Manage Colors for 100Gb/s EPON

Yuxin (Eugene) Dai

Cox Communications

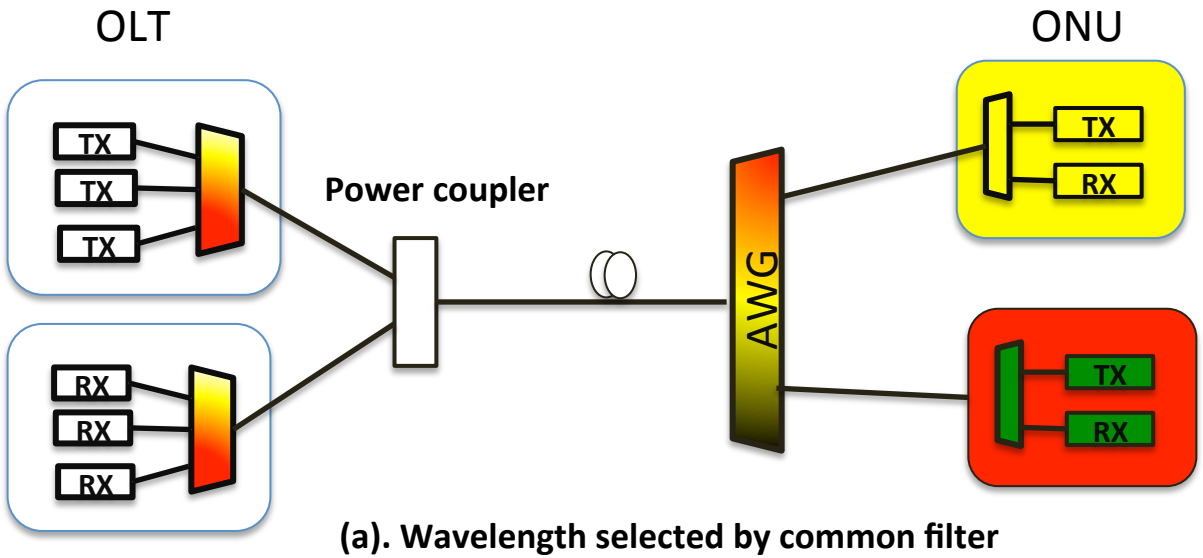
IEEE Interim meeting 100G EPON TF, January 2016

Atlanta GA, USA

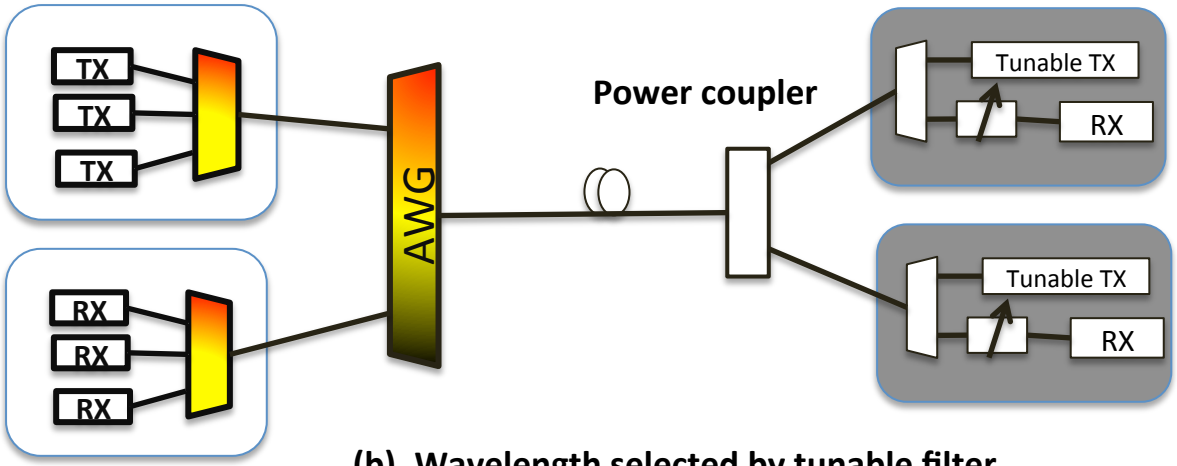
Outline

- Wavelength Broadcast WDM-TDM PON
- Wavelength Select WDM-TDM PON
- Color management
- Pay-as-grow of 25G EPON with WB WDM-TDM PON

Wavelength Select WDM PON



(a). Wavelength selected by common filter



(b). Wavelength selected by tunable filter

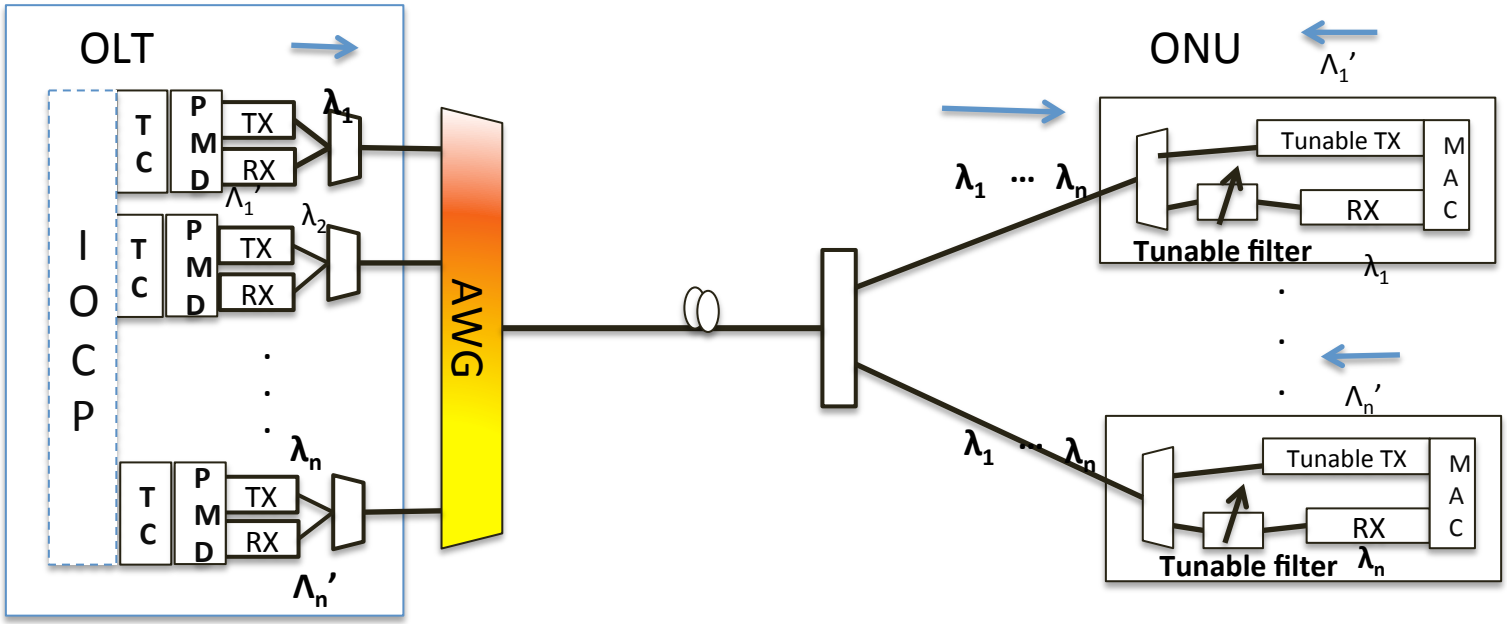
- Wavelength is selected by filters
- Low cost optics
- "Color" ONUs

- Wavelength is selected by tunable optics
- "Colorless" ONUs
- NG-PON2 is build upon WS-WDM PON
- High cost tunable optics

Color management in WS WDM-PON

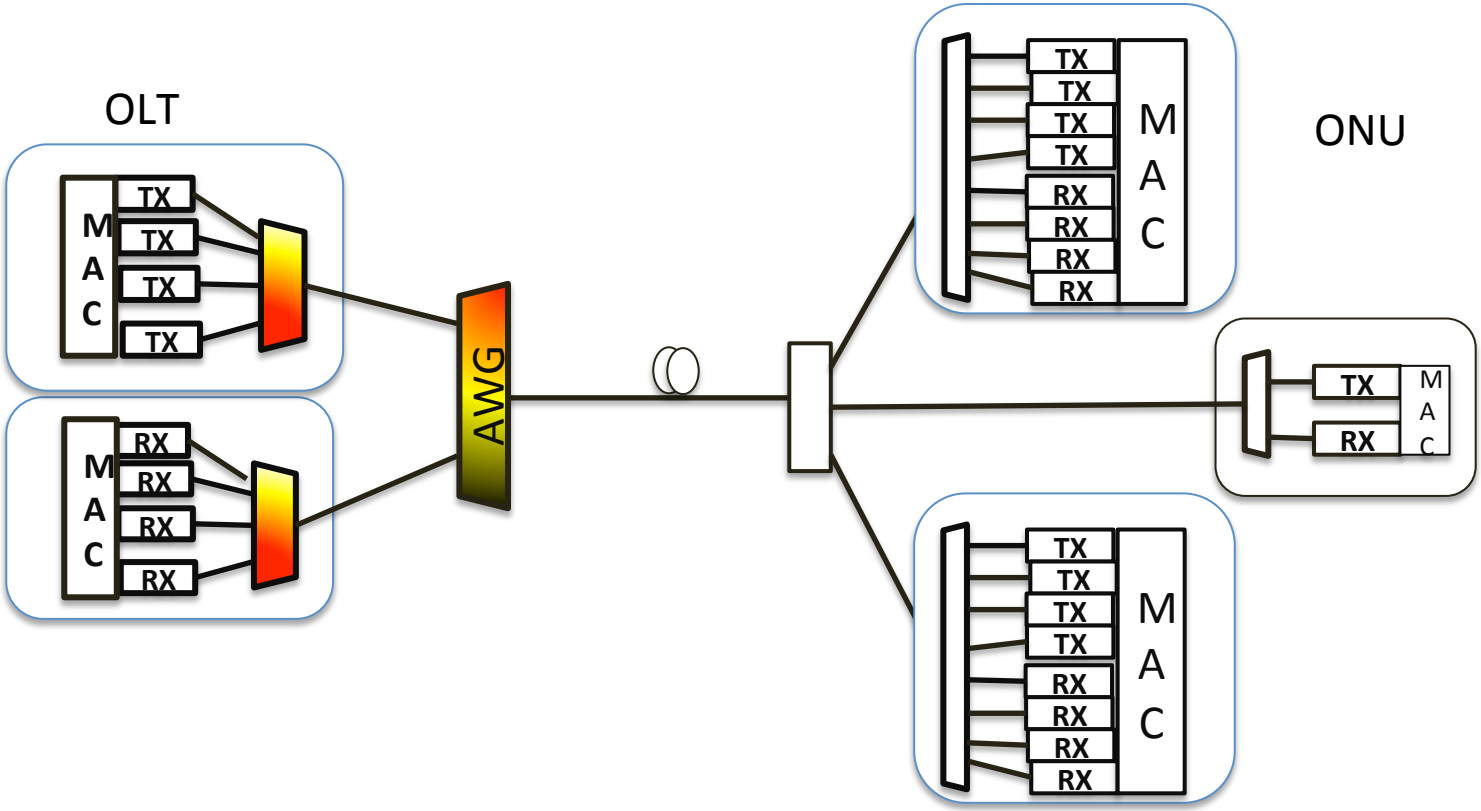
- "Color" is managed by fixed common filters or tunable filters
- Fixed common filters result in "color ONU"
- Tunable filters result in "colorless ONU"
- Colorless ONU is considered as a general requirement
- However tunable optics for ONU has consequences:
  - High cost of tunable laser and tunable filter
  - The complication of tuning protocols; may need out-of-band signing
  - Integration issues of tunable laser and tunable filter
  - The limitation of tuning range
    - Limits how many channels can be covered
    - Require DWDM grade
- Form low cost prospective it is not a preferred choice for EPON.

WS WDM-TDM PON (NG-PON2)



- Hybrid WS-WDM PON and TDM PON
- No wavelength domain scheduling besides initial wavelength setup
- Data traffic is scheduled in TDM domain
- Maximal data rate = channel rate
- Channel aggregation instead of channel bonding

Wavelength Broadcast WDM PON

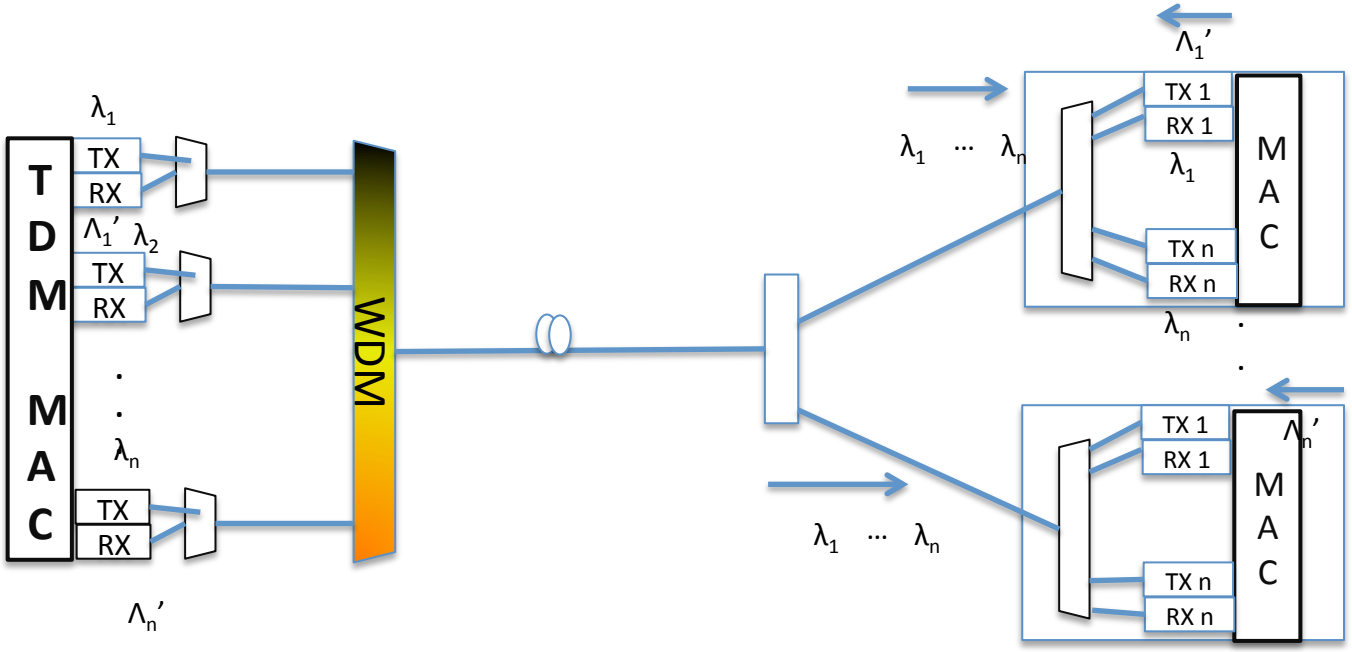


- **No wavelength selection; wavelengths are broadcast to all ONUs**
- **Low cost optics; but less flexible**
- **It could support mixed generation at the cost of efficiency or complexity**

Wavelength Broadcast WDM and Ethernet

- Parallel WDM with fixed colors are used recently in high-speed Ethernet
- 40G, 100G and 400G Ethernet all use parallel WDM with fixed wavelength
- Parallel WDM with fixed colors is WB-WDM, if used in PON it will be WB-WDM PON
- The advantage of fixed wavelength WDM is low cost optics which is essential for Ethernet
- The potential problems are lack of flexibility and color management

WB WDM-TDM PON (100Gb/s EPON)

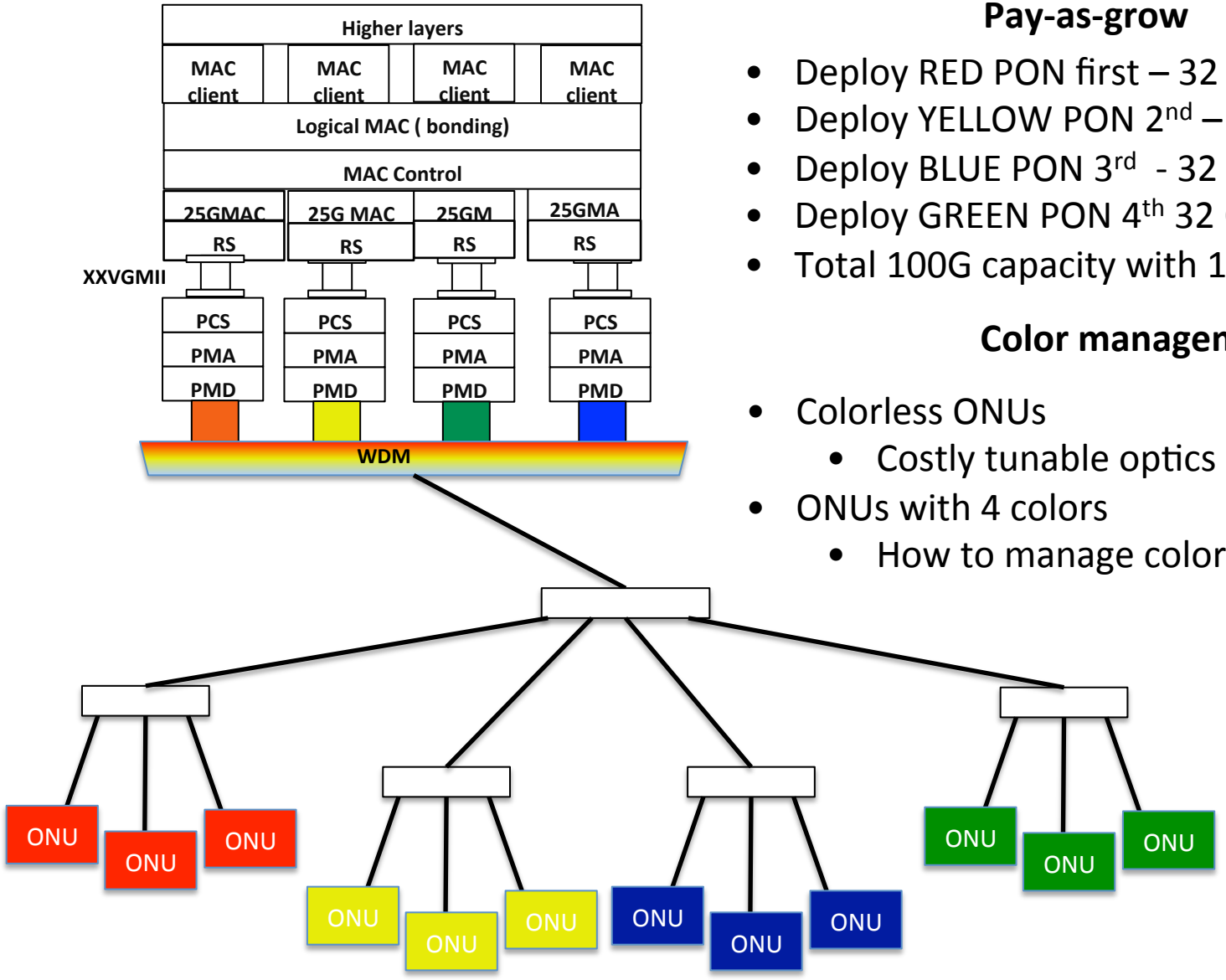


- Hybrid WB-WDM PON and TDM PON.
- No wavelength setup is needed
- Data traffic is normally scheduled in TDM domain
- Channel bonding could be at RS or MAC layers. With channel bonding the Maximal Data Rate = n x channel rate

Color management in WB WDM-PON

- In WB-WDM, “colors” are fixed, and broadcast to all ONUs
- An ONU receives all the wavelengths; and all wavelengths can be bonded together, such as in 100Gb/s ONU, there is no need for color management
- However, if “generations” are involved, there is a need to manage colors
  - 100G EPON only consist 25Gb/s ONUs
  - Mixed 25Gb/s, 50Gb/s, 75Gb/s and 100Gb/s ONUs
- One solution is using tunable optics at ONU: WS-WDM
- The better way is to manage colors within WB-WDM with fixed optics

100G EPON with 25Gb/s ONUs in pay-as-grow



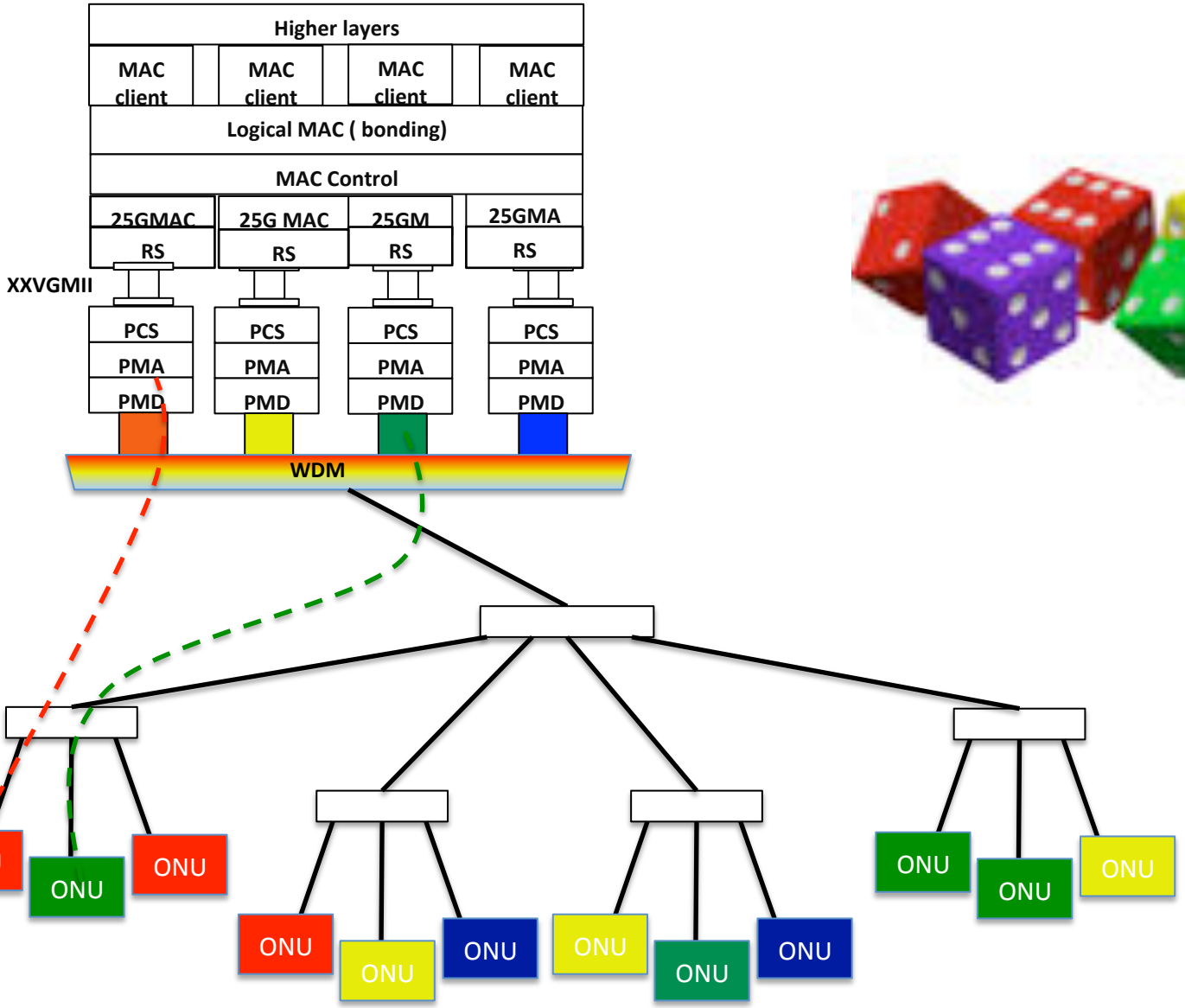
Pay-as-grow

- Deploy RED PON first – 32 ONUs, 25Gb/s
- Deploy YELLOW PON 2nd – 32 ONUs, 25Gb/s
- Deploy BLUE PON 3rd - 32 ONUs, 25gb/s
- Deploy GREEN PON 4th 32 ONUs, 25Gb/s
- Total 100G capacity with 128 ONUs

Color management

- Colorless ONUs
  - Costly tunable optics and complications
- ONUs with 4 colors
  - How to manage colors?

Manage colors by probability



Color management with fixed wavelengths

- There are 4 types of 25Gb/s ONUs with 4 colors
- Since there is no filters in the ODN, an ONU with any color can be attached 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
- Color can be managed by probability
- Variations in color distribution only affect traffic balance among the 4 lanes during the deploying period

Conclusions

- 100G EPON with 4 types of fixed wavelength ONUs in a pay-as-grow model is feasible
- Color can be managed by probability or by inventory management
- The traffic in all 4 lanes will be balanced when the 100G EPON is fully loaded

Thanks

Eugene.dai@cox.com