Fixed and Tunable Options for 100Gb/s EPON

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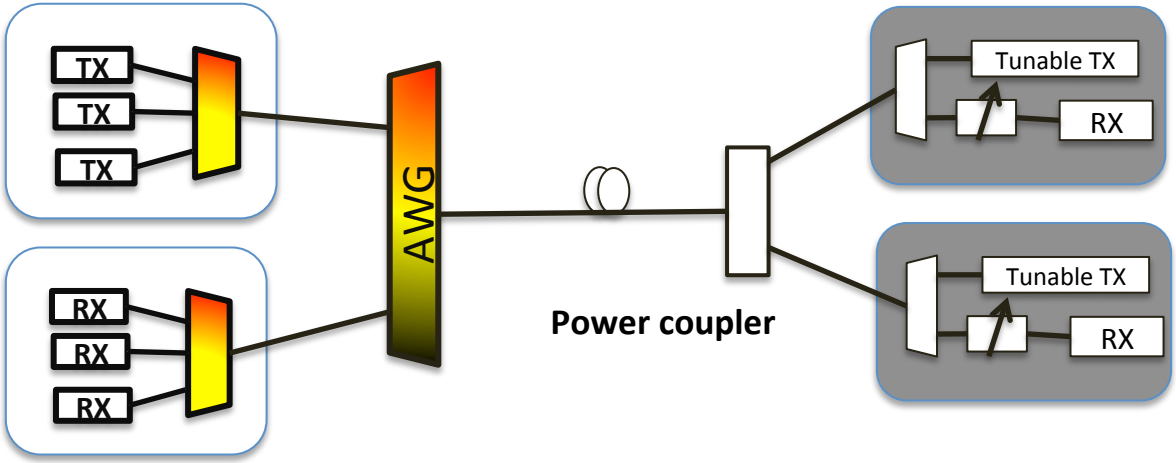
Outline

- WDM PON with tunable or fixed optics
- 100 Gb/s EPON build on tunable optics
- 100 Gb/s EPON build on fixed optics
- 100 Gb/s EPON with fixed and tunable optics

Tunable Optics and Wavelength Select WDM PON

Wavelength Select WDM PON with tunable optics

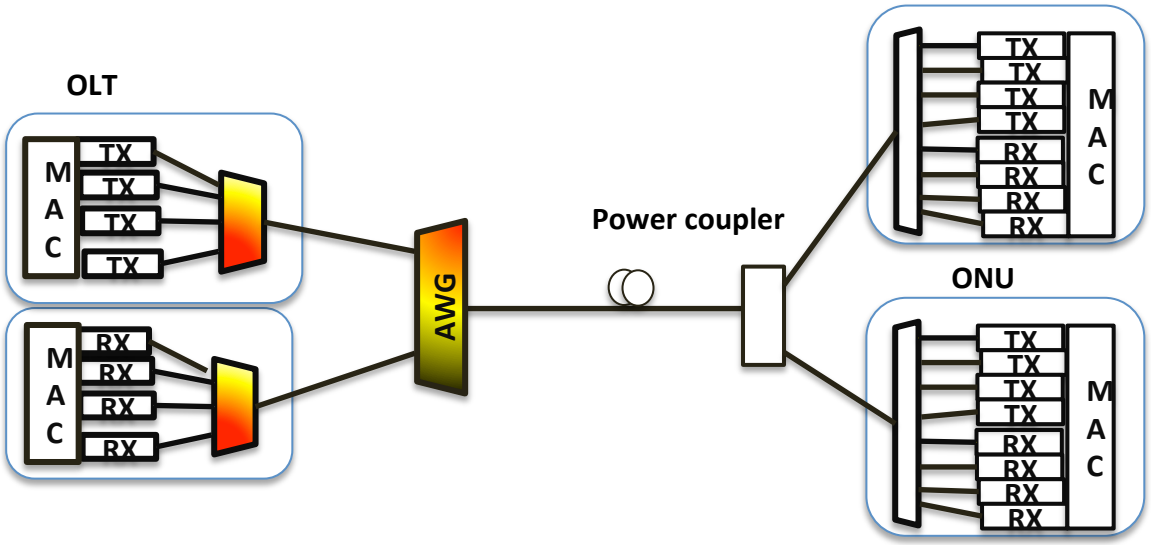


Wavelength Select WDM PON

- Each ONU is assigned a wavelength by the OLT
- Normally it is a signal channel system
- No channel bonding

- **Wavelength selection can be achieved by using tunable optics**
- **"Colorless" ONUs**
- **NG-PON2 is built upon WS-WDM PON**
- **High cost tunable optics**

Fixed Optics and Wavelength Broadcast WDM PON

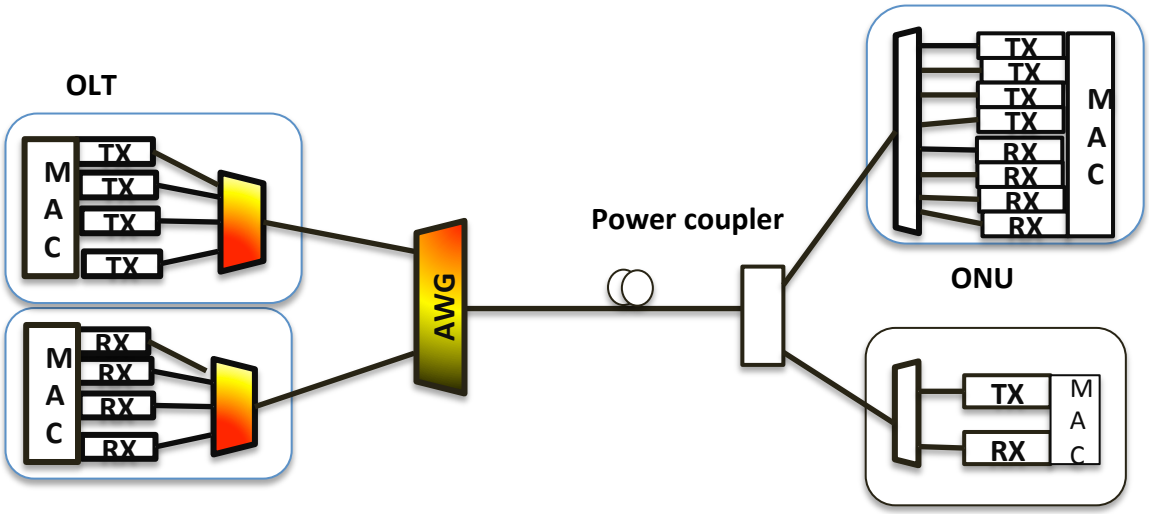


Wavelength Broadcast WDM PON

- No wavelength selection
- Each ONU receives all of the wavelengths
- Channel bonding could be used (due to the broadcat nature)

- Since there is no wavelength selection, fixed optics are used
- Low cost; but less flexible
- Multi-lane Ethernet uses point-to-point WDM in broadcast fashion
- However, if channel bonding is used in P2MP PON, mixed generations could cause problems
  - Some ONUs don't receive all the wavelengths

WS WDM PON with Mixed Generations



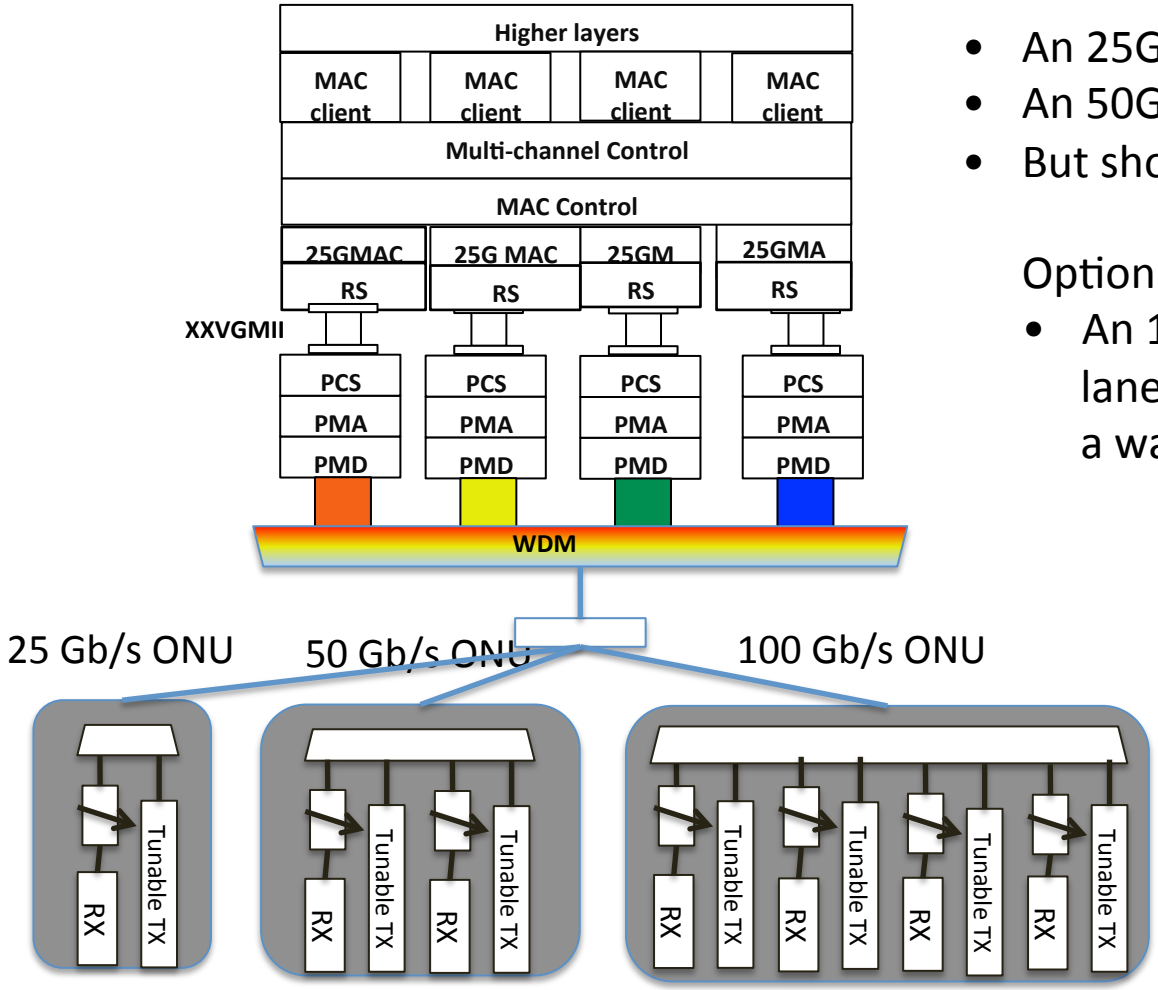
WS WDM PON with Mixed Generations

- Some ONUs are capable of receiving all the wavelengths
- Some ONUs only receive a subset of wavelengths
- Problems in wavelength plan and scheduling (addressed in a separated contribution)

Two solutions

- Use fixed optics, accept "color" ONUs, and allow some kind of "color" management
- Use tunable optics. Besides the high cost issue, we have to deal with some kind of "inconsistency" – tunable transceivers in a broadcast system

100G EPON with tunable optics in mixed generations



- An 25G ONU should tune to 1 channel
- An 50G ONU should tune to 2 channels
- But should 100G ONUs be tunable?

Option 1: 100G ONUs are tunable

- An 100G ONU receives from all 4 lanes, using tunable optics seems a waste

Option 2: 100G ONUs are fixed

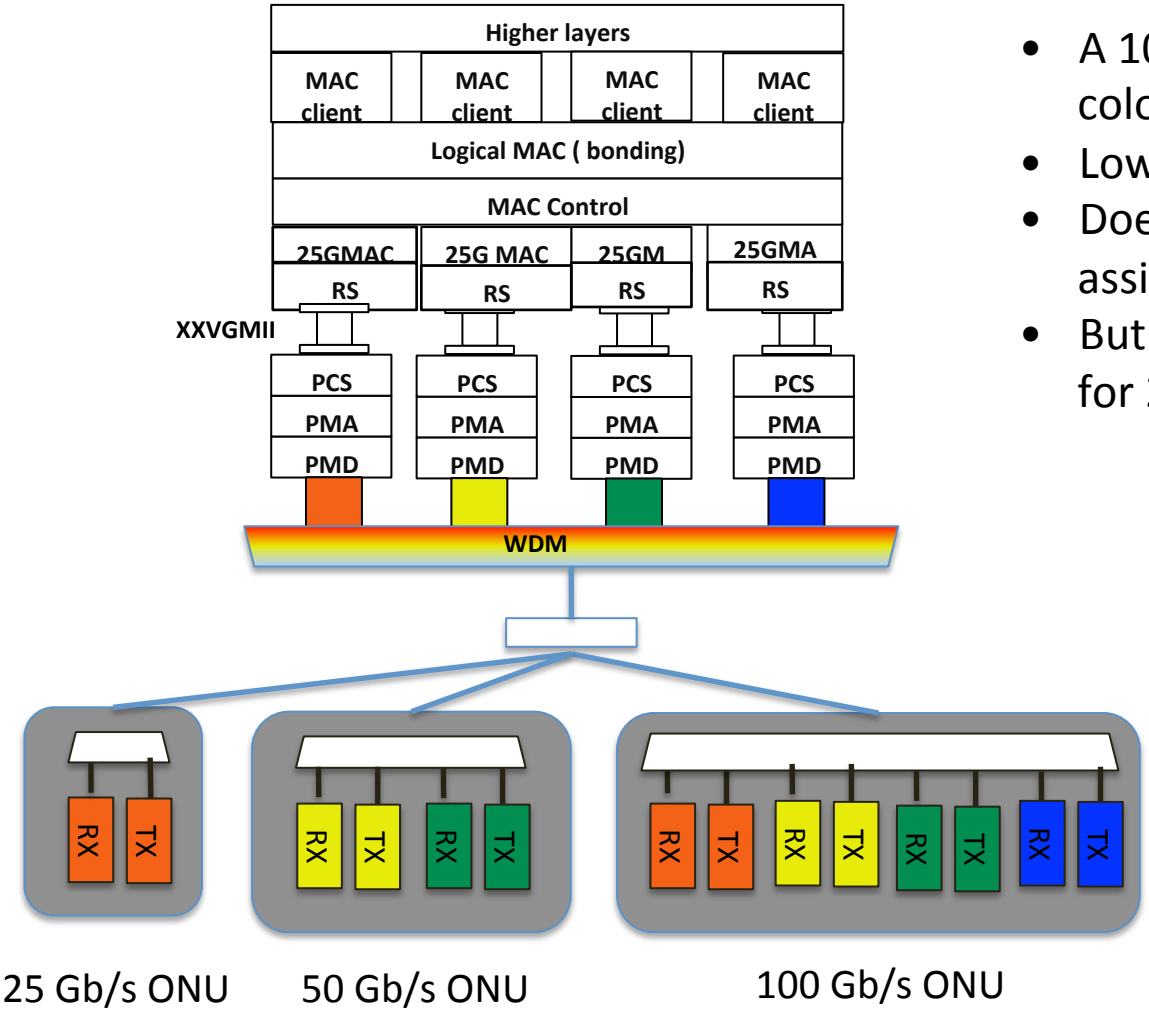
- Complications in wavelength assignment protocol – some ONUs do not accept wavelength assignment

100G EPON with tunable optics

- It is technically feasible from optical layer point of view; but need wavelength assignment protocol that could be complicated
- A 50G ONU needs two tunable optical transceivers; the cost of optics will very high
- A 100G ONU uses four tunable transceivers with even higher cost

More flexible, but multiple tunable optics will be very expensive

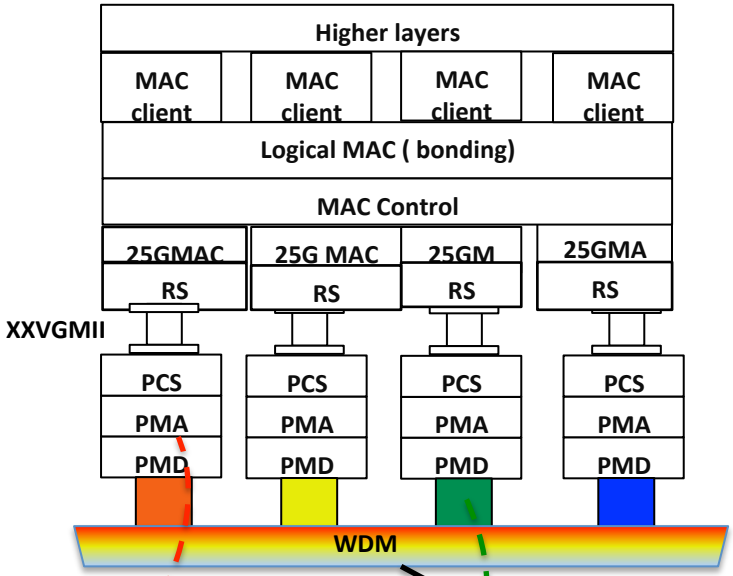
100G EPON with fixed optics in mixed generations



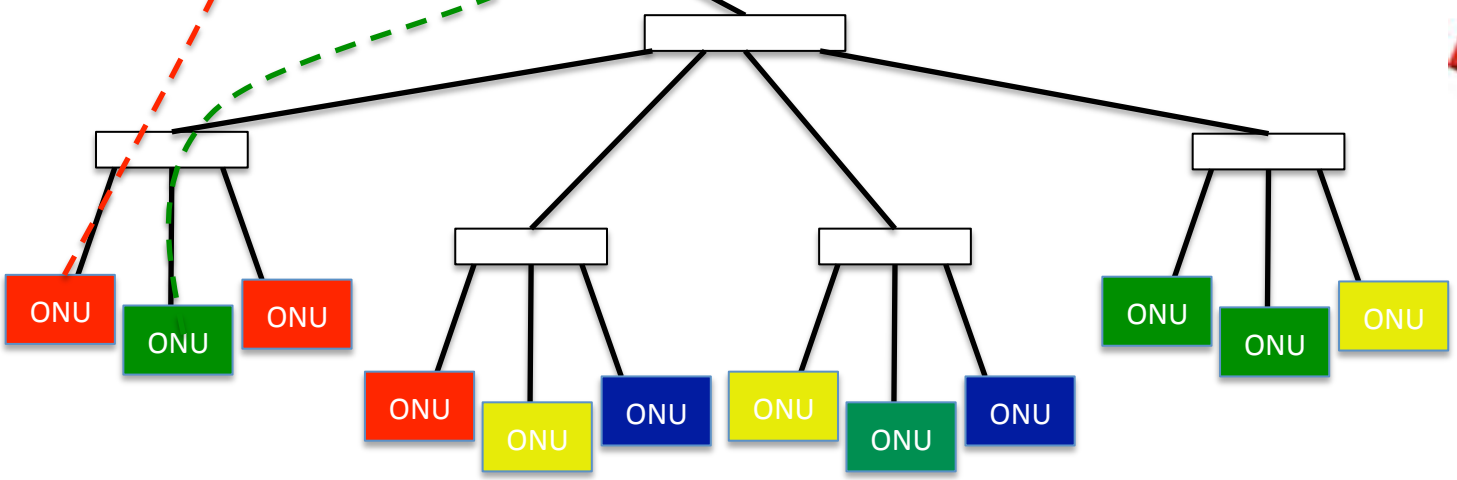
- A 100G ONU has all colors, no color management is needed
- Low cost fixed optics
- Doesn't need wavelength assignment protocol
- But color management is needed for 25G and 50G ONUs

Only need to manage four colors

To manage or not to manage… “colors”



- Since there are no filters in the ODN, an ONU with any color can be attached to any splitter port
- There is no color miss-match problem in WB-WDM PON (in contrast to WS-WDM PON)
- Color can be managed by inventory management (tight management)
- Color can be managed by “inventory + probability” (loose management)
- Variations in color distribution only affect traffic balance among the 4 lanes during the deploying period



100G EPON with fixed optics

- It is technically feasible from the optical layer and protocol layer
- A 100G ONU has all 4 colors, no color management is needed
- Need to manage colors for 25G and 50G ONUs
- Only need to manage a maximum of 4 colors
- Tight management: colors are managed by inventory control
- Loose management: colors are managed by bulk inventory control and deployed randomly

With minimum effort in color management, a 100G EPON with fixed optics is much simpler and has much lower cost

100G EPON with fixed and tunable optics

- 25G ONUs can used mixed fixed and tunable optics
  - Fixed optics for the 1st lane
  - Tunable optics for lane 2 to lane 4.
- A 50G ONU uses fixed optics for the 1st lane, tunable optics to tune from lane 2 to lane 4.
- A 100G ONU can choose to have 4 fixed wavelength transceivers

The cost will be in between fixed and tunable options, but mixed tunable and fixed ONUs will complicate wavelength assignment protocol

Conclusion

- A 100G EPON with tunable optics has to deal with the problem of using multiple high cost tunable transceivers in an ONU.
- With some effort in color management, a 100G EPON with fixed optics has much lower cost and is simpler
- A third option is to used mixed tunable and fixed optics but we need to consider the complication in wavelength assignment protocol

Thanks

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