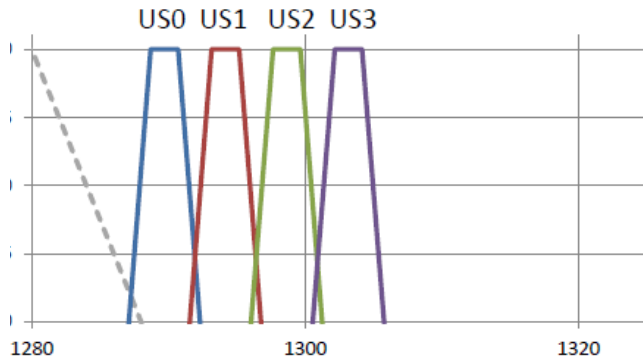


# Upstream wavelength plan comparison

- Ed Harstead
- March 2017

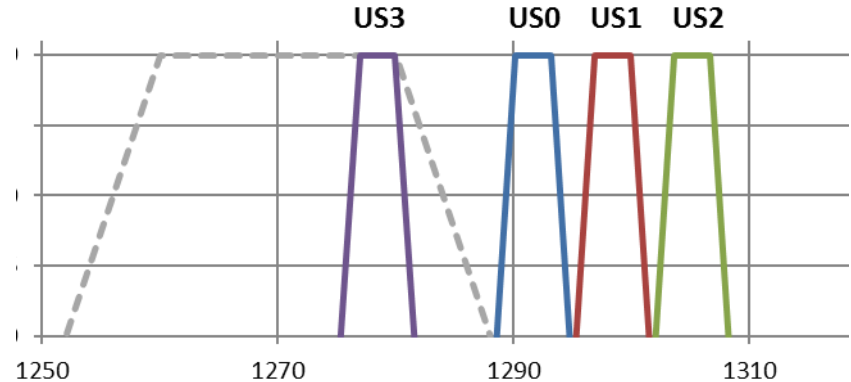
# WDM co-existence plans

Plan A guo\_3ca\_1\_0117



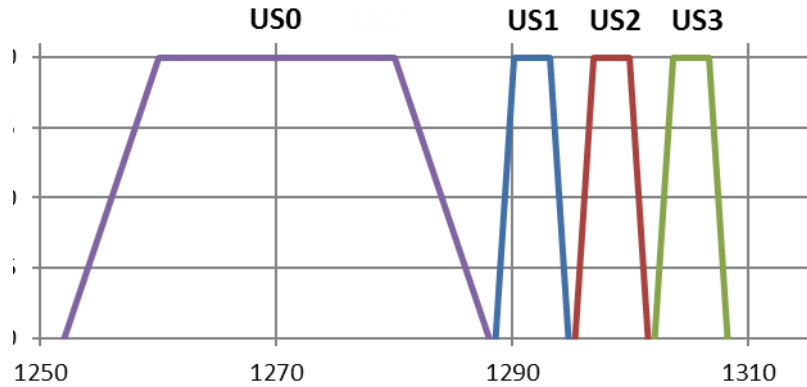
Convergence option #1 (guo\_3ca\_1\_0317)

- WDM co-existence for 25G & 50G.
- TDM co-existence for 100G.

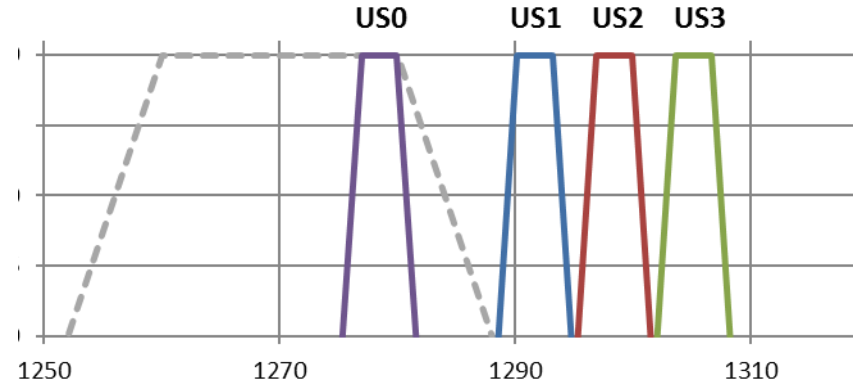


# TDM co-existence plans

Plan B harstead\_3ca\_1\_0117

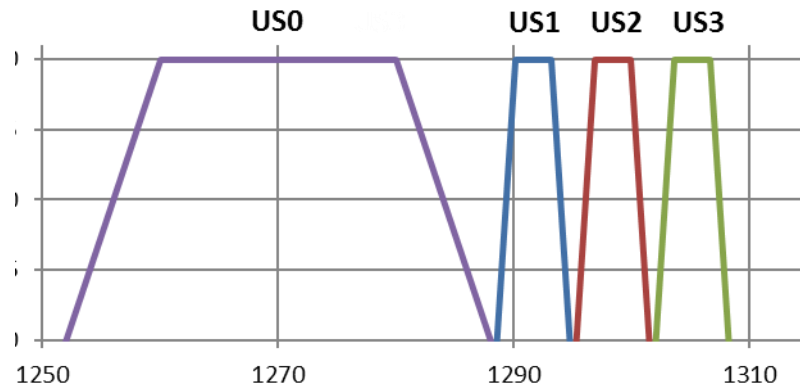


Convergence option #2 (guo\_3ca\_1\_0317)



# Compromise TDM/WDM plan

- 25G on US0: TDM co-existence
- 25G on US1:
  - WDM co-existence for 25G.
  - TDM co-existence for 50G & 100G.



(harstead\_3ca\_1\_0317)

# Comparison: all plans

| Element          | Co-existence 10G EPON:  | Plan A<br>guo_3ca_1_0117 | Convergence option<br>#1           | Plan B<br>harstead_3ca_1_0117 | Convergence option<br>#2 | Compromise plan                                     |                      |
|------------------|---|--------------------------|------------------------------------|-------------------------------|--------------------------|---|----------------------|
|                  |   | WDM                      | WDM for 25G, 50G.<br>TDM for 100G. | TDM                           | TDM                      | WDM for 25G.<br>TDM for 50G, 100G.<br>(1290 nm ONU) | TDM<br>(1270 nm ONU) |
| 25G power budget | Wider DS/US gap (about 12 nm): 0-0.2 dB advantage   | no                       | no                                 | yes                           | yes                      | no  | no                   |
| 25G power budget | To support 25/10 or 10/10 ONUs: One less filter in OLT (upstream): 0.5 dB advantage   | no                       | no                                 | yes                           | yes                      | no  | yes                  |
| 25/25 ONU        | Potential use of uncooled DML: 33% optics cost savings  | no                       | no                                 | yes                           | no                       | no  | yes                  |
| 25G OLT          | to support 10G upstream, additional 10G receiver and 1280/1290 nm filter  | yes                      | yes                                | no                            | no                       | yes   | no                   |
| 25/50/100G OLTs  | requires multi rate receiver (implementation risk?)   | no                       | 100G                               | 25G, 50G, 100G                | 25G, 50G, 100G           | 50G, 100G   | 25G, 50G, 100G       |
| 100G ONU         | Relaxed wavelength tolerance (3 nm vs. 2 nm): 25% transmitter cost savings  | no                       | yes                                | yes                           | yes                      | yes   | yes                  |
| 100G OLT         | 1260-1280 receiver sensitivity (implementation risk?)   | no                       | yes                                | yes                           | yes                      | yes   | yes                  |
| Capacity         | 25G upstream capacity shared with 10G (1G)  | no                       | 100G                               | 25G, 50G, 100G                | 25G, 50G, 100G           | 50G, 100G   | 25G, 50G, 100G       |
| Operations       | In PONs with no 25/10 ONUs, allow separate 10G OLT  | yes                      | 25G, 50G OLT                       | no                            | no                       | 25G OLT   | no                   |
| All              | 25G co-existence with GPON (US 1290-1330 nm). Improves the probability of a converged wavelength plan with ITU-T, driving higher volumes on common optics for lower costs | no                       | no                                 | yes                           | yes                      | no  | yes                  |
| Future           | Leaves some or all of 1260-1280 nm for future use (when no 10G EPON co-existence requirement)   | all                      | some                               | no                            | some                     | no  | no                   |

# Comparison WDM co-existence plans

| Element          | Co-existence 10G EPON:  | Plan A<br>guo_3ca_1_0117 | Convergence option<br>#1           | Compromise plan                                     |
|------------------|---|--------------------------|------------------------------------|---|
|                  |   | WDM                      | WDM for 25G, 50G.<br>TDM for 100G. | WDM for 25G.<br>TDM for 50G, 100G.<br>(1290 nm ONU) |
| 25G power budget | Wider DS/US gap (about 12 nm): 0-0.2 dB advantage   | no                       | no                                 | no  |
| 25G power budget | To support 25/10 or 10/10 ONUs: One less filter in OLT (upstream): 0.5 dB advantage   | no                       | no                                 | no  |
| 25/25 ONU        | Potential use of uncooled DML: 33% optics cost savings  | no                       | no                                 | no  |
| 25G OLT          | to support 10G upstream, additional 10G receiver and 1280/1290 nm filter  | yes                      | yes                                | yes   |
| 25/50/100G OLTs  | requires multi rate receiver (implementation risk?)   | no                       | 100G                               | 50G, 100G   |
| 100G ONU         | Relaxed wavelength tolerance (3 nm vs. 2 nm): 25% transmitter cost savings  | no                       | yes                                | yes   |
| 100G OLT         | 1260-1280 receiver sensitivity (implementation risk?)   | no                       | yes                                | yes   |
| Capacity         | 25G upstream capacity shared with 10G (1G)  | no                       | 100G                               | 50G, 100G   |
| Operations       | In PONs with no 25/10 ONUs, allow separate 10G OLT  | yes                      | 25G, 50G OLT                       | 25G OLT   |
| All              | 25G co-existence with GPON (US 1290-1330 nm). Improves the probability of a converged wavelength plan with ITU-T, driving higher volumes on common optics for lower costs | no                       | no                                 | no  |
| Future           | Leaves some or all of 1260-1280 nm for future use (when no 10G EPON co-existence requirement)   | all                      | some                               | no  |

# Comparison TDM co-existence plans

| Element          |   | Plan B<br>harstead_3ca_1_0117 | Convergence option<br>#2 | Compromise plan      |
|------------------|---|-------------------------------|--------------------------|----------------------|
|                  | Co-existence 10G EPON:  | TDM                           | TDM                      | TDM<br>(1270 nm ONU) |
| 25G power budget | Wider DS/US gap (about 12 nm): 0-0.2 dB advantage   | yes                           | yes                      | no                   |
| 25G power budget | To support 25/10 or 10/10 ONUs: One less filter in OLT (upstream): 0.5 dB advantage   | yes                           | yes                      | yes                  |
| 25/25 ONU        | Potential use of uncooled DML: 33% optics cost savings  | yes                           | no                       | yes                  |
| 25G OLT          | to support 10G upstream, additional 10G receiver and 1280/1290 nm filter  | no                            | no                       | no                   |
| 25/50/100G OLTs  | requires multi rate receiver (implementation risk?)   | 25G, 50G, 100G                | 25G, 50G, 100G           | 25G, 50G, 100G       |
| 100G ONU         | Relaxed wavelength tolerance (3 nm vs. 2 nm): 25% transmitter cost savings  | yes                           | yes                      | yes                  |
| 100G OLT         | 1260-1280 receiver sensitivity (implementation risk?)   | yes                           | yes                      | yes                  |
| Capacity         | 25G upstream capacity shared with 10G (1G)  | 25G, 50G, 100G                | 25G, 50G, 100G           | 25G, 50G, 100G       |
| Operations       | In PONs with no 25/10 ONUs, allow separate 10G OLT  | no                            | no                       | no                   |
| All              | 25G co-existence with GPON (US 1290-1330 nm). Improves the probability of a converged wavelength plan with ITU-T, driving higher volumes on common optics for lower costs | yes                           | yes                      | yes                  |
| Future           | Leaves some or all of 1260-1280 nm for future use (when no 10G EPON co-existence requirement)   | no                            | some                     | no                   |

# Summary

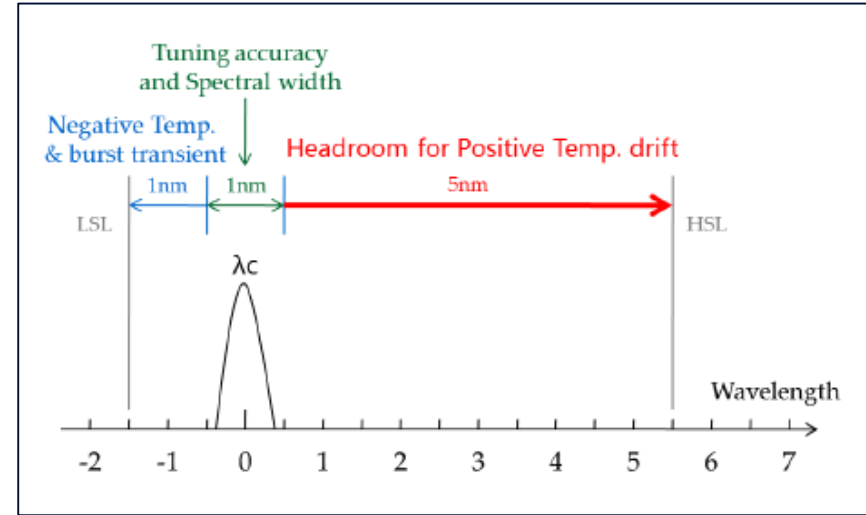
- Upstream and downstream wavelength plans can be optimized separately
- Comparisons between (various) WDM co-existence and TDM co-existence upstream wavelength plans are presented
- The compromise TDM-WDM plan can support both the delineation of 10G/25G of WDM co-existence and the lower cost implementation of TDM co-existence.
- The compromise plan compares pretty favorably to pure WDM and pure TDM co-existence plans in each case



# USO wavelength tolerance: 7 nm

- Proposed in zhang\_3ca\_1\_0317 as a cost reduction: should be quantified
- It could apply to
  - Convergence option #1
  - Plan B
  - Convergence option #2
  - Compromise TDM/WDM plan
- Comparison:

| Parameter  | USO wavelength tolerance |         |          |
|--|--------------------------|---------|----------|
|  | 2-3 nm                   | 7 nm    | 20 nm    |
| Uncooled DML?  | No                       | No      | possible |
| 25G ONU laser cost                                   | Highest                  | Medium  | Lowest   |
| SOA+PIN performance relative to 2-3 nm (approximate) |                          | -0.5 dB | -1.5 dB  |



zhang\_3ca\_1\_0317

bonk\_3ca\_1\_0117

**NOKIA**