# Consideration of WDM filter loss for 100G EPON

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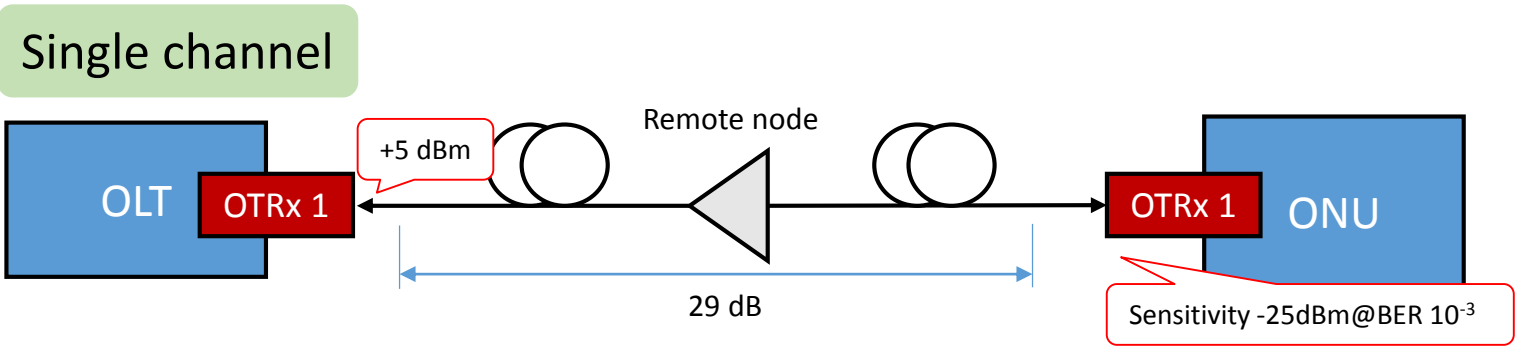
# Motivation

- In the 100G EPON, OLT and ONU will use optical filters to multiplex and to demultiplex WDM downstream and upstream signals.
  - MUX, DeMUX, band splitter and so on.
- To compensate insertion loss of optical filters, an output power of 100G EPON optical transceiver must be increased.

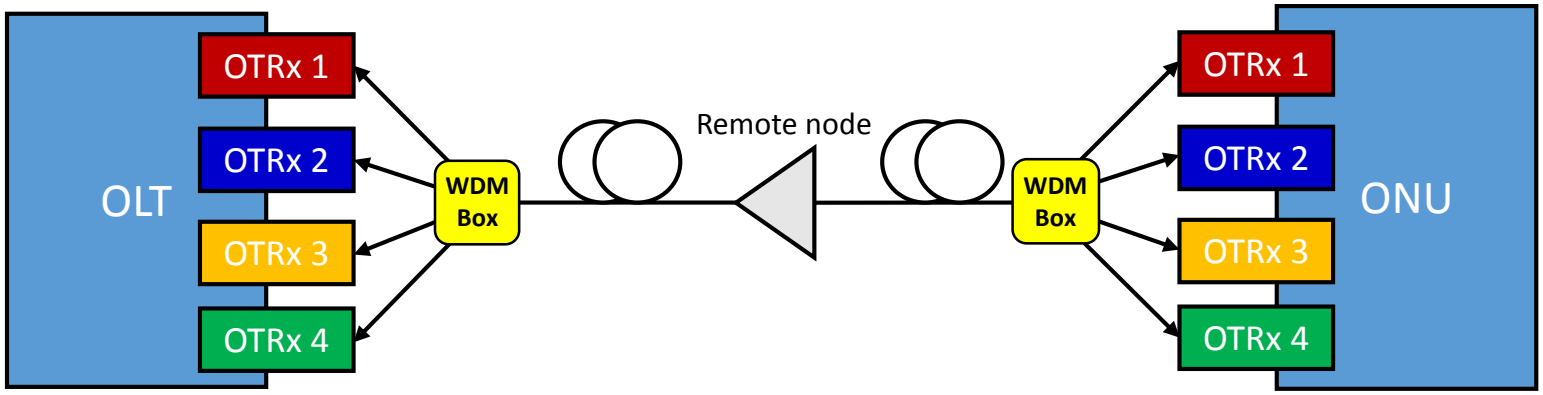
# Single channel 100G EPON




- 25G EPON will use a single wavelength optical transceiver.
- In our previous contribution, we provided experiment results that an output power of O-band EML transmitter is +5 dBm@1309.5 nm with 7 dB of ER. And a measured average sensitivity of 25G APD receiver is -25dBm at BER $10^{-3}$.
  - http://www.ieee802.org/3/ca/public/meeting_archive/2016/03/lee_3ca_1_0316.pdf
- Single channel 25G EML Tx and 25G APD Rx can be used for single channel case of 100G EPON with PR30 power budget.

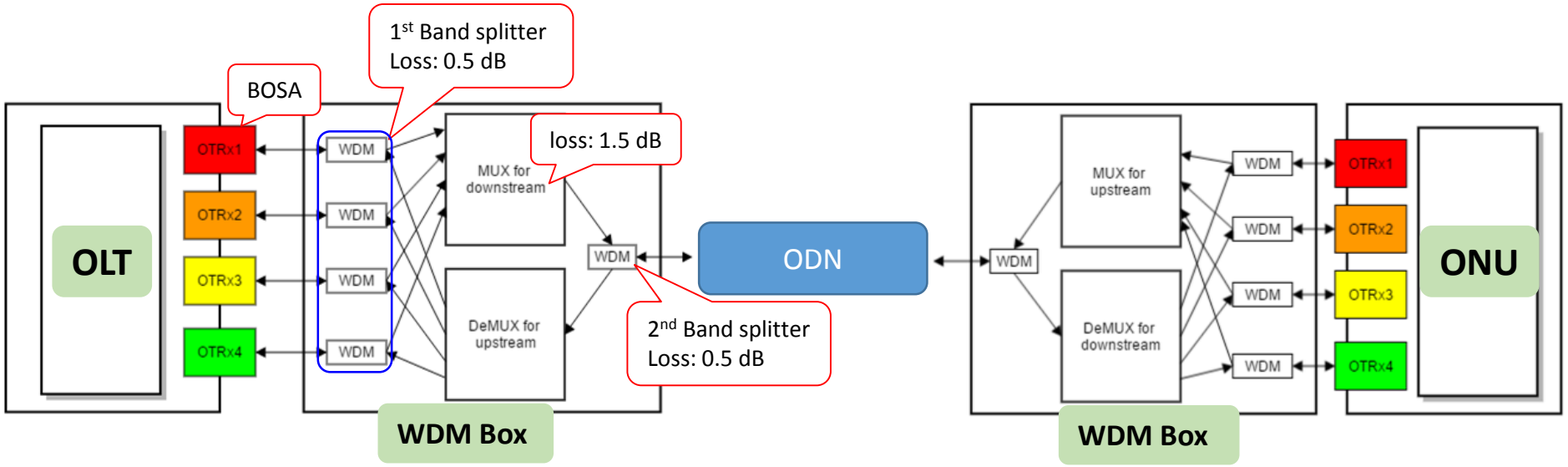
# Multi-channel 100G EPON

Multi-channel case




- 50G or 100G EPON will need multiple optical transceivers for WDM transmission.
  - BOSA is preferred due to a single output port of optical transceiver.
- 50G or 100G EPON OLT and ONU must have WDM box to multiplex and demultiplex downstream signals and upstream signals.

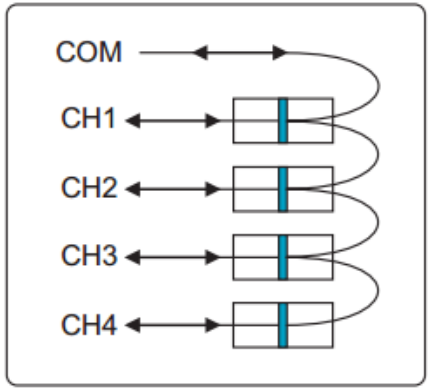
# WDM box configuration




- WDM box configure 1st band splitter, MUX, DeMUX and 2nd band splitter.
- Total insertion loss of WDM box is estimated to 2.5 dB, typically.
  - 4 channel MUX of LAN WDM filter has 1.5 dB of insertion loss.
  - If optical transceivers have dual ports than 1st WDM filter can be removed.

# Loss of LAN WDM filter

[Internal configuration]




**Performance Specification**

| Parameters | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operating Wavelength | | λop | 1280 | | 1330 | mm |
| Channels Number | | | | 4 | | |
| Channel Spacing | | | | 800 | | GHz |
| Channel ITU Wavelength | CH1 | λi | 1294.53 | 1295.56 | 1296.59 | nm |
| | CH2 | | 1299.02 | 1300.05 | 1301.09 | |
| | CH3 | | 1303.54 | 1304.58 | 1305.63 | |
| | CH4 | | 1308.09 | 1309.14 | 1310.19 | |
| Insertion Loss | Premium Grade | IL | | | 1.5 | dB |
| | Standard Grade | | | | 1.9 | dB |
| Passband Flatness | | | | | 0.5 | dB |

[Company A]

LAN WDM, 4 Channel, July 2008

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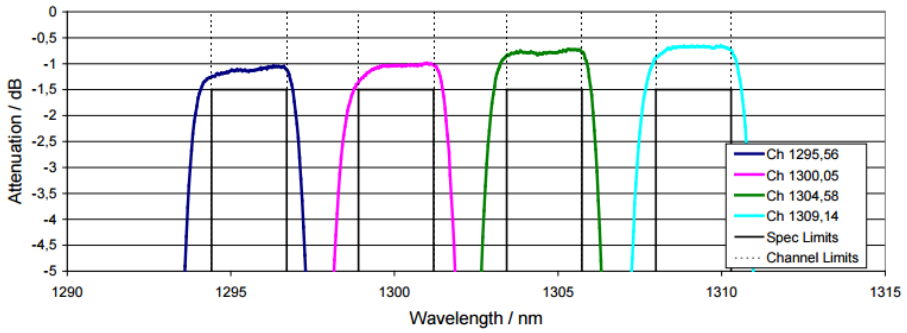


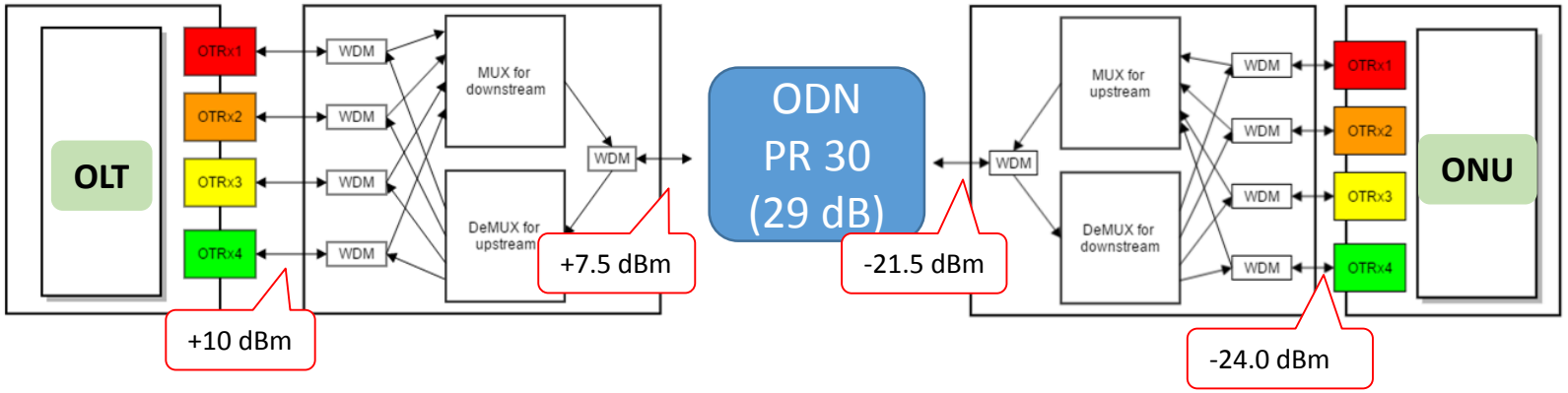

| Wavelength [nm] | 1295.56 | 1300.05 | 1304.58 | 1309.14 |
|---|---|---|---|---|
| Insertion Loss at 25°C [dB] | -1.26 | -1.37 | -0.87 | -0.91 |
| Insertion Loss (0°…70°C) [dB] | -1.38 | -1.48 | -0.90 | -0.91 |

Meets target insertion loss < 1.5 dB

[Company B]

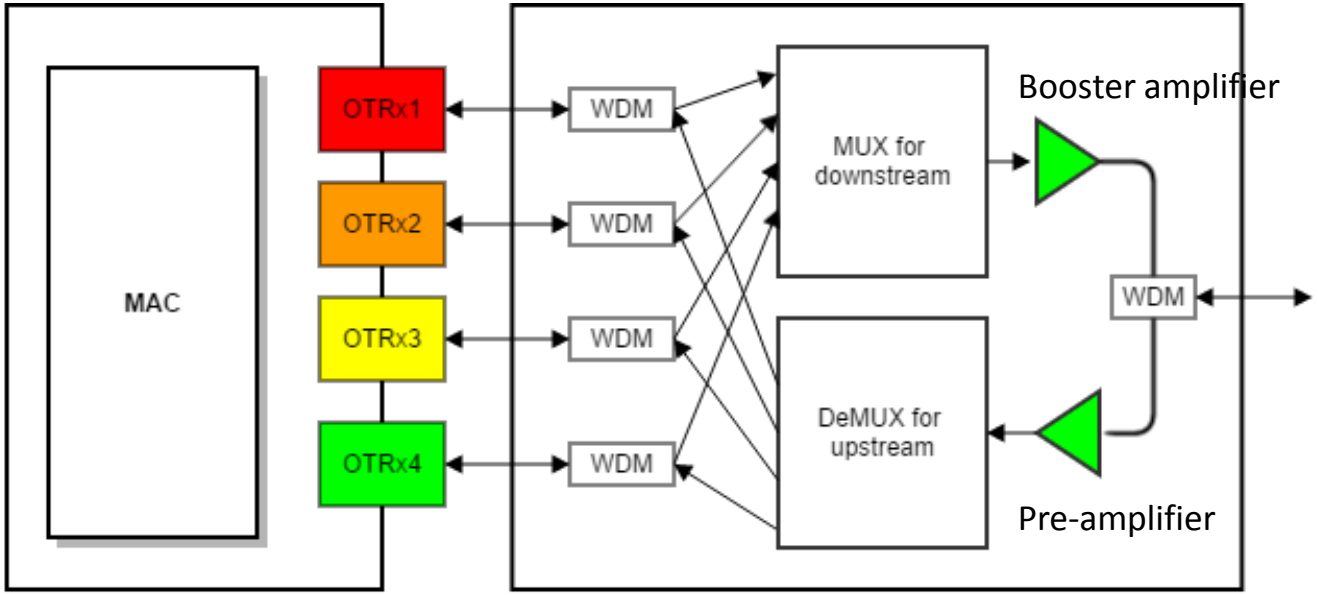
# Loss compensation of WDM box

- The output power of OLT transceiver will be increased as much as the total insertion loss of WDM box (OLT: 2.5 dB, ONU: 2.5 dB)
- For multi-channel 100G EPON, the output power of transmitter must be +10 dBm in front of the WDM box
  - Sensitivity of 25G APD Rx is -25 dBm@ BER $10^{-3}$
  - 29 dB of ODN loss




- +10 dBm output power would be achievable by using a cooled SOA integrated EML transmitter.
  - http://www.ieee802.org/3/ca/public/meeting_archive/2016/03/umeda_3ca_1_0316.pdf

# Optical amplifier




- Using external optical amplifiers at OLT is one candidate for compensating the insertion losses of WDM box in OLT and ONU.
- Considering low-cost, OLT must use a booster amplifier and a pre-amplifier for downstream and upstream signals rather than using the amplifier at ONU.
- A SOA can be applicable to O-band signal amplification.
- WDM crosstalk in SOA would be a huddle for 100G EPON application.

# Conclusion

- Multi-channel 100G EPON (50G or 100G capacity) will use optical filters for multiplexing and demultiplexing in front of optical transceivers.
- Loss compensation of WDM filters should be considered for N x 25G EPON.