Channel Bonding for Next Generation Passive Optical Network Stage 2 (NG-PON2)

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Why NG-PON2?

> Higher bandwidth requirement due to the emerging applications: Edge network cannot support emerging applications such as HD video, mobile front-haul/backhaul and high speed Ethernet [1].

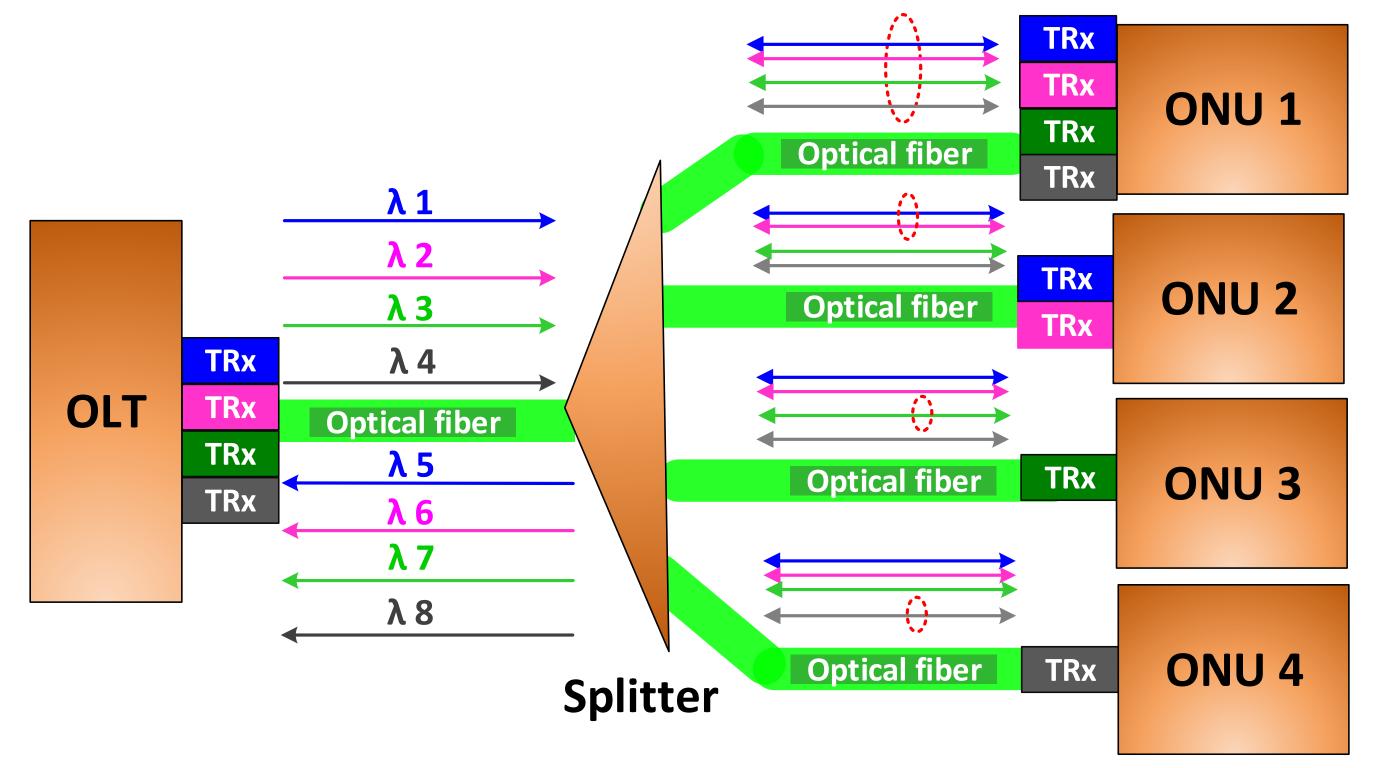




Why channel bonding?

New Jersey Institute of Technology

> Channel bonding advantages: *i*) high capacity, *ii*) flexible bandwidth allocation, and *iii*) low CAPEX.



https://www.wirelessweek.com/ne ws/2017/06/nokia-bell-labs-toutsuse-10g-pon-mobile-fronthaul

Fig. 1: Emerging applications are driving for flexible high-capacity broadband access.

TWDM TC layer structure of current NG-PON2

> TWDM TC layer of GPON is "equivalent" to Data Link layer of **OSI model.**

> TWDM TC layer is composed of three sublayers: *i*) TWDM TC service adaptation sublayer, *ii*) TWDM TC framing sublayer, and *iii*) TWDM TC PHY adaptation

Multiplexing Transmission Convergence



() 06/20/2017 - 12:37pm **by Diana Goovaerts**

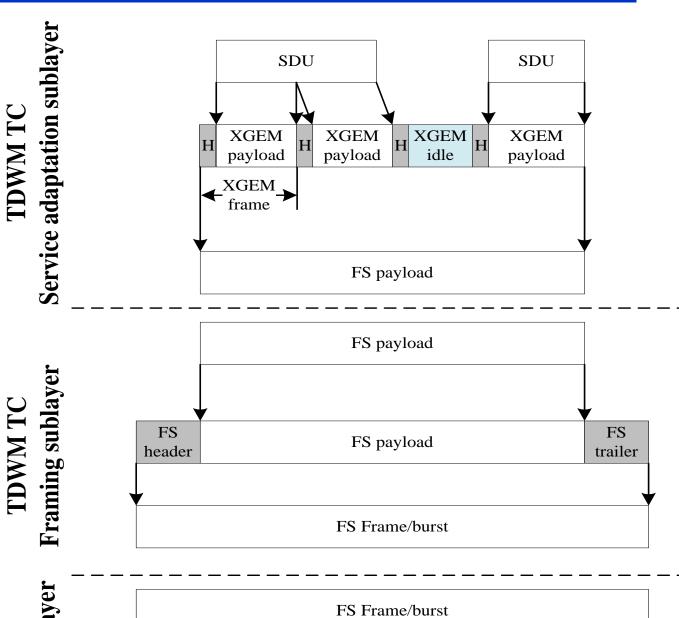
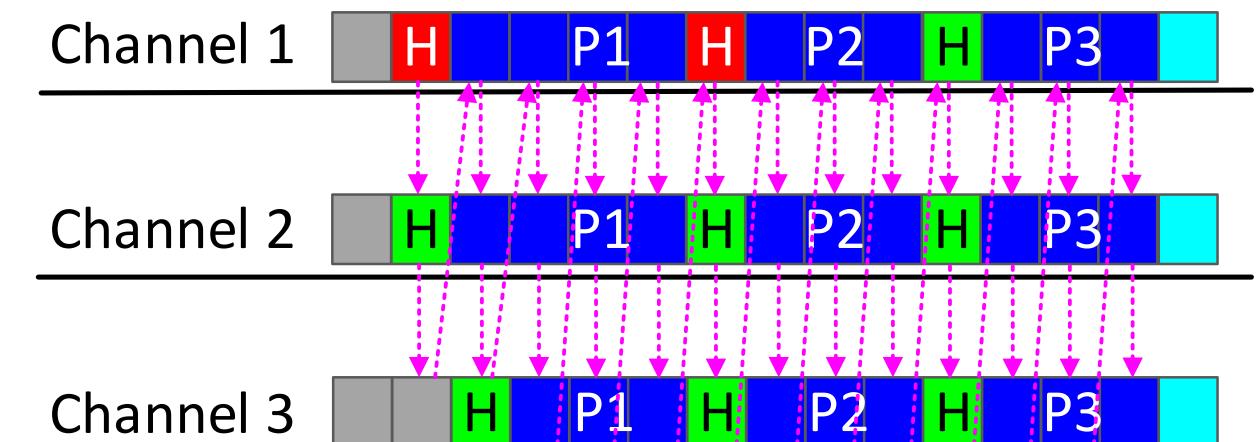


Fig. 2: An example of channel bonding for NG-PON2.

Inter-leaving scheduling technique

> Traffic is distributed to the available channels via an interleaving scheduling technique.



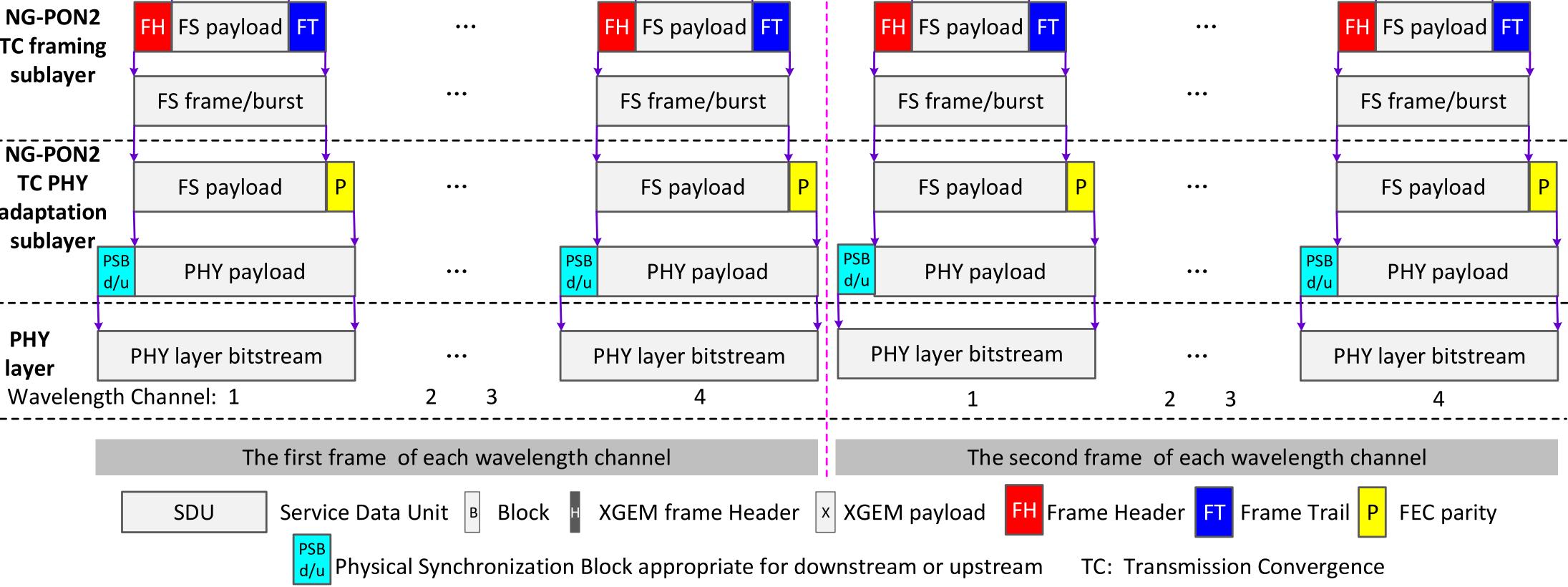
sublayer [1]. ubla FEC data FEC data Channel bonding at service FEC data FEC data adaptation layer provisions the Scrambled PHY frame/burst payload PSBd/u Channel 4 **P2** H **H** P1 н **P3** highest flexibility. Header of a new packet H Header of continuing packet laye PHY layer bitstream **XGEM:**XG-PON encapsulation method **SDU:** Service data unit PHY IY frame(125us)/burs **TWDM TC:** Time and Wavelength Division data block Unavailable time slots Idle (nothing)

> H-XGEM frame header Fig. 3: TWDM TC Layer Structure [1].

Fig. 4: An example of inter-leaving scheduling for NG-PON2.

Our channel bonding proposal for NG-PON2

SDU SDU SDU > The channel bonding engine SDU SDU fragment SDU fragment SDU Channel operates at the service Bonding B B B • • • B B B B B B B B B • • • B B B B B B B B ••• B B B B ••• **Function** B B B B ••• B B B • • • adaptation sublayer to fulfill several functions [2]: **NG-PON2 TC** service adaptation нхнх нхн X XGEM frame ••• 📕 Y ••• 🖪 dividing Ethernet packets sublayer 1) FS payload into 8-byte blocks, 2) implementing a channel **NG-PON2** FH FS payload FT FH FS payload FT FH FS payload FT FH FS payload FT . . . • • • **TC framing** bonding algorithm, sublayer • • • • • • FS frame/burst FS frame/burst FS frame/burst FS frame/burst distributing bonded blocks 3) to the associated channels **NG-PON2 TC PHY** based on the channel FS payload FS payload FS payload FS payload • • • ... adaptation bonding algorithm, sublayer PSB d/u 4) forming XGEM frames, and PHY payload PHY payload PHY payload PHY payload • • • ... 5) forming FS super-frames.



[1]"40-Gigabit-capable passive optical networks (NG-PON2): General requirements," in ITU-T Recommendation G.989.1, Mar. 2013.

[2] L. Zhang, Y. Luo, N. Anwari, B. Gao, X. Liu and F. Effenberger, "Enhancing Next Generation Passive Optical Network Stage 2 (NG-PON2) with Channel Bonding," 2017 International Conference on Networking, Architecture, and Storage (NAS), pp. 1-6, Aug. 2017.