Selection of 100G-EPON Wavelength Plan

IEEE P802.3ca Task Force Meeting, May 2017

New Orleans, LA

Yong Guo

ZTE

Tomorrow never waits

Introduction

In Vancouver meeting, pure WDM or WDM/TDM seems the key factor for selecting final wavelength plan

- Pure WDM coexistence seems preferred by operators (straw poll #3, 4 and 5)
- WDM/TDM coexistence (either 1st ch or 4th ch) also have supporters

There are still number of questions need to be answered

- Whether WDM prevails WDM/TDM for lower OPEX?
- How large the pass band (2nm, 3nm, 20nm and others?) can satisfy transmitter cost, yields and performance? same PB for all US/DS channels or have multiple PBs?
- How G-PON/XGS-PON can be considered in coexistence?
- Will dual-rate 25/10G TIA or Triple rate 25/10/1G TIA matter the wavelength selection?

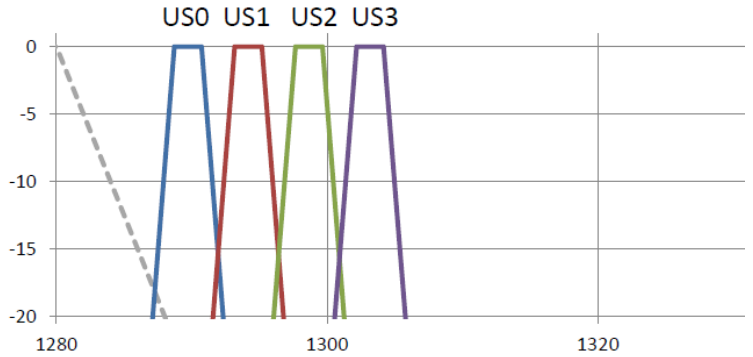
Pure WDM vs. WDM/TDM

Cost of ONU optics

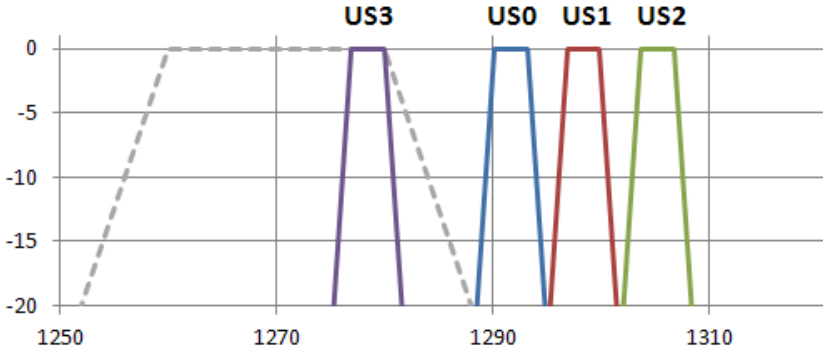
- Pure WDM simplifies operation and management but requires higher ONU cost. However, how much benefit from massive production needs further study.
- Many contributions (e.g., johnson_3ca_2_0117, harstead_3ca_2_0117, ...,) showed TDM coexistence can help relax the pass band, guard band, wavelength accuracy … and hence reduce ONU optic cost significantly.

Service level agreement

- Shared 10G/25G channel increases concern on reduced upstream capacity
- However, delay TDM to high speed version (e.g., 50G/100G) can help mitigate this concern or completely be out of trouble if 10G US is obsolete when 100G is ready.



guo_3ca_1_0117.pdf



guo_3ca_1_0317.pdf

Pass band selection

3nm

- 3nm PB has been discussed in many contributions, (e.g., zhang_3ca_1_1116, guo_3ca_1_0317, harstead_3ca_1_0117 …)
- 3nm PB is considered as a big compromise among cost, FWM, guard band, wavelength drift and spectrum usage...

2nm

- If using pure WDM coexistence, 2nm seems better choice
- But will arise cost and burst control issues

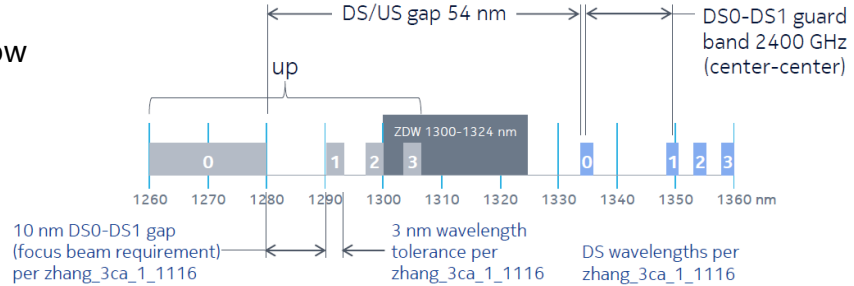
20nm

- Share with 10G-EPON US in WDM/TDM coexistence to allow uncooled DFB
- 1-2 dB lower Tx power of uncooled DFB is big concern.
- Spectrum waste if cooled DFB is used

Using same PB for all channels is recommended for production and test convenience

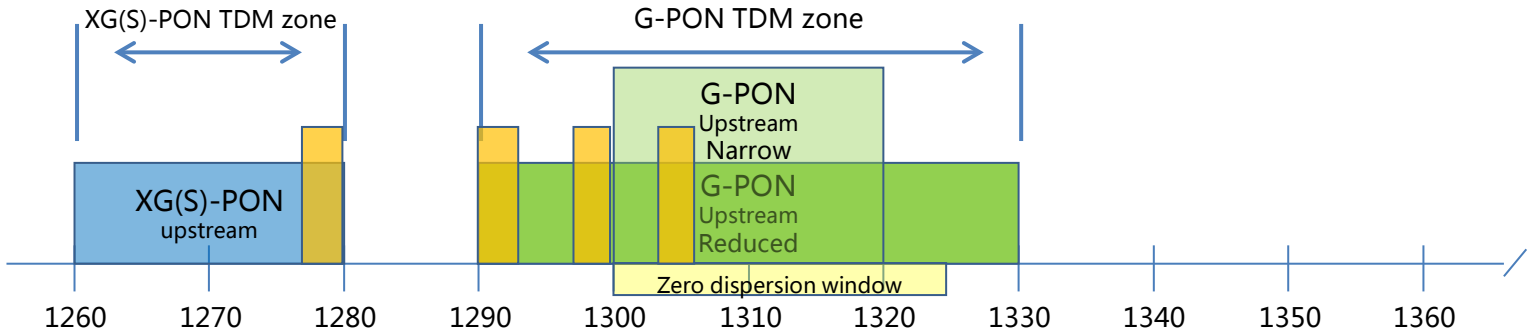
Central Wavelength Tolerance	±3nm	± 2nm	± 1.5nm	± 1nm	± 0.5nm
1st vendor's view	X	1.2X	1.6X	2.3X	3.5X
2nd vendor's view	Y	1.4Y	--	2.1Y	--

zhang_3ca_1_1116.pdf



harstead_3ca_1_0117.pdf

G-PON/XG(S)-PON coexistence



TDM coexistence is suggested between 25G and G-PON (1.25G/25G dual rate)

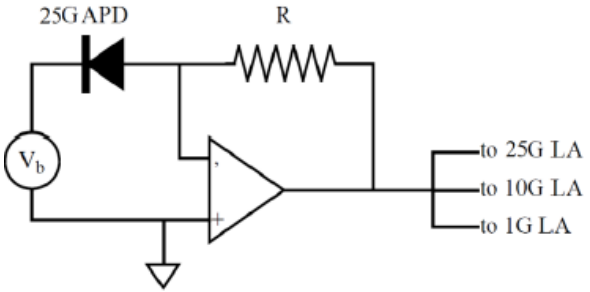
- To avoid triple rate receiver for XG(S)-PON (2.5G/10G/25G triple rate)
- 1.25G receiver has enough margin to accommodate dual-rate penalty
- When 50G/100G is ready, 1.25G and 2.5G are likely obsolete
  - G-PON spectrum can be released for 50G/100G
  - TDM coexistence can be used with 25G and XGS-PON (10G/25G dual-rate).

Dual/Triple rate receiver

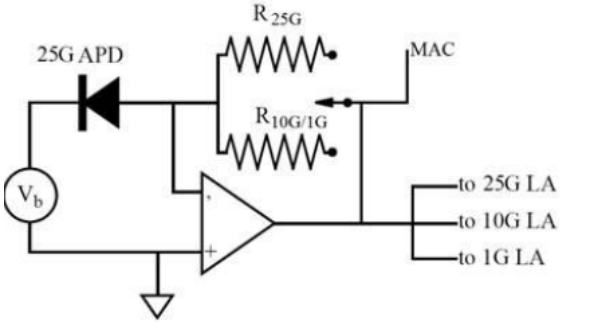
In Vancouver meeting

- Architecture and performance of triple rate receiver was discussed (zhangdezhi_3ca_1_0317.pdf).
- Implementation examples and simulation results showed
  - Design of triple rate TIA is not difficult
  - Degradation of lower rate system with dynamic resistor switch is acceptable
  - Cost increasing of triple rate receiver is believed not a critical concern.

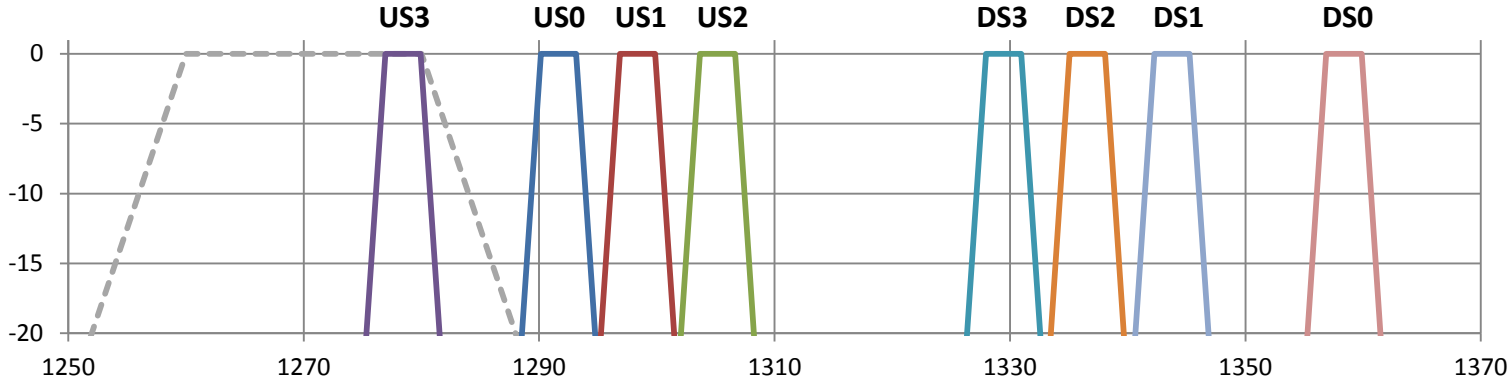
3 Rates by one static Load Resistance



3 Rates by two dynamic Load Resistance



Common 100G-EPON wavelength plan



	Center freq	Center WL
US0	232.100	1291.652
US1	230.900	1298.365
US2	229.700	1305.148
US3	234.500	1278.433
DS3	225.500	1329.457
DS2	224.300	1336.569
DS1	223.100	1343.758
DS0	220.700	1358.371

- 3nm pass band for all channels in both DS and US
  - Achieves better yields, burst tolerances, good SOA performance and less spectrum usage.
- 65nm DS/US gap for 25G-EPON
  - Reversed DS channel order where DS0 is in the longest side reduces diplexer penalty.
- WDM coexistence between 25G-EPON US0 and 10G-EPON US
  - No capacity loss for 25G, capacity loss only occurs in 100G.
- TDM coexistence between 100G-EPON US3 and 10G-EPON US
  - Delay TDM coexistence will mitigate capacity loss concern
- 1200GHz channel spacing and 2400GHz for DS1/DS0 and US3/US0
  - Integral number of 400G Hz does not prevent AWG implementation.
- Spectrum unused between 1260-1270nm can be saved for future when 10G-EPON is not used.

Conclusion

This presentation proposes a simple and converged wavelength plan.

Selection of wavelength plan

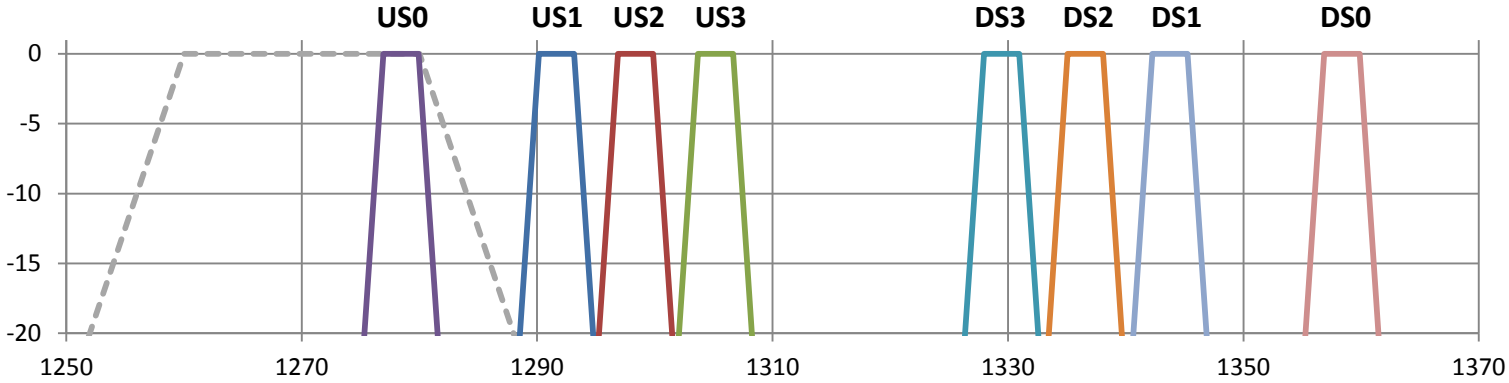
- Plenty of contributions discussed in previous meetings have provided many useful suggestions, such as, 3nm PB, 25G and 100G DS/US guard band, FWM mitigation, reversed order of DS channels, DS/US laser types (DML or EML), coexistence analysis, based on plenty of experiments and investigations.
- Many of these suggestions should be well considered.

Thank you

Tomorrow never waits

Backups

Common 100G-EPON wavelength plan Option #2



	Center freq	Center WL
US1	232.100	1291.652
US2	230.900	1298.365
US3	229.700	1305.148
US0	234.500	1278.433
DS3	225.500	1329.457
DS2	224.300	1336.569
DS1	223.100	1343.758
DS0	220.700	1358.371

Shares the exact same set of wavelengths as in Option #1

3nm pass band for 100G-EPON US0 and all other channels

- Cooled DFB can be enabled for larger output power.

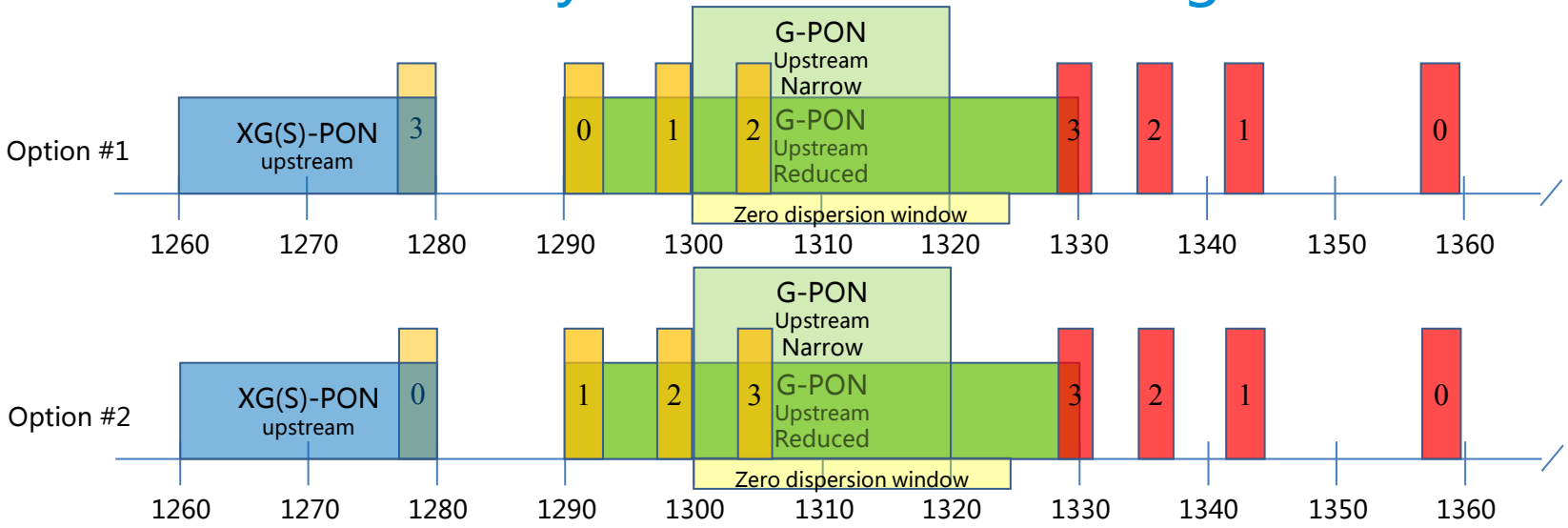
75nm DS/US gap for 25G-EPON

- Reversed DS channel order where DS0 is in the longest side

TDM coexistence between 25G-EPON US0 and 10G-EPON US

1200GHz channel spacing and 2400GHz for DS1/DS0 and US1/US0

Coexistence analysis- for ITU PON migration



Option #1	25G-PON	100G-PON
G-PON (narrow)	WDM	No
G-PON (reduced)	TDM	No
XG(S)-PON	WDM	TDM

Option #2	25G-PON	100G-PON
G-PON (narrow)	WDM	No
G-PON (reduced)	WDM	No
XG(S)-PON	TDM	TDM