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"Pay as You Grow" or Mortgage Model?

- The Needs for Standalone 25G EPON

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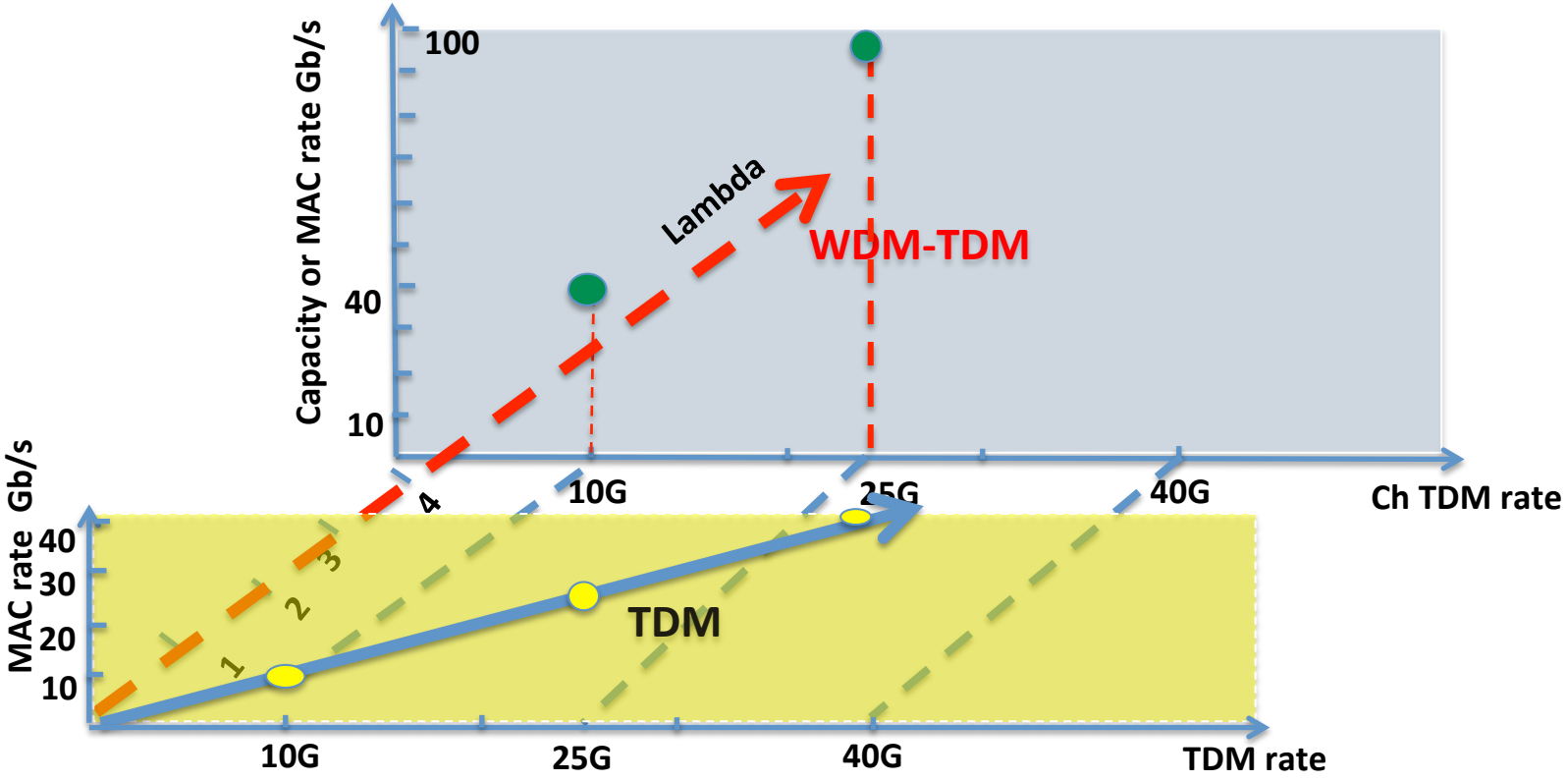
Outline

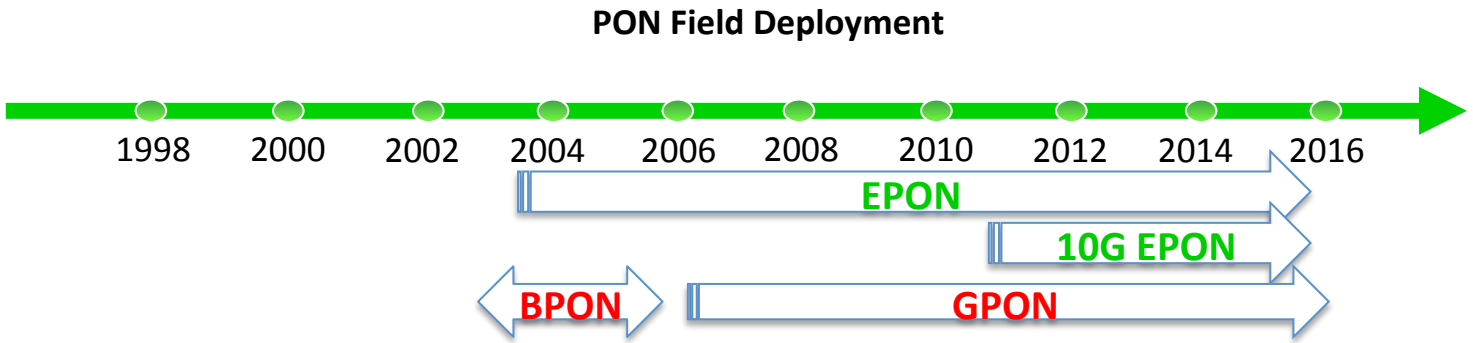
- Lessons learned
- “Pay as you grow” or mortgage model?
- Leverage single channel 25G and multi-channel 100G ONUs

Historical path of parallel TDM and WDM



- Consider WDM after TDM meets bottlenecks
- Single channel TDM and WDM coexist (for economics, difference in needs, etc)
- Next TDM rates may become feasible in the future

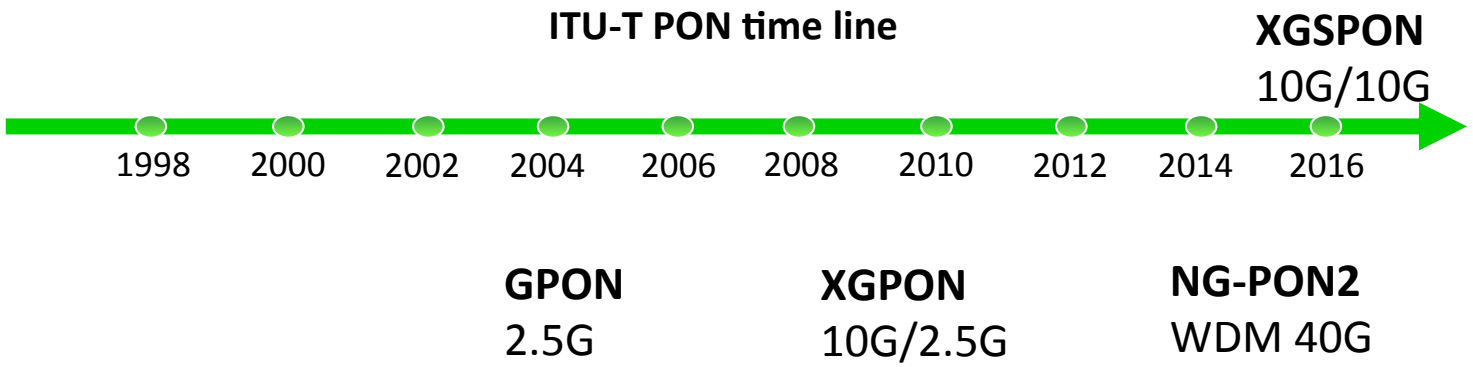
A Historical view of PON deployment



- An access network rate will last for many years.
- GPON has been deploying since 2006 (>16 years). GPON deployment may already pass the peak volume, but the deployment is continuing
- 10G EPON has been deploying since 2010 (6 years), the volume is still small. Therefore, 10G EPON still has several years to reach its peak (another 10 years?)

- **When 25G EPON starts to deploy, we expect that there will be many years (10?) for 25 Gb/s EPON reach its peak before the noticeable 100G EPON deployment begins**
- **During this time period optimizing 25G EPON for low cost is the key**

Lessons learned



- FSAN/ITU-T completed 4 ch (4X10G) NG-PON2 (basic configuration) in 2015
- Realized the needs for single channel symmetric 10G rates, FSAN/ITU-T adds 10G/10G XGSPON in 2016

Although multi-channel PON is feasible/available, it cannot replace the needs of single channel PON

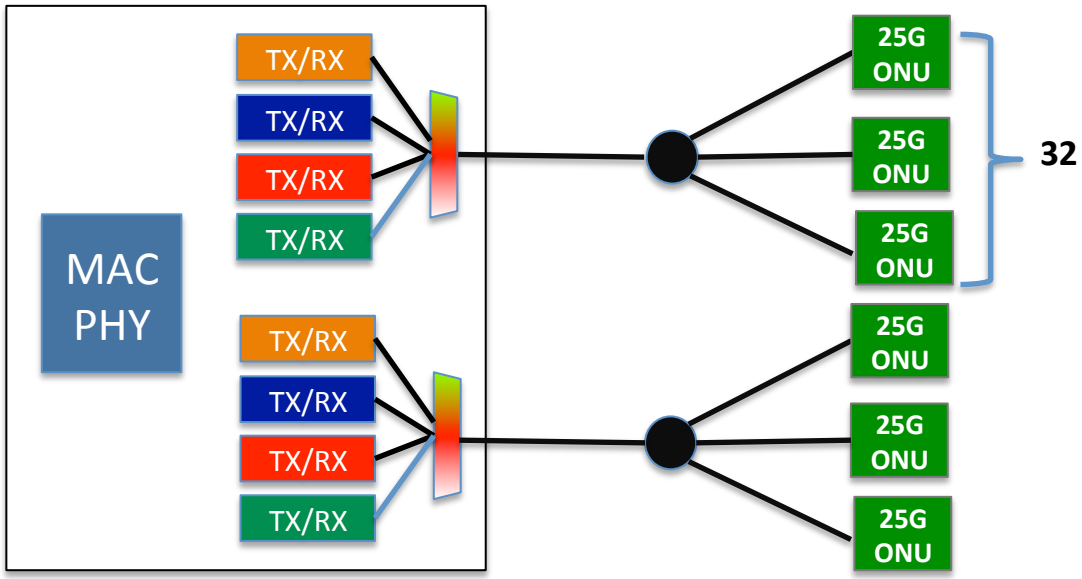
“Pay as you grow” or Mortgage model?

- “Pay as you grow” is often used to justify multi-channel PON with channel bonding
- The concept could be misleading if not used carefully
- Channel bonding exists for its own reasons
- Unconditionally believing in “pay as you grow” could end up with a 30 year mortgage model
  - Mortgage model: pay too much interest at the front
  - “Pay as you grow”: invest too much at the front for the uncertain needs and technologies of the future
- For the first 10 years or so after initial deployment, single channel 25G EPON will be dominant

Optimizing single channel 25G EPON for the economy is key for the success of 25G EPON as well as 100G EPON

“Pay as you grow” or Mortgage model ? -Scenario 1

8 ports line card with integrated WDM



Assumptions

- 8 ports/line card
- 10 line cards/chassis

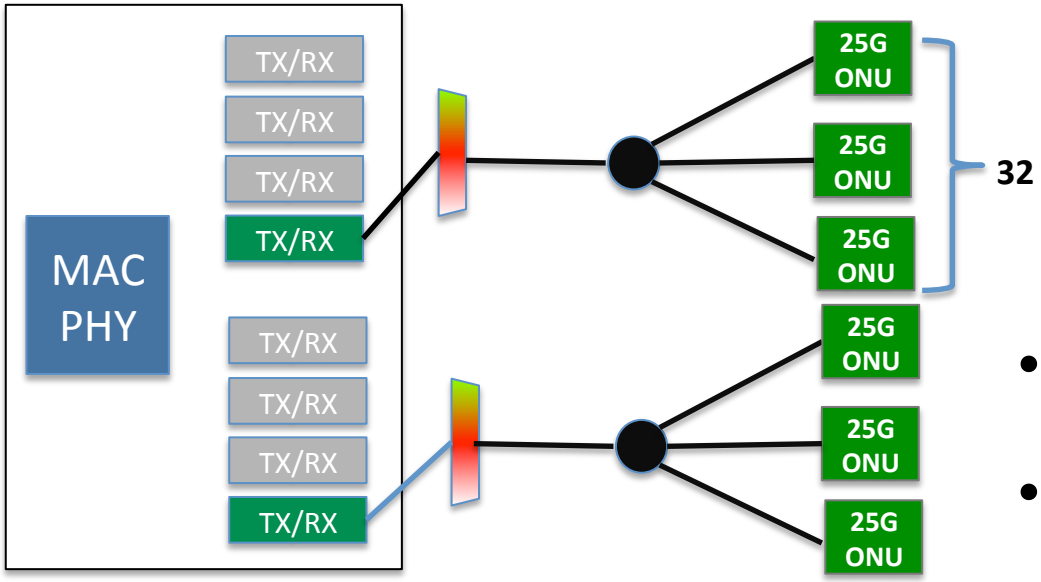
Total density (1st phase 25G only):

- Integrated WDM
  - 20 PONs, 640 ONUs
- Standalone 25G EPON
  - 80 PONs, 2560 ONUs

Large amount of resources and investments are reserved for the uncertain future – mortgage model

“Pay as you grow” or Mortgage model? - Scenario 2

8 ports line card with external WDM



Assumptions

- 8 ports/line card
- 10 line cards/chassis
- 2 plugin 25G transceivers/ card

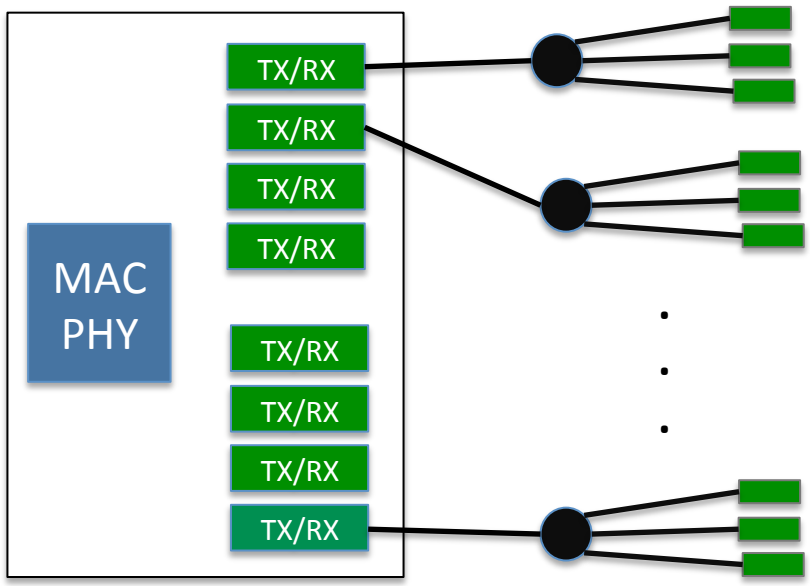
Total density (1st phase 25G only):

- Integrated WDM
  - 20 PONs, 640 ONUs
- Standalone 25G EPON
  - 80 PONs, 2560 ONUs

- **The initial cost is marginally lower than integrated WDM case**
- **There are still large amount of resources and investments are reserved for the uncertain future – mortgage model**

“Pay as you grow” or Mortgage model? -Scenario 3

8 ports line card with all 25G TX/RX



Assumptions

- 8 ports/line card
- 10 line cards/chassis
- 8 transceivers/card

Total density(1st phase 25G only):

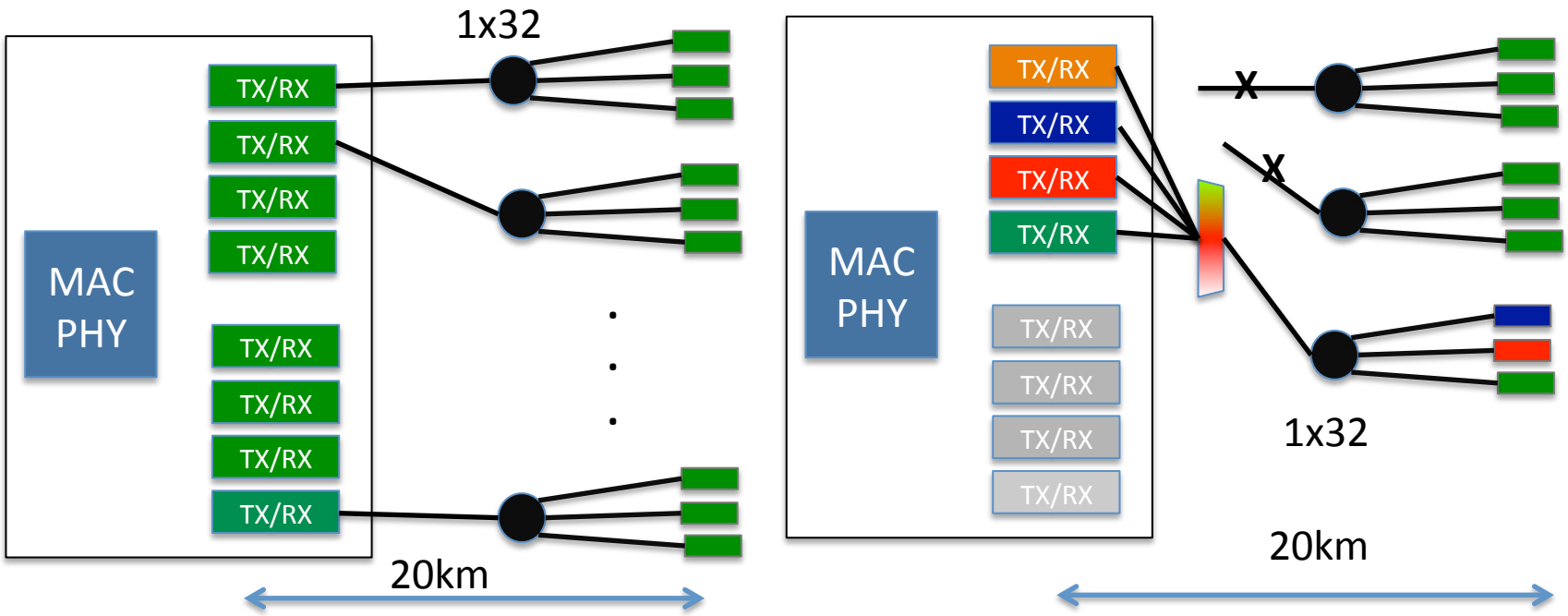
- All 25G TX/RX at OLT
  - 80 PONs, 2560 ONUs
- Standalone 25G EPON
  - 80 PONs, 2560 ONUs

- **Finally, are we get “pay as you grow”?**
- **The answer is no. This configuration has problems when migrating to 50G and 100G ONUs**

Migration to 100G in Scenario 3

8 ports line card with all 25G TX/RX

Migrate to 100G case 1

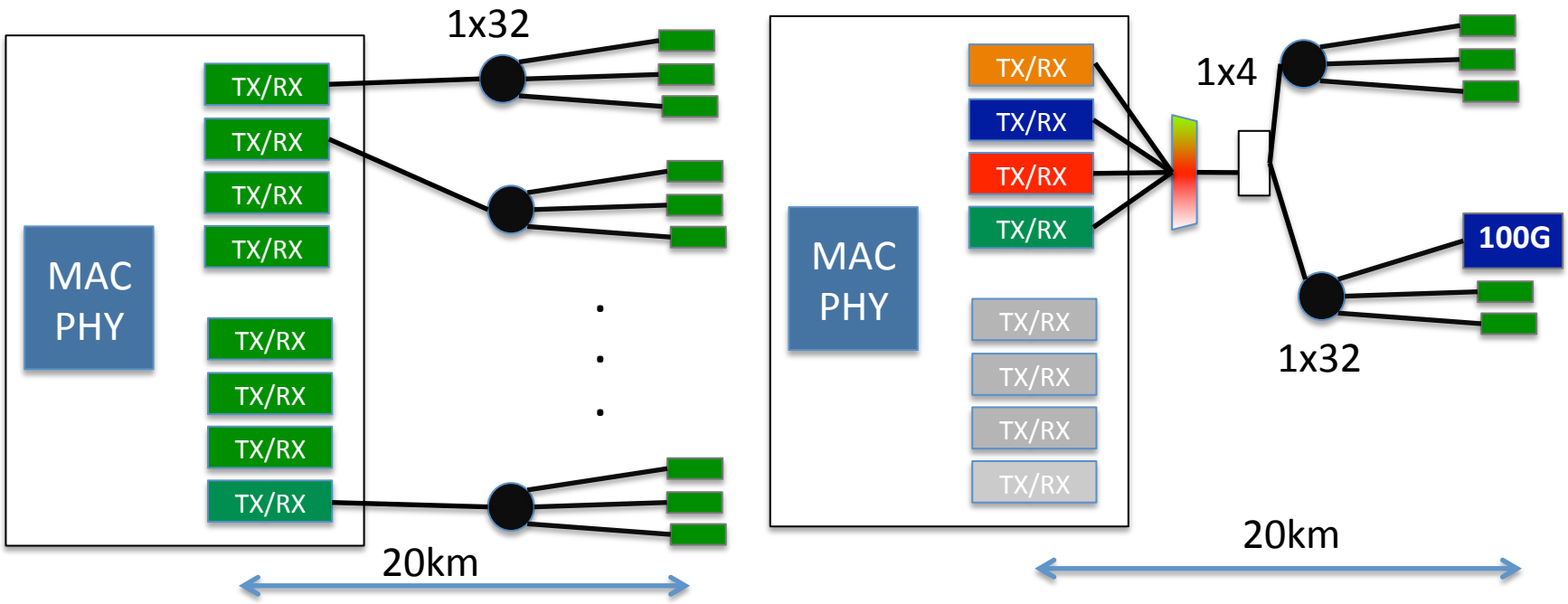


- **Limited optical power budget, only one ODN can be attached to the WDM, other 3 ODNs have to be disconnected**
- **New chassis have to be added to support other ODNs**
- **This is not "pay as you grow"**

Migration to 100G in Scenario 3 (continue)

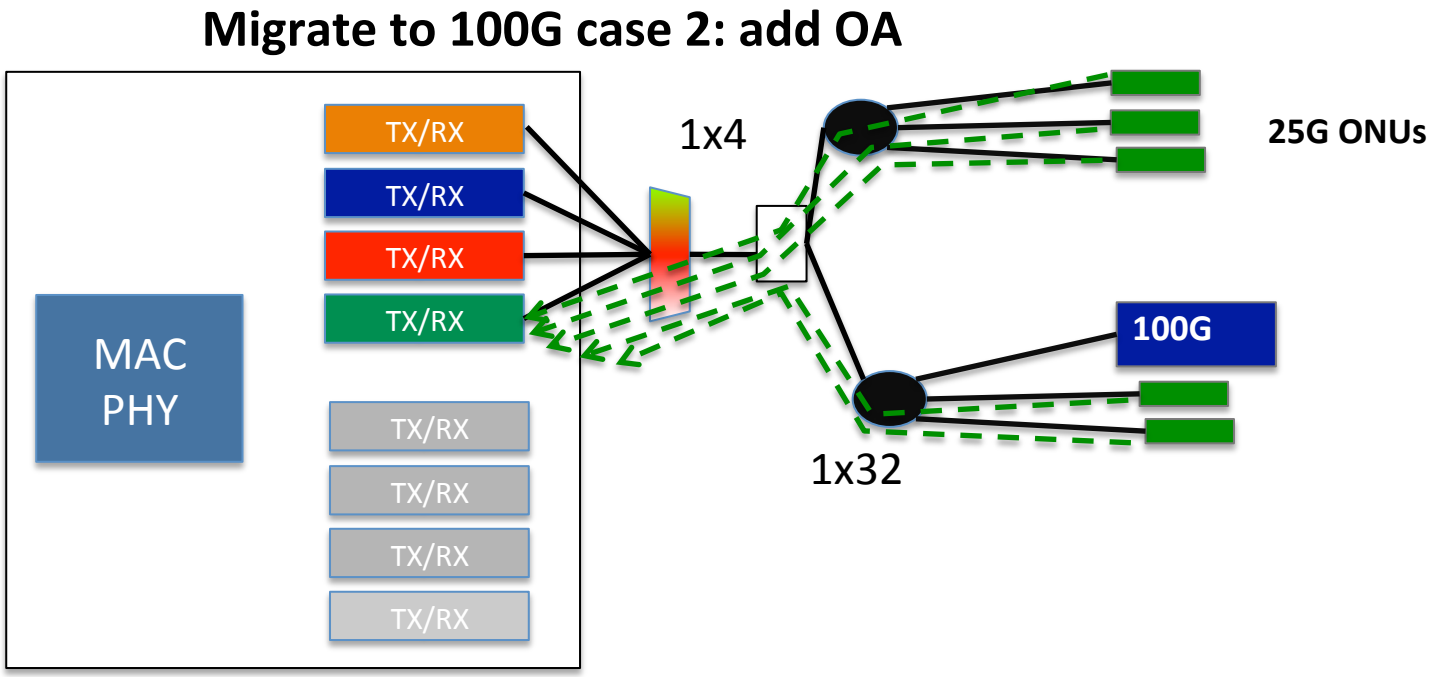
8 ports line card with all 25G TX/RX

Migrate to 100G case 2: add OA



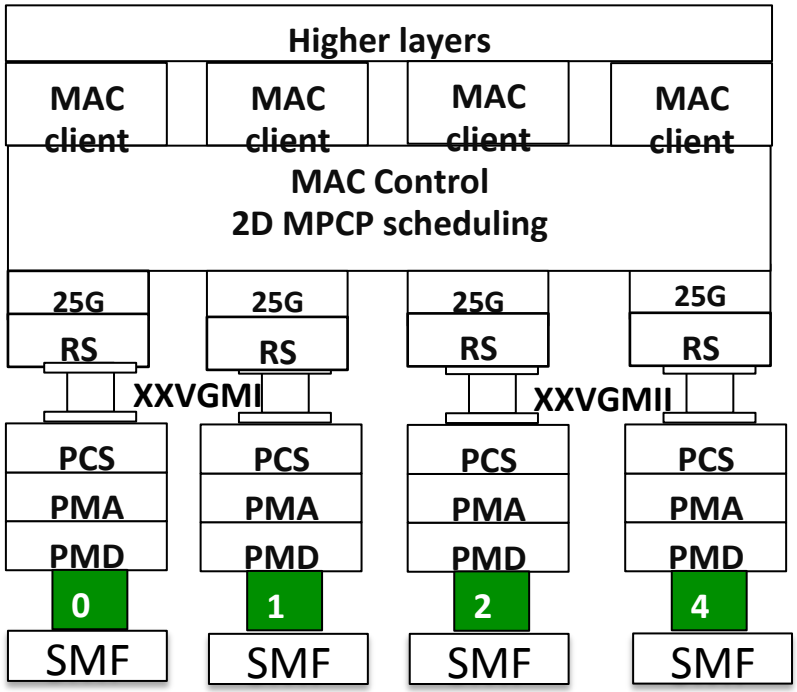
- **Assuming that adding an optical amplifier will provide needed gains (>=7dB)**
- **Then, all the 8 ODNs can be attached to a line card. Is this a "pay as you grow" scenario? The answer is still no.**

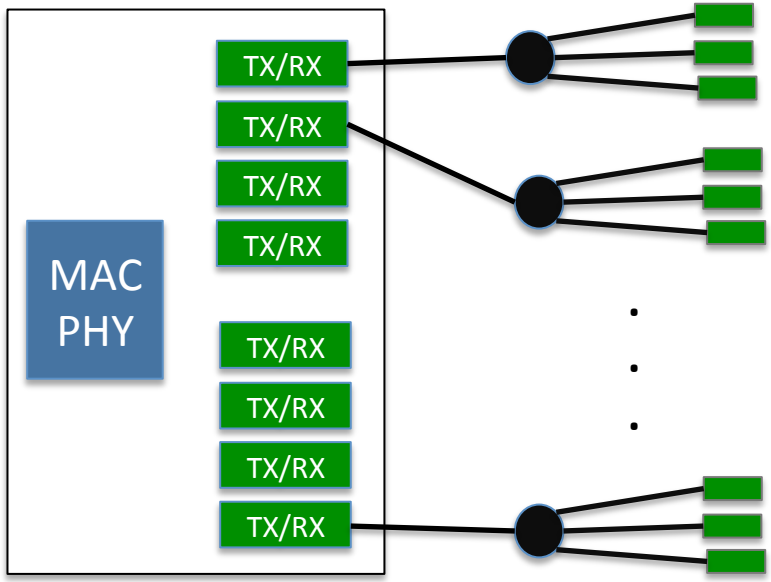
Migration to 100G in Scenario 3 (continue)



- When upgrading to 100G, even if there is only one 100G ONU in the ODN, all other 25G ONUs have to be redirected to lane 0.
- Therefore, the average bandwidth of a 25G ONU has is approximately ¼ of its average bandwidth before the upgrade
- This is definitely not what one would expect for “pay as you grow”

Leverage single channel 25G and muti-channel 100G architectures





- Allows 4 X 25G architecture without channel bonding
- At least one pair of the wavelength is in the O band for 25G channels
- This requirement does not conflict with channel bonding requirements
- A 2D scheduler can also schedule 4 independent channels

Conclusions

- Optimizing single channel 25G EPON for economy is the key for the success of 25G EPON as well as 100G EPON
- 4 X 25G architecture without channel bonding should be allowed
- At least one pair of the wavelength should be in the O band for the 25G channels
- This requirement does not conflict with the channel bonding requirements

Thanks

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