100G EPON ONU solution discussion and cost comparison

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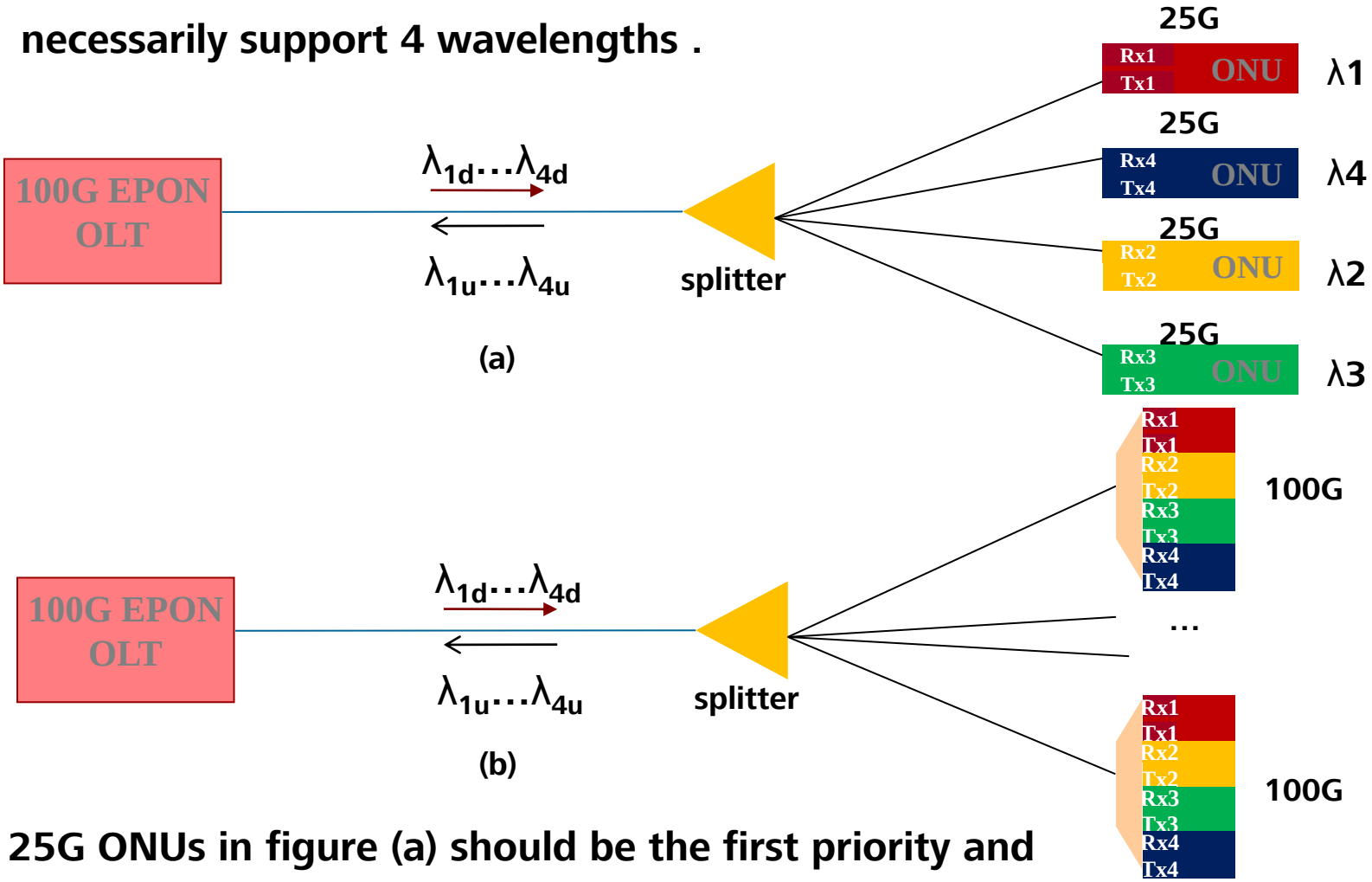
Different 100G EPON system ONUs

- 100G EPON OLT has 4 wavelengths (4*25G), but subtended ONUs do not necessarily support 4 wavelengths .



- 25G ONUs in figure (a) should be the first priority and focus for 100G EPON.

Three candidate technologies for 100G EPON ONUs

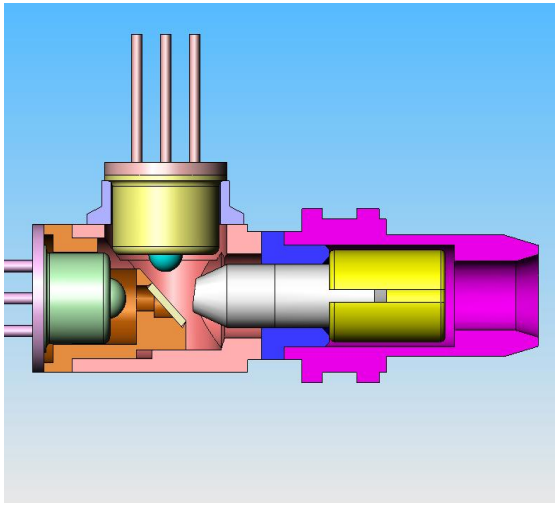
- **Aim for 100G EPON:**
  - Peak rate per ONU ≥ 25Gb/s
  - Different ONUs should be able to work on any one of 4 wavelengths

- **Three possible solutions:**
  - 1) Fixed wavelength , single 25Gb/s TRx , colored (CWDM)
  - 2) 4 λTunable, single 25Gb/s TRx, colorless (DWDM)
  - 3) 4 λ array, four 25Gb/s TRx, colorless

Note: All of the following slides are based on assumption using 10G optics to achieve a 25Gb/s line rate.

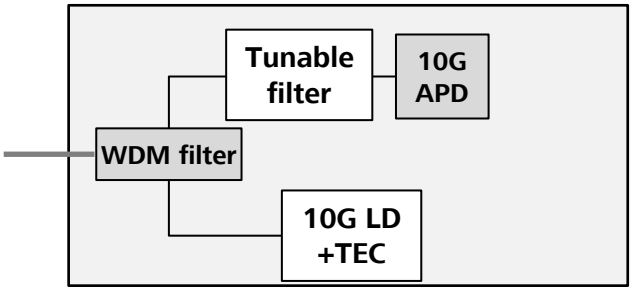
Fix wavelength single 25G transceiver

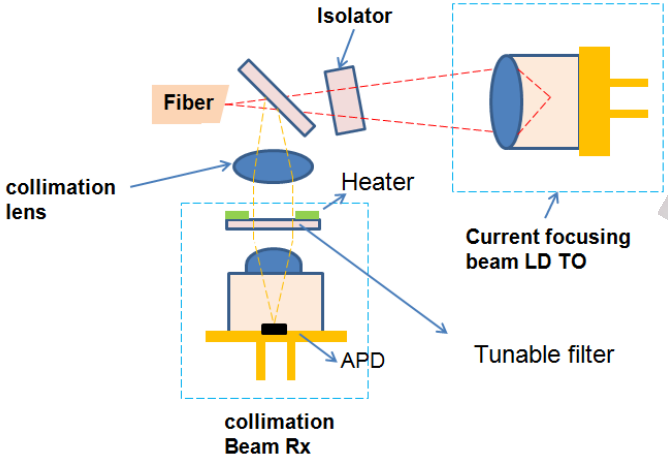
- **If we consider a fixed wavelength 25G TRx, the lowest cost solution:**
  - > 20nm operating wavelength band
  - uncooled operation, No TEC
  - downstream and upstream wavelength separation > 35 nm



Single channel Fix wavelength Cost		
	Cost	Note
1*10G LD	X	P(LD)= P_0
1*10G receiver	Y	R(APD)= R_0
1* WDM	~0	Negligible
Total	1*X+1*Y	

4*100GHz tunable transceiver



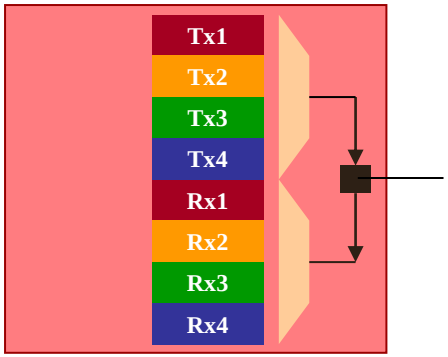


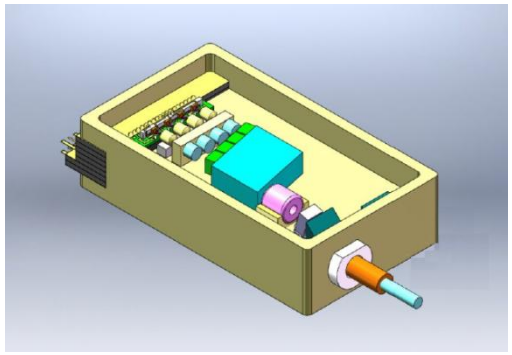
Thermal Tuning:
Tunable Tx: LD + TEC,
Tunable Rx: APD + tunable filter

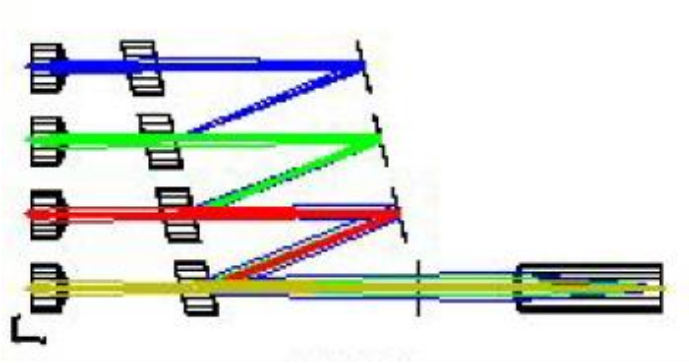
Item	Fix Rx	Tunable Rx
TO Cap	√	√
TO Header	√	√
collimate lens		√
Heater		√
Tunable Filter		√
filter Submount		√
Focus Lens	√	√
APD	√	√
TIA	√	√
Capacitors	√	√
Thermistor		√

4* 100GHz DWDM tunable TRX		
	Cost	Note
1* 10G LD	1.2 X	DWDM Wavelength, more accurate λ0
1*TEC	~0.6 X	Including packaging, submont, thermistor
1*10G APD	1.2 Y	R = R0 -1dB(due to the extra loss of TF)
Tuning parts	0.8Y	collimated Lens, TF
WDM	~0	
Total	1.8 X + 2 Y	

4 wavelength Arrays







- Assumption
  - Single fiber bidirectional 4 λ
  - CWDM ,>20nm spacing, uncooled
  - Same launch power /sensitivity
  - Based on discrete components rather than optical integration

	4 *10G TRx Array cost	
	Cost	Notes
4* 10G LD	4*1.25 X	3dB more output power from LD chips
4* 10G APD	4*1.5 Y	3dB higher sensitivity
WDM	Z	comparable to X+Y
Total	5X+6Y+Z	~ 6X+7Y

Reasons optical integration is not suitable for access

- The yield of 10G typical optical chips are still low, integration will significantly increase the cost due to the rapid yield decreases
  - 10G EML yield << 50%
  - 10G DFB yield < 50%
  - 10G APD yield < 50%

- The main stream packaging technology for OSA is still active alignment, the coupling efficiency for each chip need to be optimized one by one. Array packaging is more difficult than for a single chip.
- Integration introduces additional loss which cannot be tolerated in access systems

Summary

- The cost of tunable optics will be more expensive than fixed wavelength optics (2 times more than fixed)

- The cost of 4 λ transceiver arrays will be much higher compared with tunable optics (3 times more than tunable).

- 100G EPON should focus on 25Gb/s single transceiver ONUs from the low cost consideration.