NG-EPON

Coexistence Considerations

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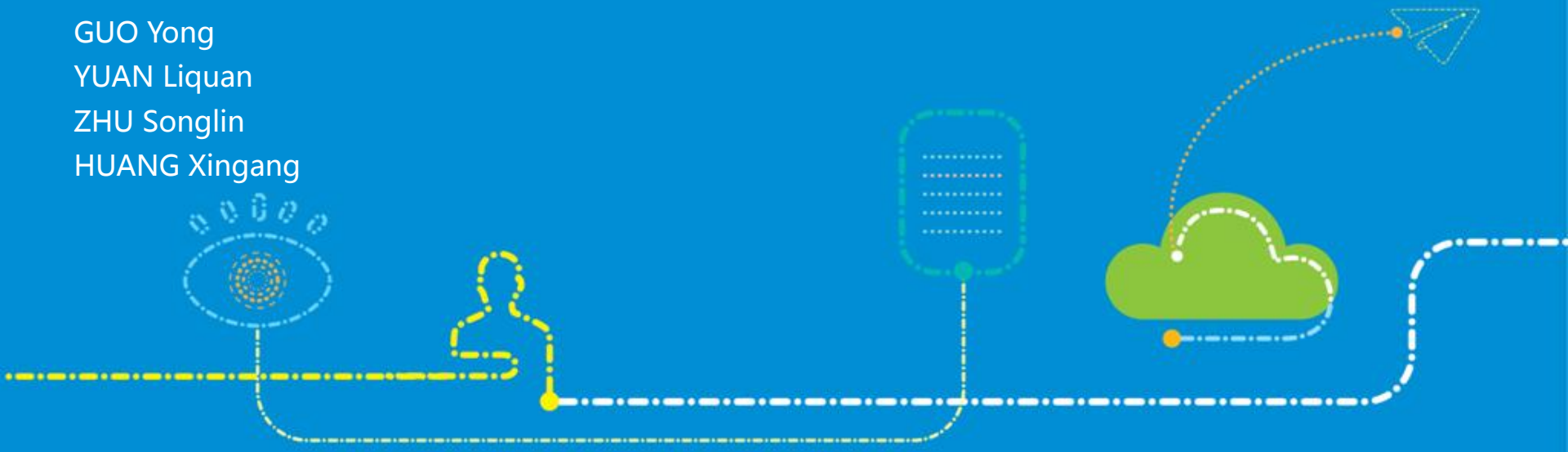

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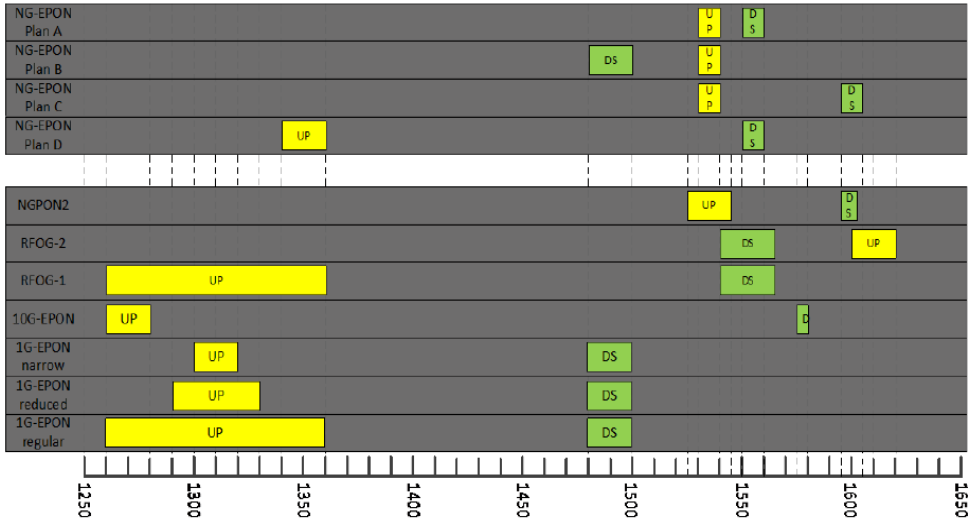
NG-EPON Objectives in Discussing

Objectives

- Support subscriber access networks using point to multipoint topologies on optical fiber
- PHY(s) to have a BER better than or equal to 10^{-12} at the MAC/PLS service interface (or the frame loss ratio equivalent)
- Support power budgets equivalent to power budgets defined by EPON in 802.3-2015
- MAC data rate of at least 25 Gb/s in downstream and at least 25 Gb/s in upstream
- MAC data rate of at least 25 Gb/s in downstream and at least 10 Gb/s in upstream
- MAC data rate of at least 40 Gb/s in downstream and at least 40 Gb/s in upstream

Should Coexistence Objective be Added?

As captured in NG-EPON IC report, 4 wavelength plans apply to 4 coexistence scenarios respectively



- Plan A for **1G-EPON, 10G-EPON, and NG-EPON**
  - Downstream 1550 nm and 1560 nm
  - Upstream 1530 nm and 1540 nm
- Plan B for **RFoG downstream, 10G-EPON, and NG-EPON**
  - Downstream 1480 nm and 1500 nm
  - Upstream 1530 nm and 1540 nm
- Plan C for **RFoG downstream, 1G-EPON, 10G-EPON, and NG-EPON**
  - Downstream 1595 nm and 1605 nm
  - Upstream 1530 nm and 1540 nm
- Plan D for **1G-EPON, 10G-EPON, and NG-EPON**
  - Downstream 1550 nm and 1560 nm
  - Upstream 1340 nm and 1360 nm.

Coexistence objective can help reduce number of wavelength plans.

Impact Factors in Coexistence Considerations

Available wavelength resource

- Very limited wavelength options if taking all coexistence characters into account (water peak, legacy PONs, filter edge, pass band range…)
- Dispersion penalty for S, C, L band should be considered , especially for upstream (using DML in ONU)

Availability and cost of optical components

- Must leverage mature industry supply chain, such as C or S band

Channel count

- Stuff more wavelength channels requires high cost DWDM multiplexers, amplifiers, tunable transceivers…

Co-propagation crosstalk

- Downstream Raman crosstalk mostly affect analog RF video signal, multi-wavelength system becomes worse
- In case of multi-wavelength system, upstream inter-channel crosstalk because of poor inter-channel isolation by the power splitter and the low side-mode suppression ratio of normal DFB lasers should be considered

Upstream reflection

- Probably affect analog RF video signal, due to unreliable ONU receiver filter design

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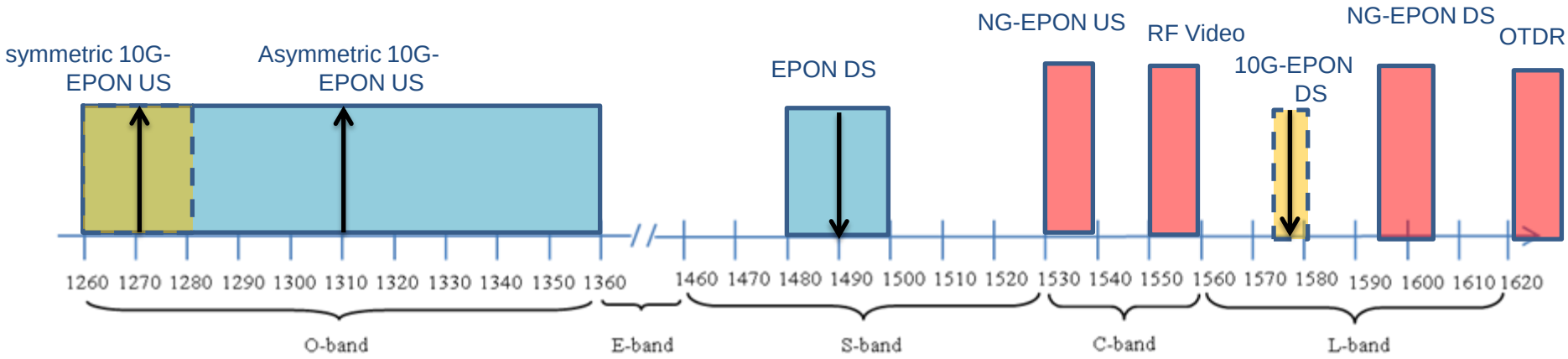
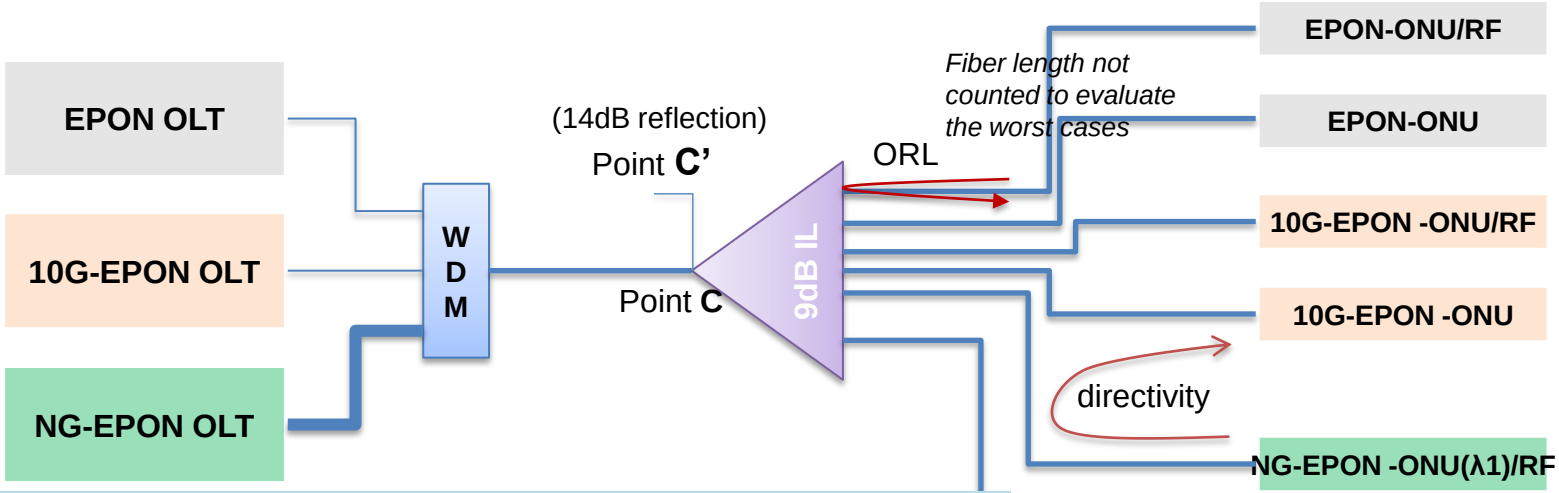
NG-EPON Coexistence with RF Video (Plan B & C)



In case of NG-EPON coexisting with RF, RF band (1550-1560nm) is trapped in between the NG-EPON upstream (1530-1540nm) and 10G-EPON downstream (1575-1581nm). As a result, the guard band from upper edge of NG-EPON upstream (1540nm) to lower edge of RF band (1550nm) is then left to only 10nm. Unfortunately, from filter vendor's feedback, the 45 degree pass band filter is difficult to meet guard band requirements that less than 20nm. In order to eliminate the NG-EPON upstream reflection, wavelength blocking filter (WBF) is required in downstream RF video receiver.

Analysis of NG-EPON Upstream Reflection to RF DS

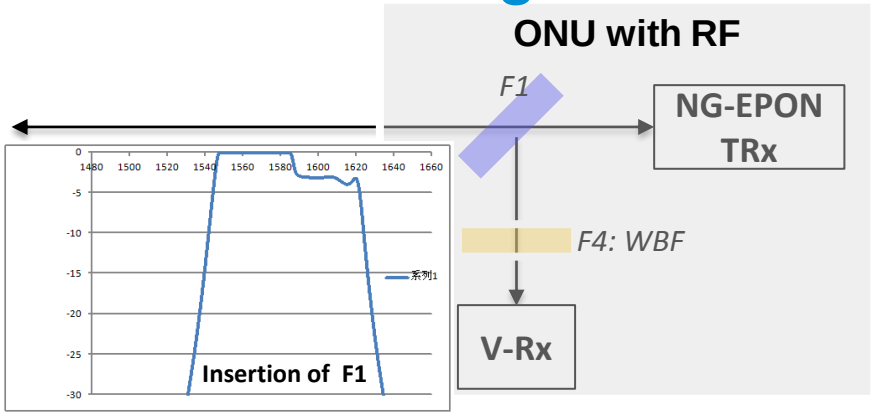


In worst case, 2:8 PLC (one port C' open) is used:
-14dB reflection in the C' , 9dB IL single-way, ORL would be -14-9-9=-32dB

In best case, port C' could be well processed:
-50dB ORL and directivity in C' can be achieved, 9dB IL single-way

It was found that particularly many 1:8 splitter were in fact made by 2:8 PLC chips (that means the splitter is really a 2:8 splitter with one port open in the package box).

Traditional Design of ONU Receiver with RF



Assuming **S** represents the V-Rx sensitivity at –12dBm

Reflected interference signal is defined by X

X(dBm)=ONU_{Tx}– ORL – F1 – F4,

In case of multi-wavelength system

X(dBm)=ONU_{Tx}+ $10lg^{N}$ – ORL – F1 – F4,

N is the number of wavelengths

1 λ:

Worst case

X=7dBm -32dB-14dB-30dB = -69dBm

with F4: S/X=-12dBm + 69dBm = 57dB >>35dB;
w/o F4: S/X=-12dBm+39dBm= 27dB<35dB[1];

Best case

X=7dBm -50dB-14dB-30dB= -87dBm

with F4: S/X=-12dBm+87dBm=65 dB >> 35dB;
w/o F4: S/X=-12dBm+57dBm=45 dB > 35dB

4 λs:

Worst case

X=7dBm + 6dB-32dB-14dB-30dB = -63dBm

with F4: S/X=-12dBm + 63dBm = 51dB >>35dB;
w/o F4: S/X=-12dBm+33dBm= 21dB<35dB;

Best case

X=7dBm + 6dB-50dB-14dB-30dB= -81dBm

with F4: S/X=-12dBm+81dBm=69 dB >> 35dB;
w/o F4: S/X=-12dBm+51dBm=39 dB > 35dB

[1] Based on S. Ikeda presentation at ECOC 2006

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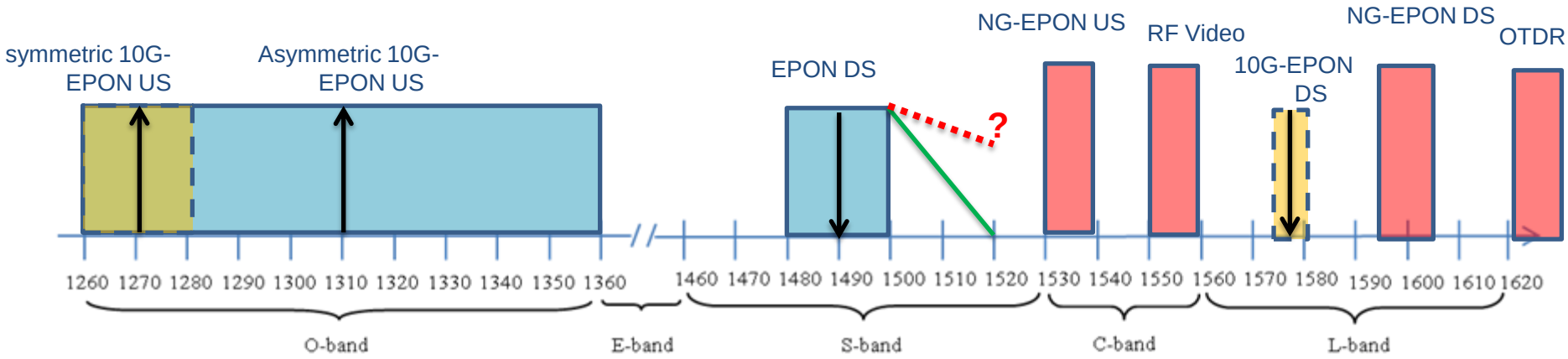
Analysis of NG-EPON Upstream Reflection to EPON DS



In case of NG-EPON coexisting with EPON, the guard band from upper edge of EPON downstream (1500nm) to lower edge of NG-EPON upstream band (1530nm) is 30nm.

In normal case (as far as ZTE's filter vendors are concerned), the upper width of EPON downstream filter would be 20nm (i.e., 30dB isolation edge at 1520nm).

However, such filters in other early deployed EPON ONU receivers might not be so good or even not defined. That means the NG-EPON upstream reflection could severely impact the EPON ONU receivers.

Conclusions

Coexistence objective is necessary to help reduce the number of wavelength plans

Many factors significantly impact the coexistence

Upstream reflection of NG-EPON is analyzed in coexistence with RF video downstream and EPON downstream

- Analysis shows some edge cases might jeopardize RF video performance and EPON downstream
- Additional ONU filtering is suggested to be specified and implemented to avoid such edge cases
- Or some legacy systems (such as RF video or 1G-EPON) can no longer be considered as coexistence objectives

Thank you

Tomorrow never waits