XG-PON1 Review

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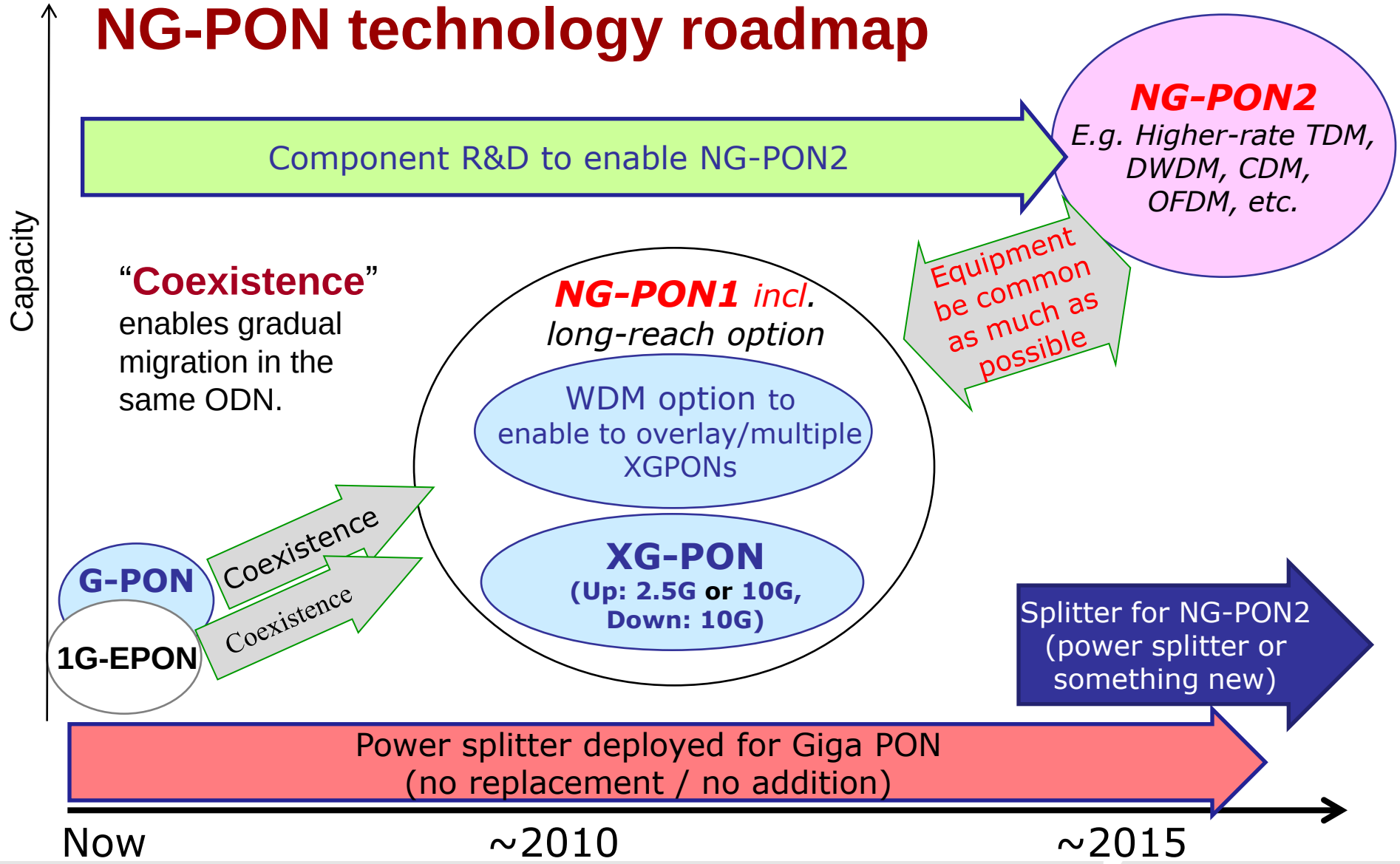
Outline

- Overview of the NGA candidates
- The anointed XG-PON1: 10G/2.5G asymmetric
- Wavelength plan
- The “Coexistence Crisis”
- Power budgets
- Protocol foundation
- Standardization plan

High level taxonomy

- **There are many techniques in play in the industry**
- **FSAN has attempted to structure these into “NGA1” and “NGA2”**
- **At the roughest level of approximation…**
- **NGA1 = 10G total capacity and compatibility with GPON**
  - 10G serial transmission
  - CWDM multiplexing
- **NGA2 = 40G total capacity and compatibility not necessary**
  - True WDM PON, with 1G per wavelength

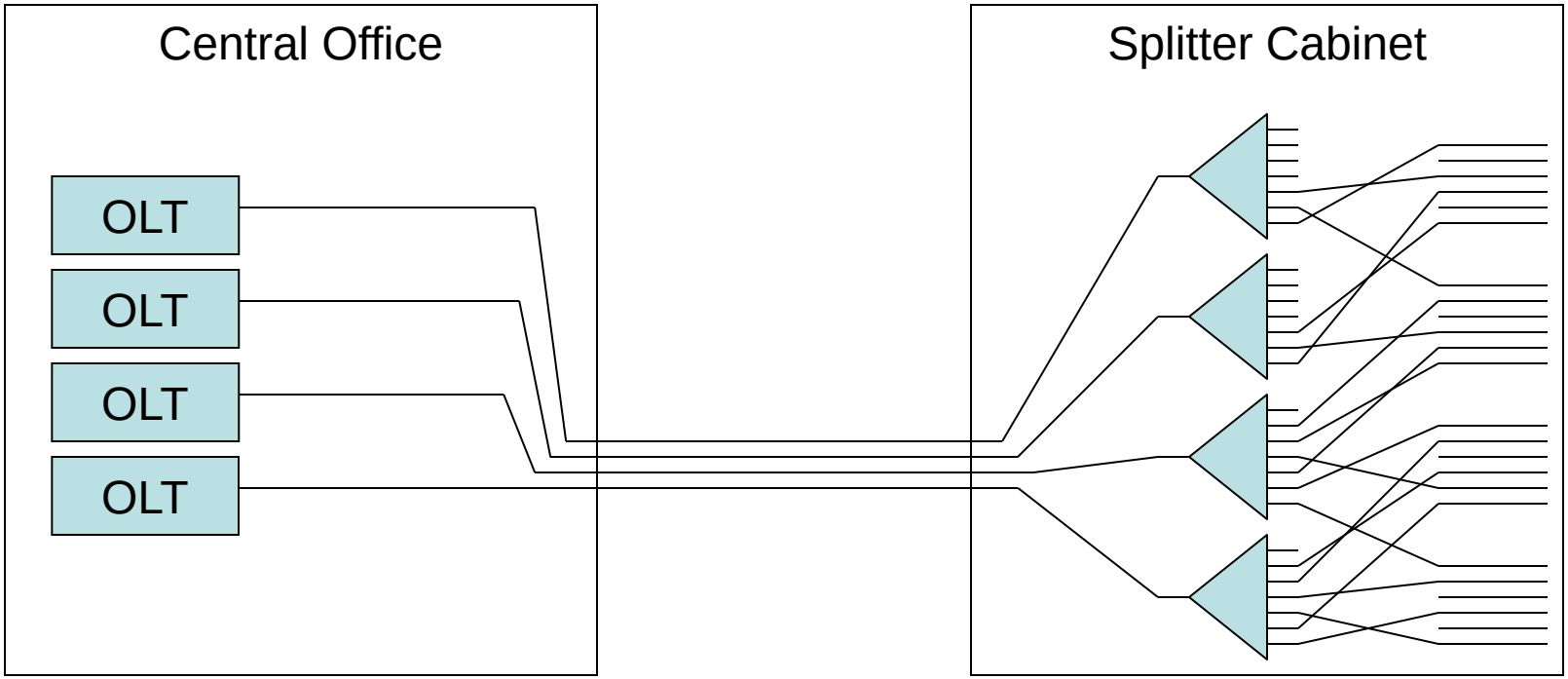
NG-PON technology roadmap



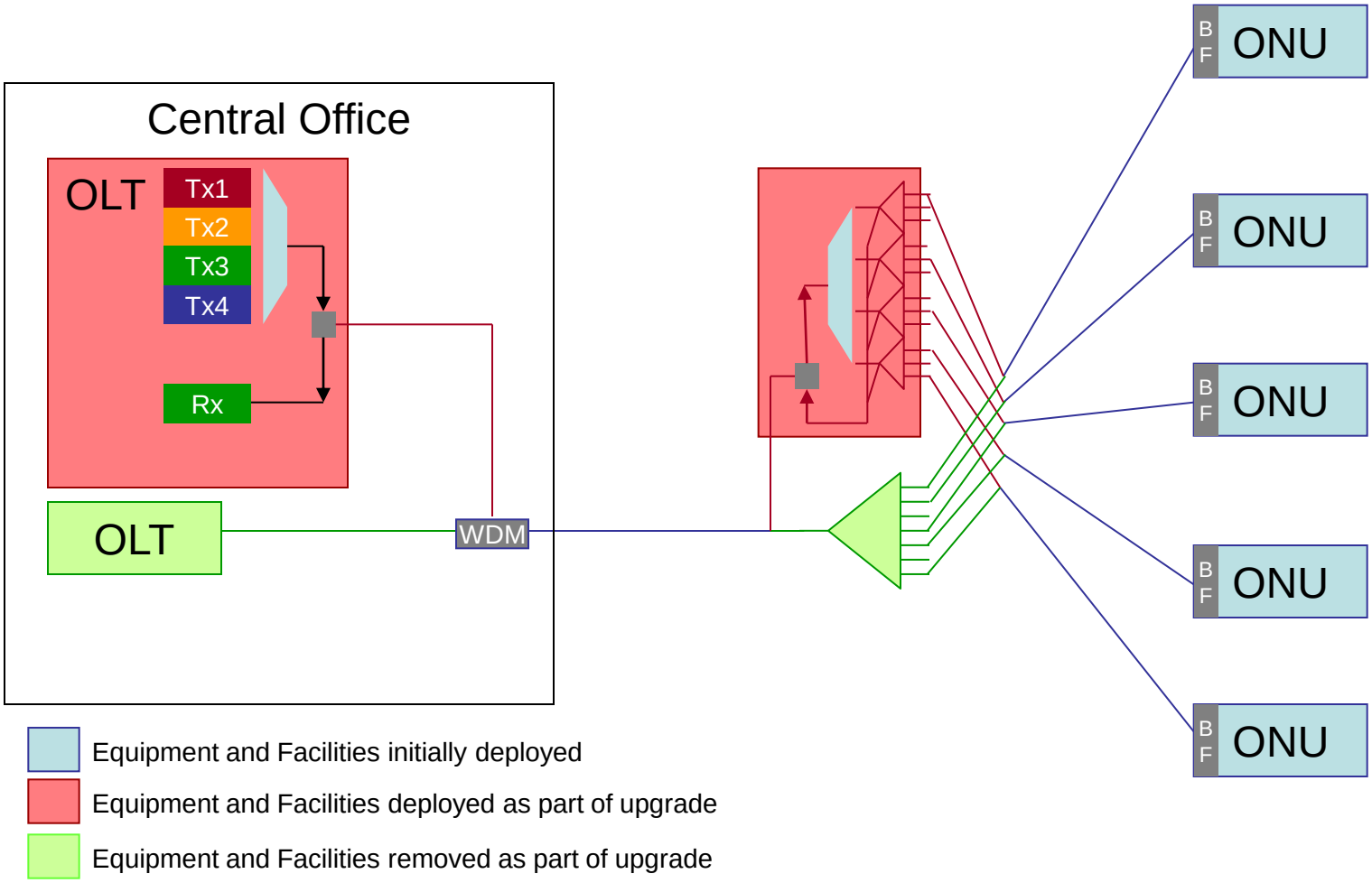
NGA1 capacity increase Candidate technologies

- **Physical split reduction [No new technology]**
- **WDM bidirectional split reduction**
- **WDM downstream-only split reduction**
- **XG-PON1: 10G down, Nx2.5G up**
- **XG-PON2: 10G symmetric**
- **Reach enhanced versions of the XG-PONs**

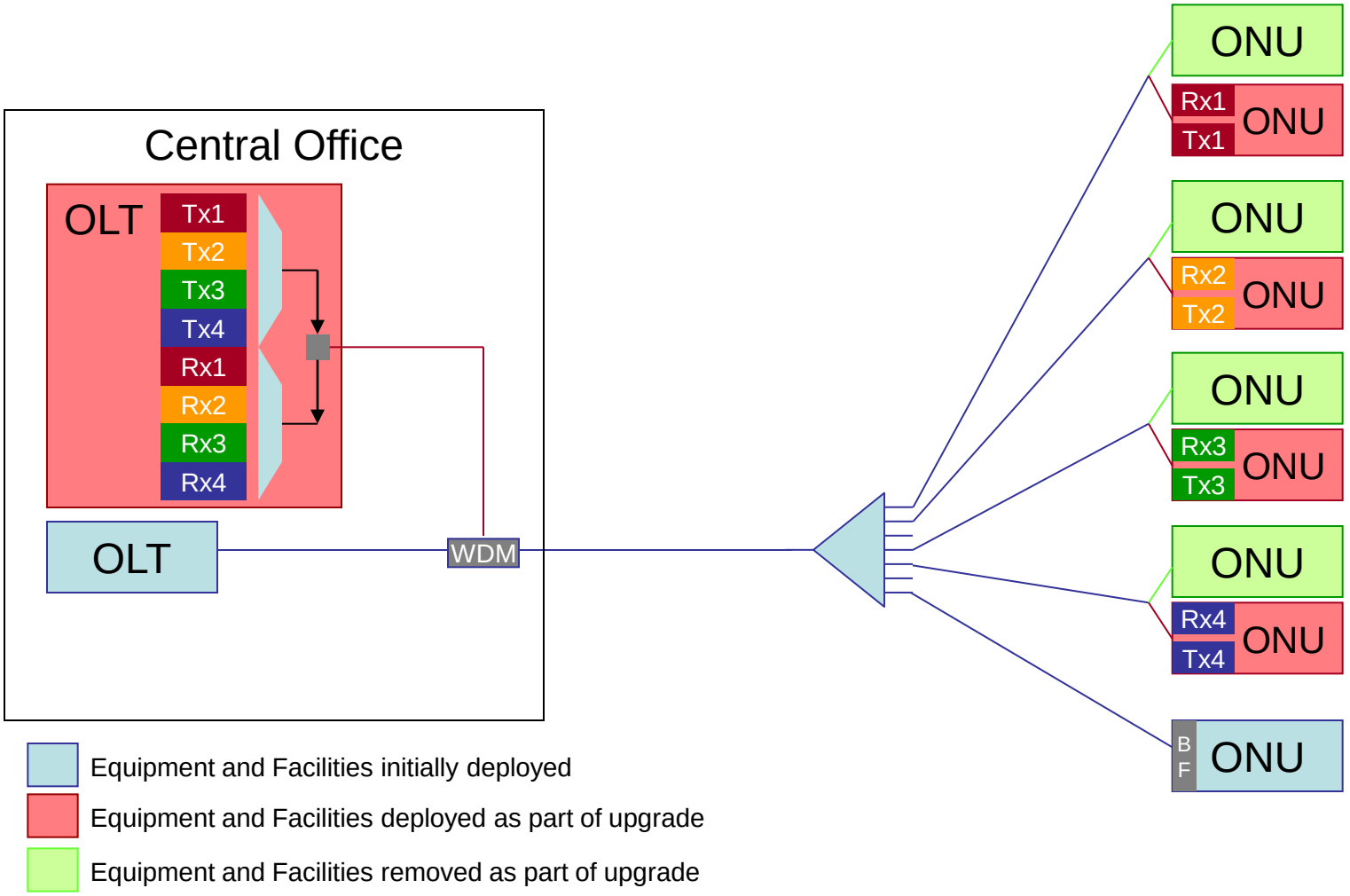
Physical split reduction



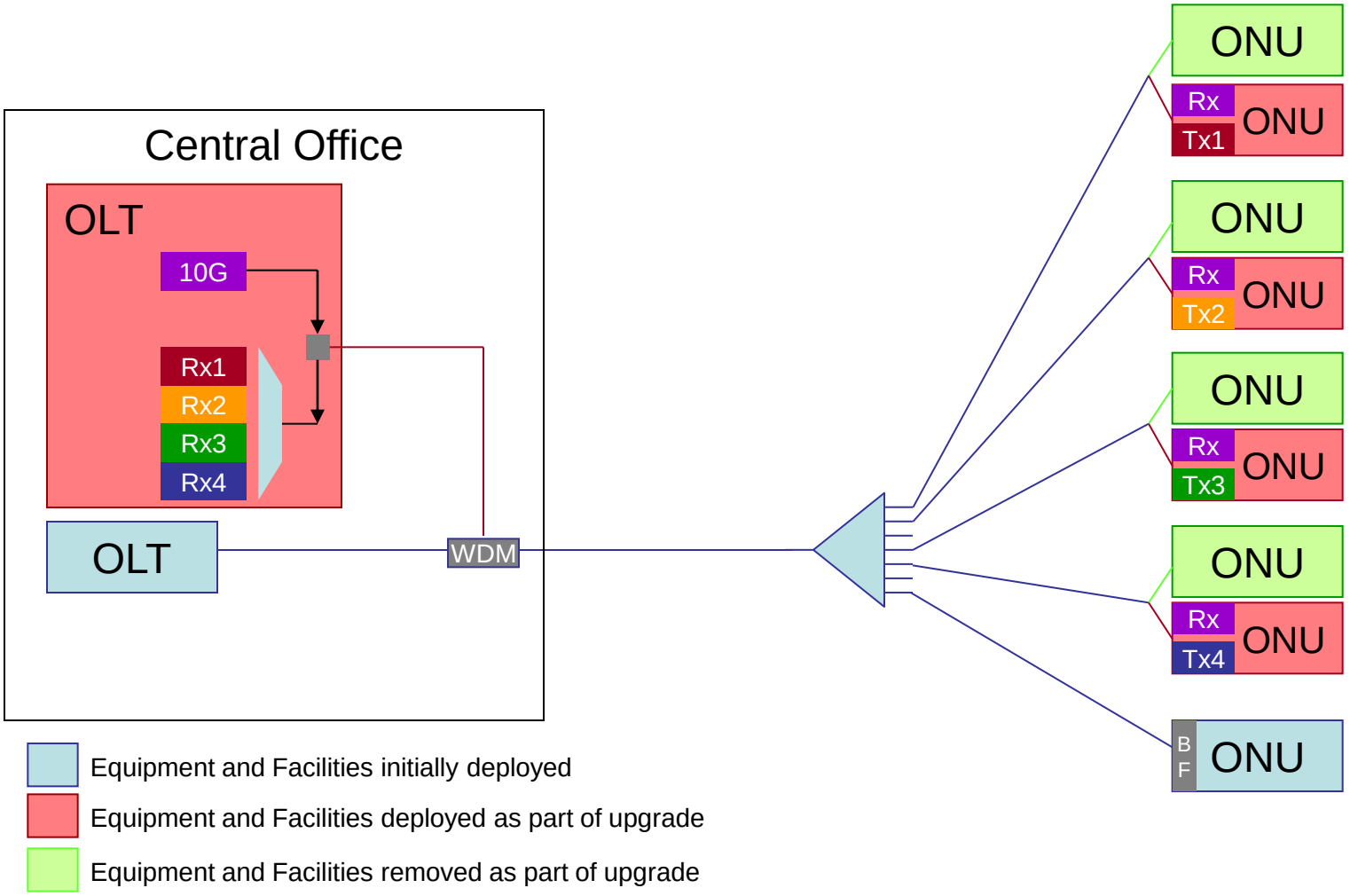
“Stacked G-PON” scheme



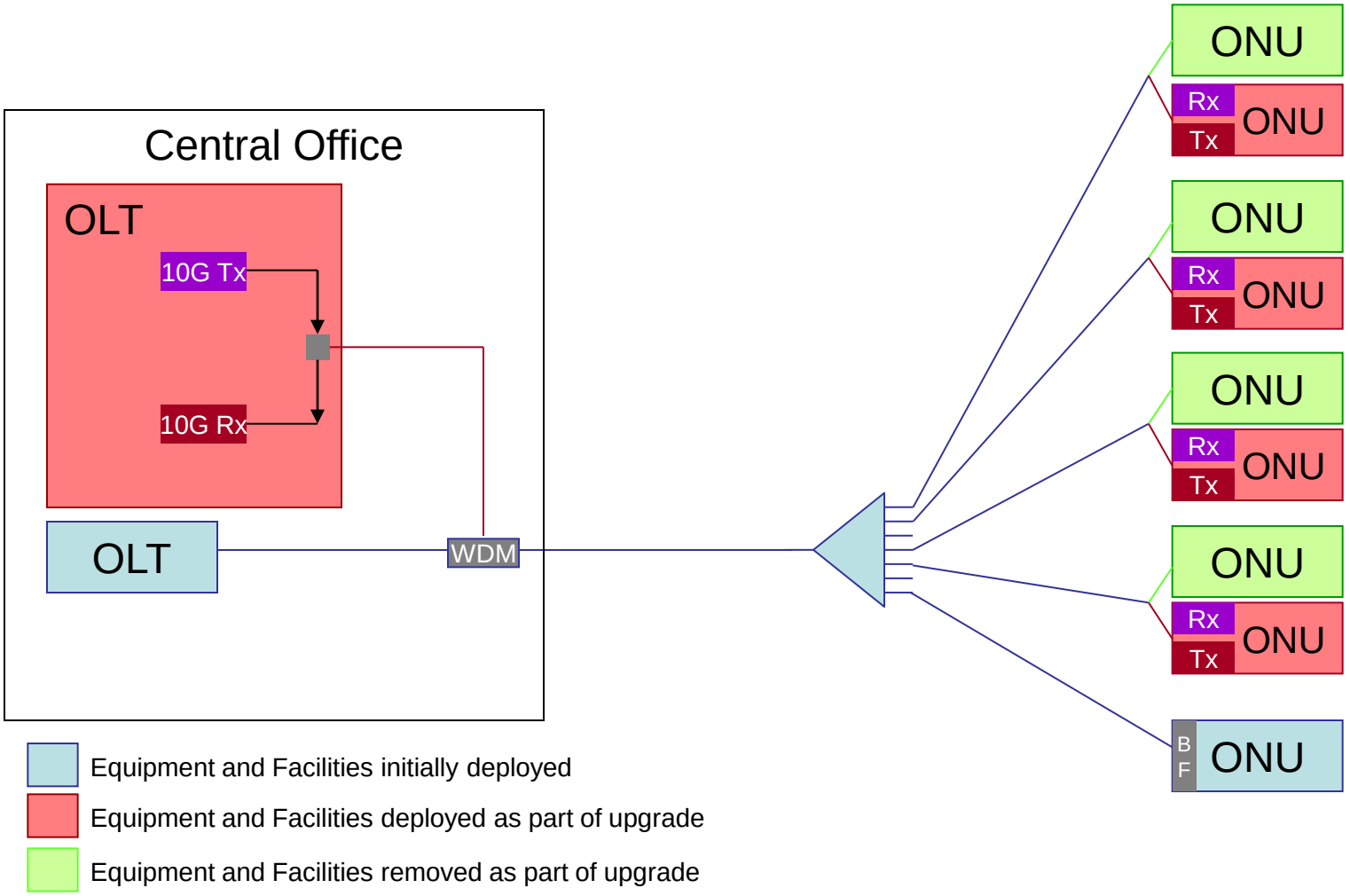
“Multiplexed G-PON” scheme



10/Nx2.5G Scheme “XG-PON1”



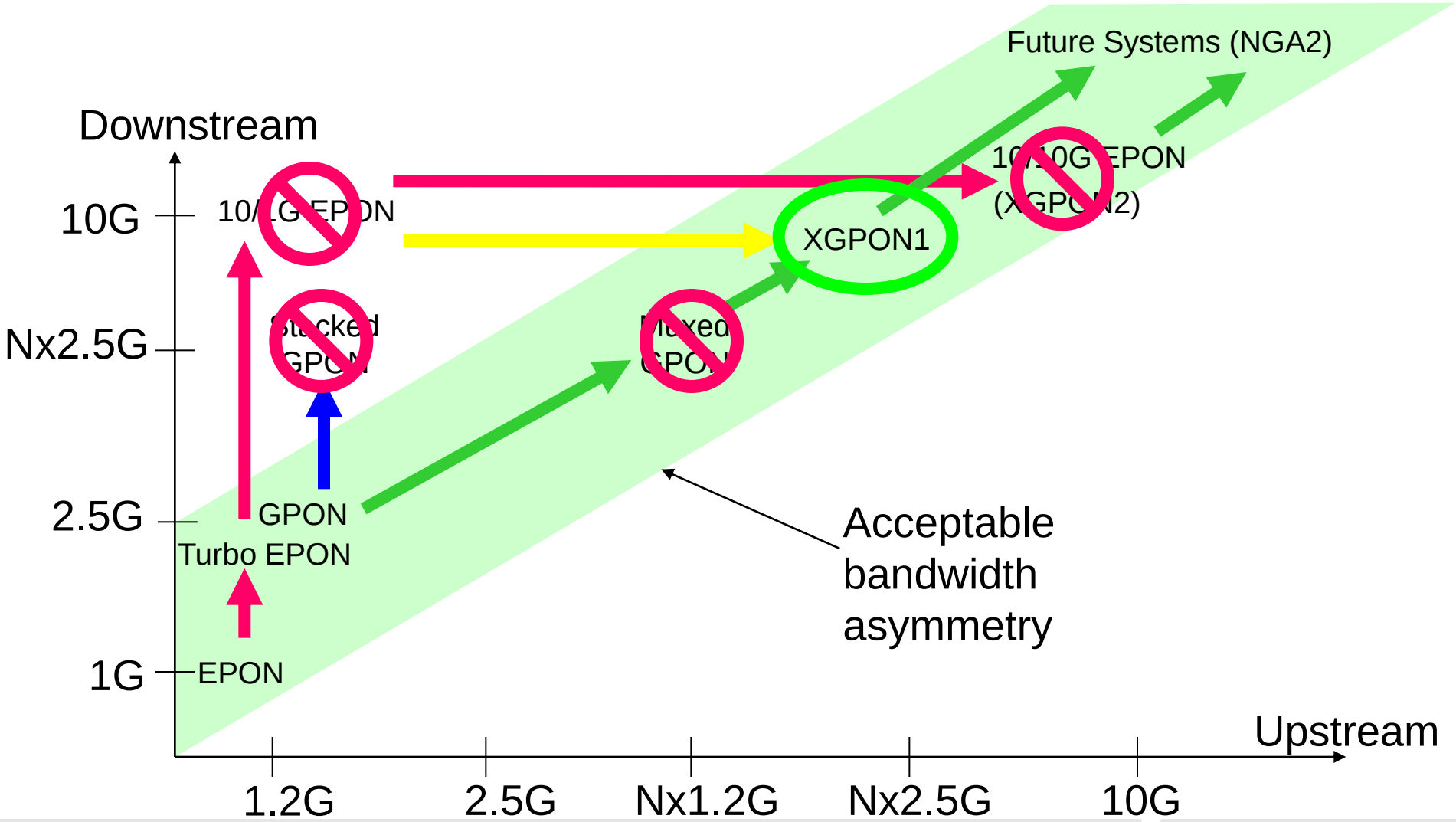
10 Symmetric Scheme “XG-PON2”



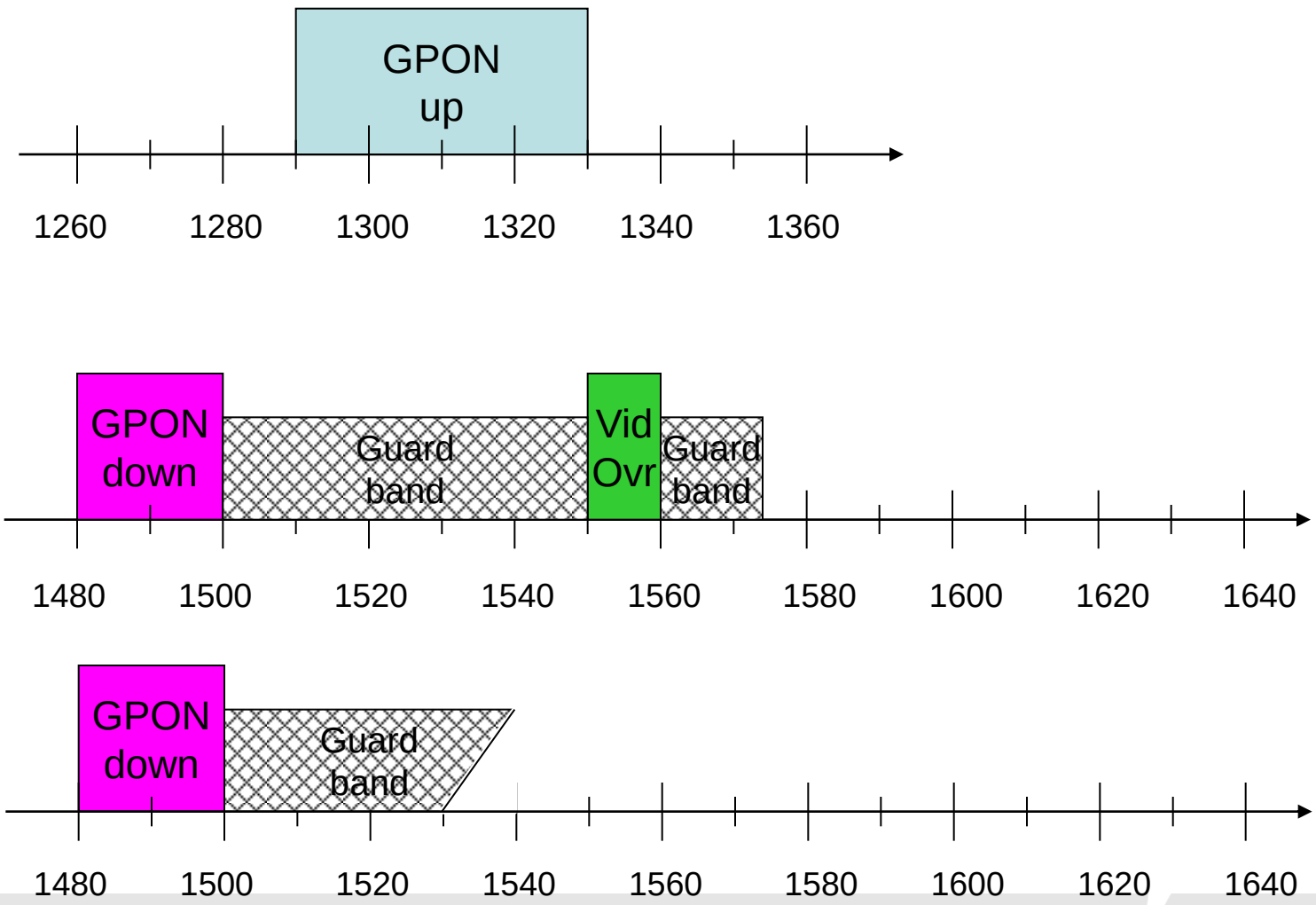
Reach enhanced XG-PONs

- **Same topology as ‘conventional’ XG-PON**
- **Use more advanced laser source at the ONU**
  - Narrow wavelength band (~0.5 nm) via cooled source
  - C-band wavelength choice
- **Employ EDFA at every OLT port to achieve**
  - Increase power budget
  - Increased split ratio
  - Increased distance

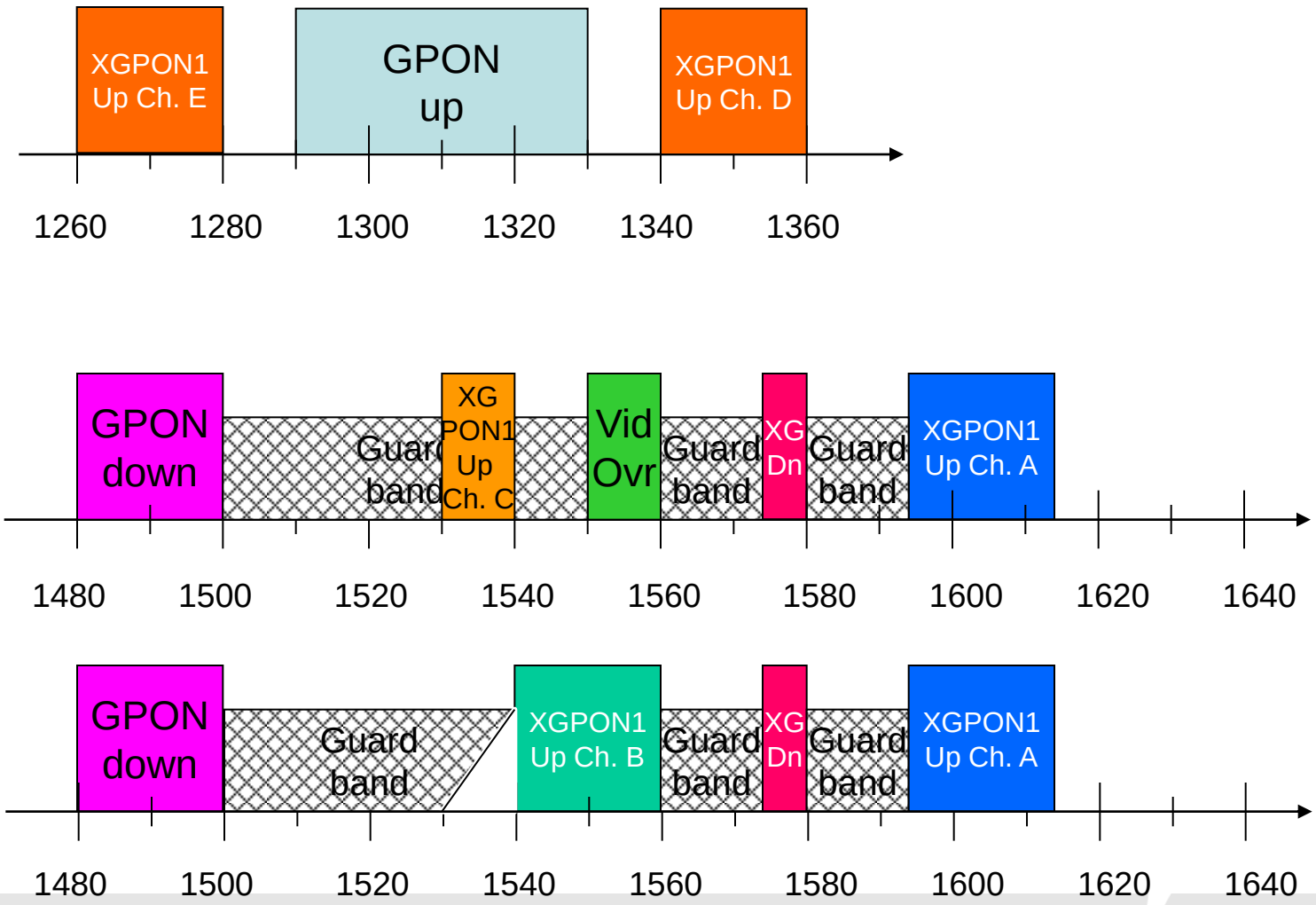
The selection of XG-PON1



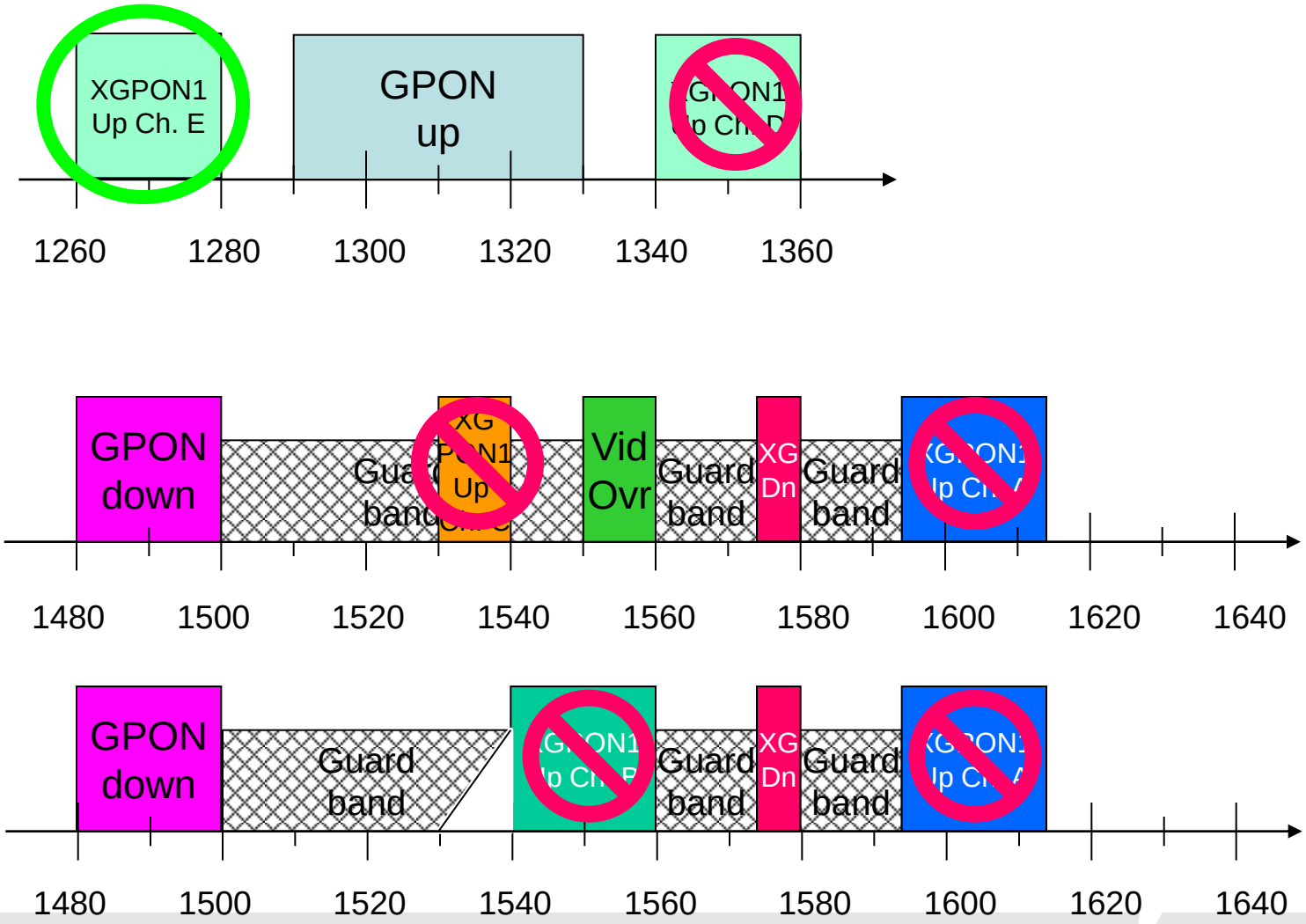
Designing the spectrum plan: Starting point



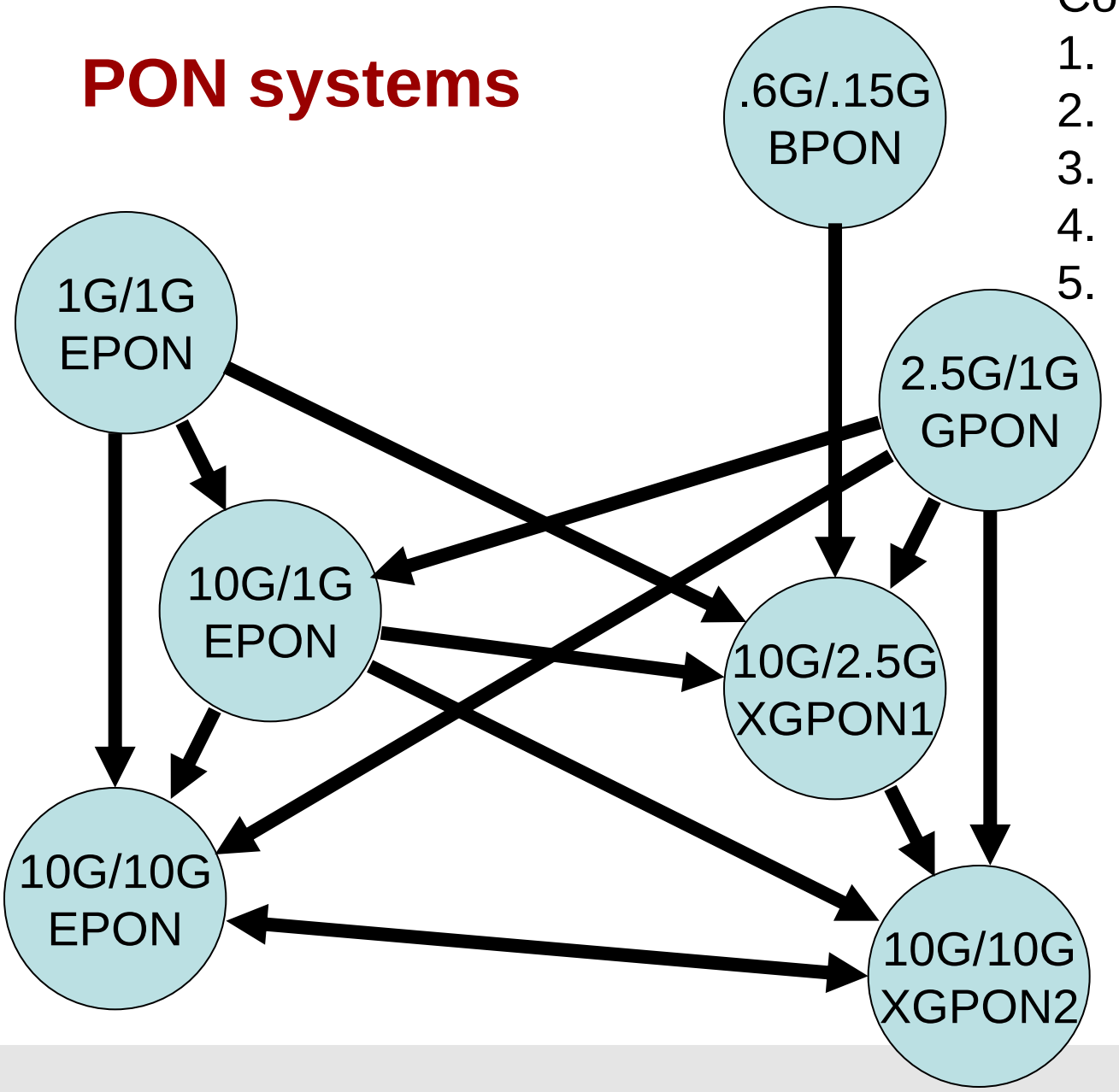
All the candidates line up



The basic XG-PON1 spectrum



PON systems



Coexistence pathways:

1. IEEE system
2. ITU System
3. ITU-to-IEEE system
4. EPON to XG-PON
5. 10G-to-XG-PON

Coexistence Crisis

- **If we want all compatibility pathways, then the 10G downstream must use a common line rate / code**
  - This would be 64b66b running at 10.3125 Gb/s
- **However, operators consider this unneeded**
  - One upgrade to Generation 4 equipment is enough!
  - It is highly unlikely that 10/1 would be upgraded to 10/2.5, or 10/2.5 to 10/10
- **Thus, XG-PON1 can use its own line rate / code**
  - NRZ, 9.95328 Gb/s downstream, 2.48832 Gb/s upstream

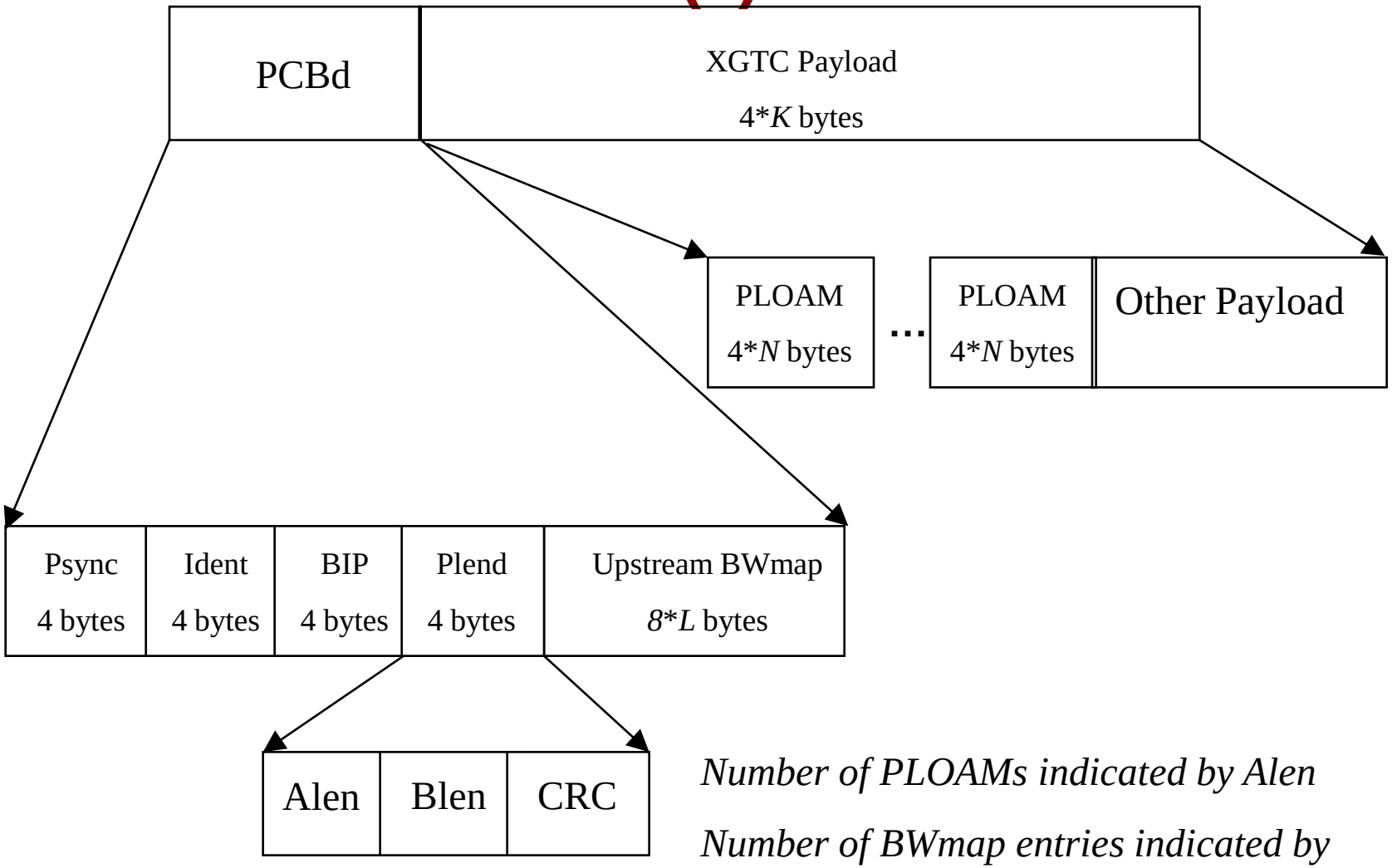
Downstream budgets

	Nominal-1	Nominal-2 APD	Nominal-2 PIN	Extended (APD)
Tx max	+6.0	+8.0	+12.5	+10.0
Tx min	+2.0	+4.0	+10.5	+6.0~7.0*
Loss	29.0	31.0	31.0	33.0
OPP	1	1	1	1~2*
Rx Sen (1e-3)	-28.0	-28.0	-21.5	-28.0
Rx Over	-8.0	-8.0	-3.5	-8.0

Upstream budgets

	Nominal-1	Nominal-2	Extended
Tx max	+7.0	+7.0	+7.0
Tx min	+2.0	+2.0	+2.0
Loss	29.0	31.0	33.0
OPP	0.5	0.5	0.5
Rx Sen (1e-4)	-27.5	-29.5	-31.5
Rx Over	-7.0	-9.0	-11.0

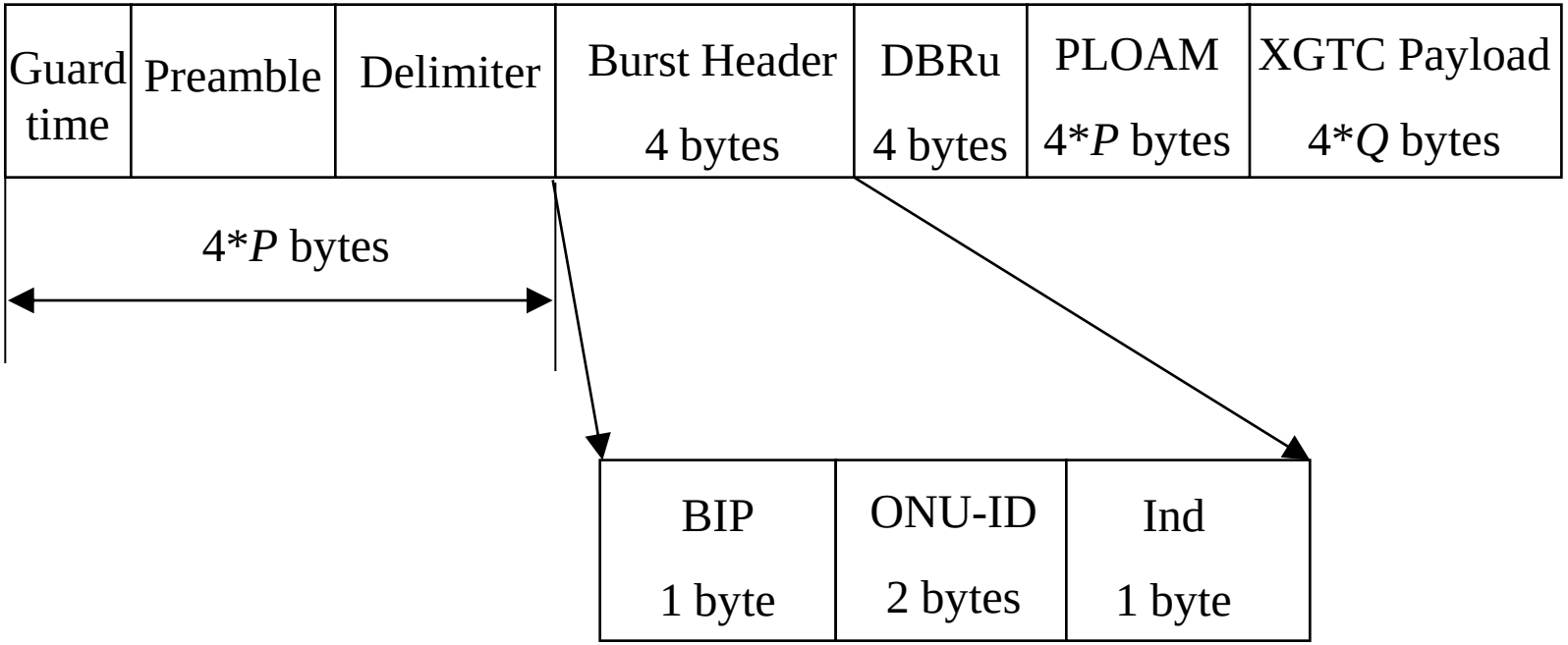
Protocol foundations (1): Downstr. Frame



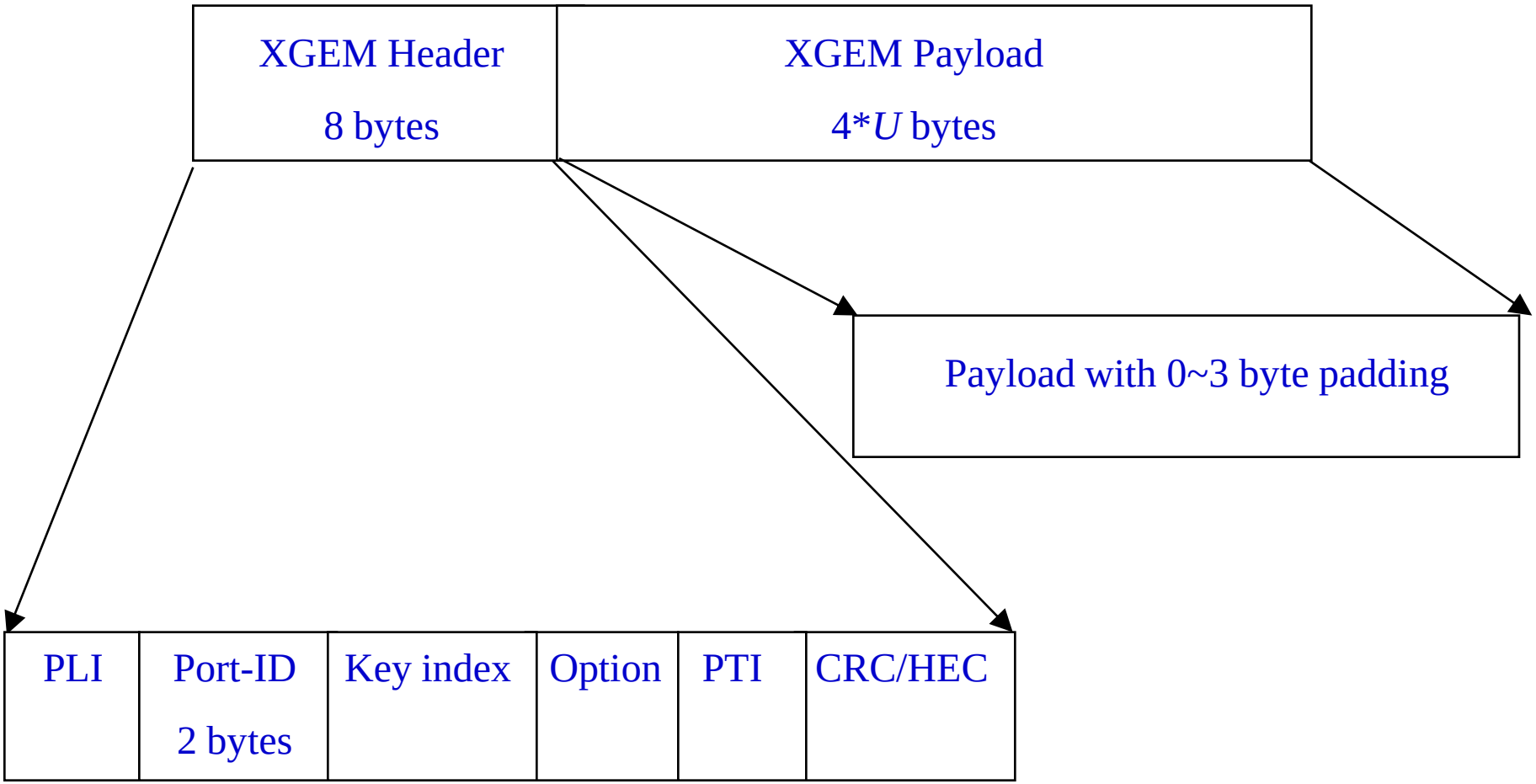
Number of PLOAMs indicated by Alen

Number of BWmap entries indicated by Blen

Protocol foundations (2): Upstream Burst



Protocol foundations (3)



Standardization Plan

- **FSAN and ITU-T (Q2/15) are working together to complete the G.987 series**
  - G.987: Common definitions and acronyms: AAP
  - G.987.1: System requirements: AAP
  - G.987.2: Physical media dependent specification: AAP
  - G.987.3: Transmission covergence specification: June 2010
- **The ONU management and configuration interface (OMCI) will be generalized in the G.988 document**
- **All work will be finished by June 2010**

Conclusions

- **FSAN / ITU-T has thought long and hard over the next PON**
  - Coexistence with current deployment is key
  - Cost effective bandwidth is the watch-word
- **XG-PON1 provides the a good blend of characteristics**
  - Compatibility with G-PON and GE-PON
  - Higher bandwidth, with acceptable asymmetry
  - High loss budget capabilities
  - Low cost for equipment
- **Timeline**
  - Standard completed by 2010
  - First trial expected by year's end
  - Significant deployments in 2012