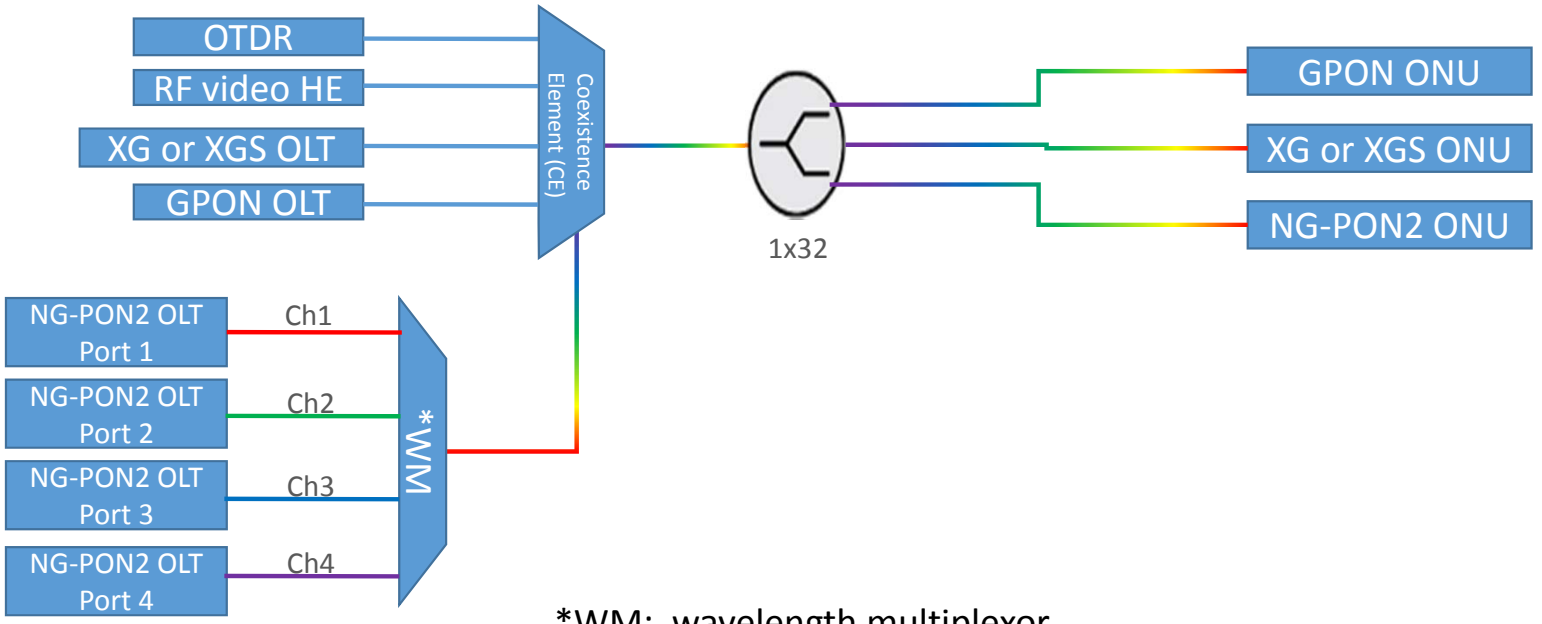


- Whether one chooses XG-PON or XGS-PON will depend on need and cost. 10G optics for ONU will be more costly than 2.5G optics.

*Optical Time-Domain Reflectometer is an instrument used to characterize an optical fiber.

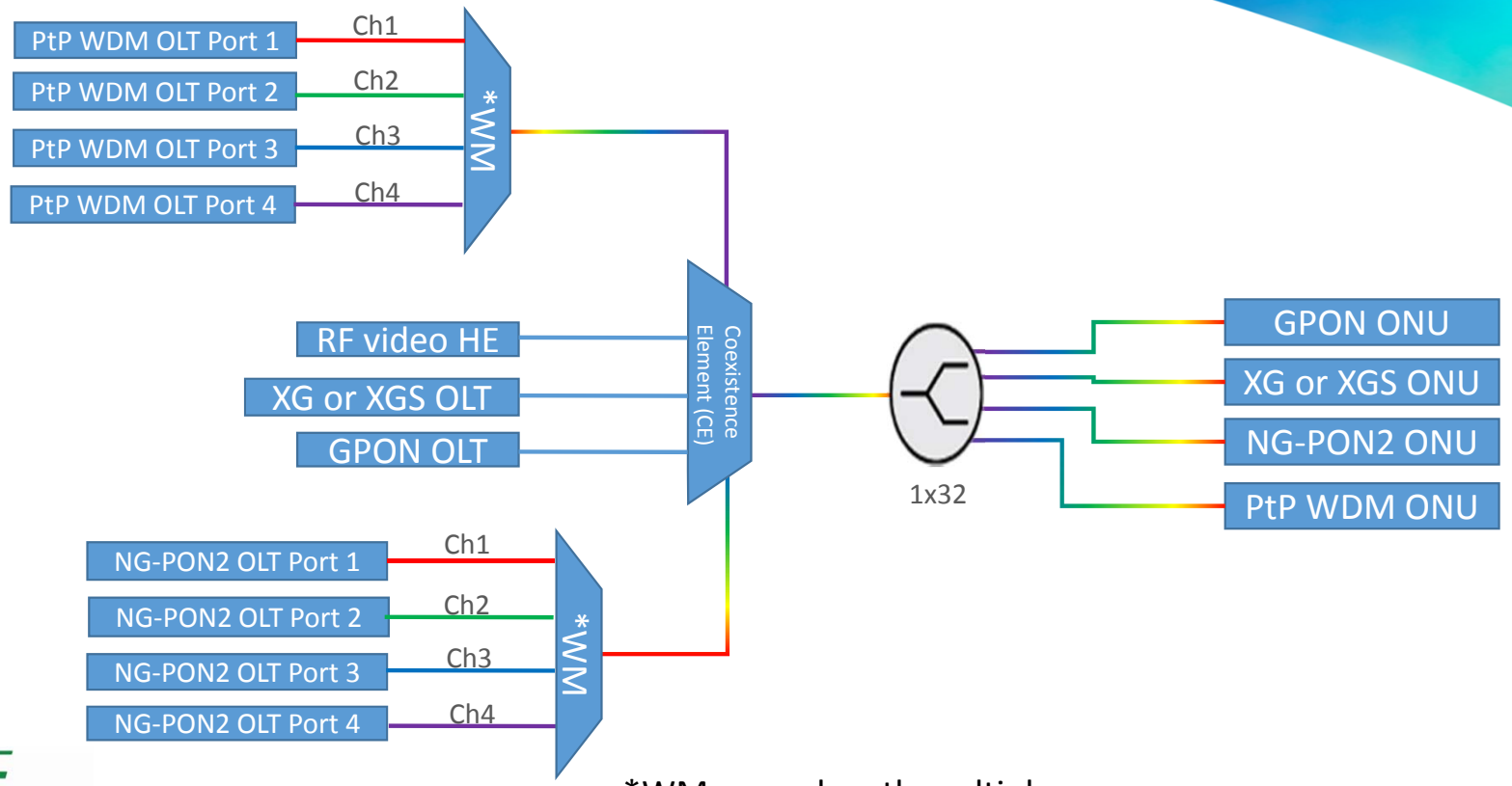
10G-PON Coexistence with Legacy Systems

- When tunable optics become more affordable, NG-PON2 could be overlaid over GPON and or XG-PON/XGS-PON.



*WM: wavelength multiplexor

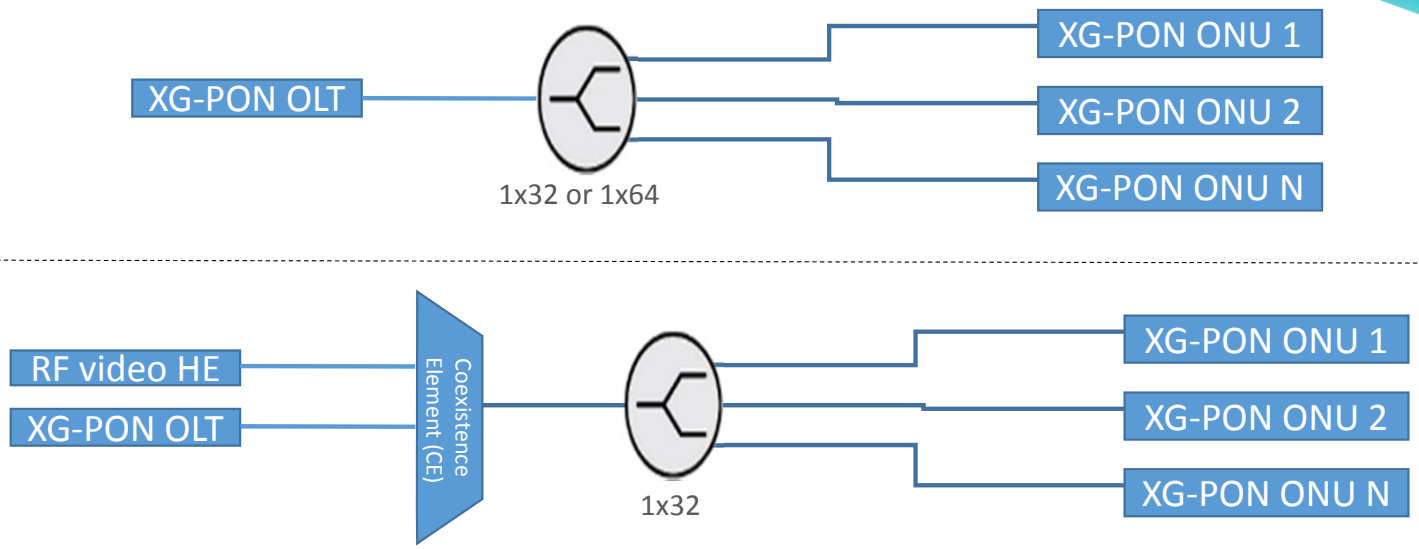
10G-PON Coexistence with Legacy Systems



*WM: wavelength multiplexor

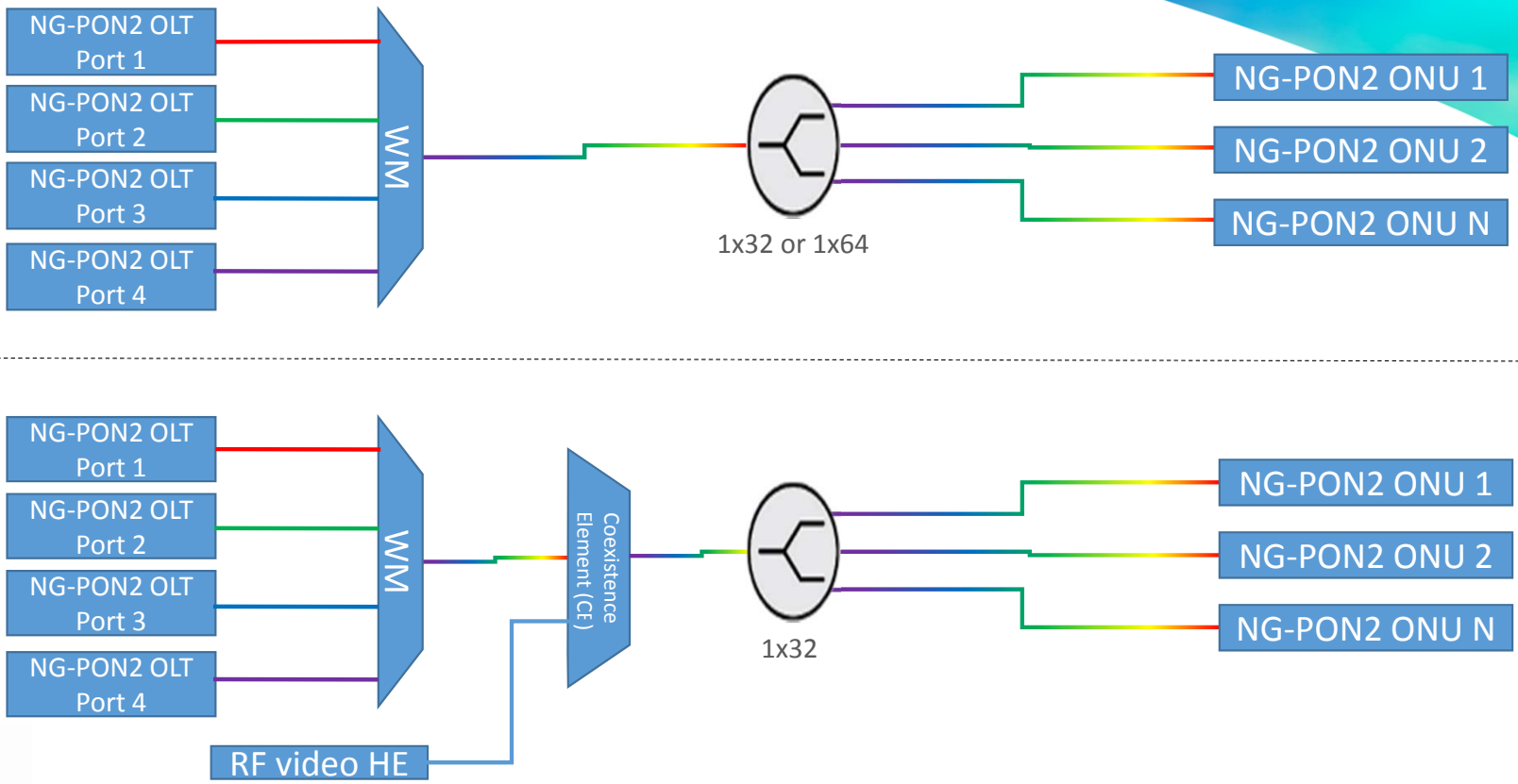
ACE Association of Communication Engineers

XG-PON Greenfield with/with out RF



- XG-PON and XGS-PON use the same wavelength bands.

NG-PON2 Greenfield with/without RF



Deployment Considerations

- Account for added attenuation from coexistence elements and higher attenuation at 1270 nm.
- Replacement of old Splitters that don't support the full spectrum from 1260 nm to 1650 nm.
- Check for U-grade splitters.
  - A-grade and S-grade = 1260-1360 / 1480-1580.
  - U-grade = 1260 – 1650.
- Check for GPON ONUs that don't have proper filters to block the 10G PON wavelengths.
  - Check with vendor before deploying 10G PON.
  - May need to add filters to ONU or deploy 10G-PON as a separate stand alone system.

Deployment Considerations

- For Companies that have deployed RF video.
- XG-PON and XGS-PON can coexist with RF video and RF return.
- NG-PON2 could be an option if system has RF return.
  - RFoG standard states RF return wavelength is at 1610 nm +/- 10 nm with some early deployments using 1590 nm.
  - If RFoG system uses 1610 nm, a portion of the upstream NG-PON TWDM channels will be unusable.
  - If RFoG system uses 1590 nm, **all** of the upstream NG-PON TWDM channels will be unusable.

Summary

- Many options in deploying a 10G-PON system.
  - XG-PON1: 10G/2.5G - least costly (residential use?)
    - Compatible with legacy GPON and NG-PON2
  - XGS-PON: 10G/10G – MDU, business, Cell Tower.
    - More costly than XG-PON1.
    - Uses same wavelengths as XG-PON1.
    - Probably the most likely candidate for initial deployment if cost is comparable to XG-PON1.
  - NG-PON2: Multiple 10G/10G systems that can be stacked.
    - Uses tunable optics.
    - Will become more prevalent once cost effective tunable optics are available.

QUESTIONS??

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