Joint ITU/IEEE Workshop on Ethernet - Emerging Applications and Technologies

(Geneva, Switzerland, 22 September2012)

Progress in Optical Access Standards

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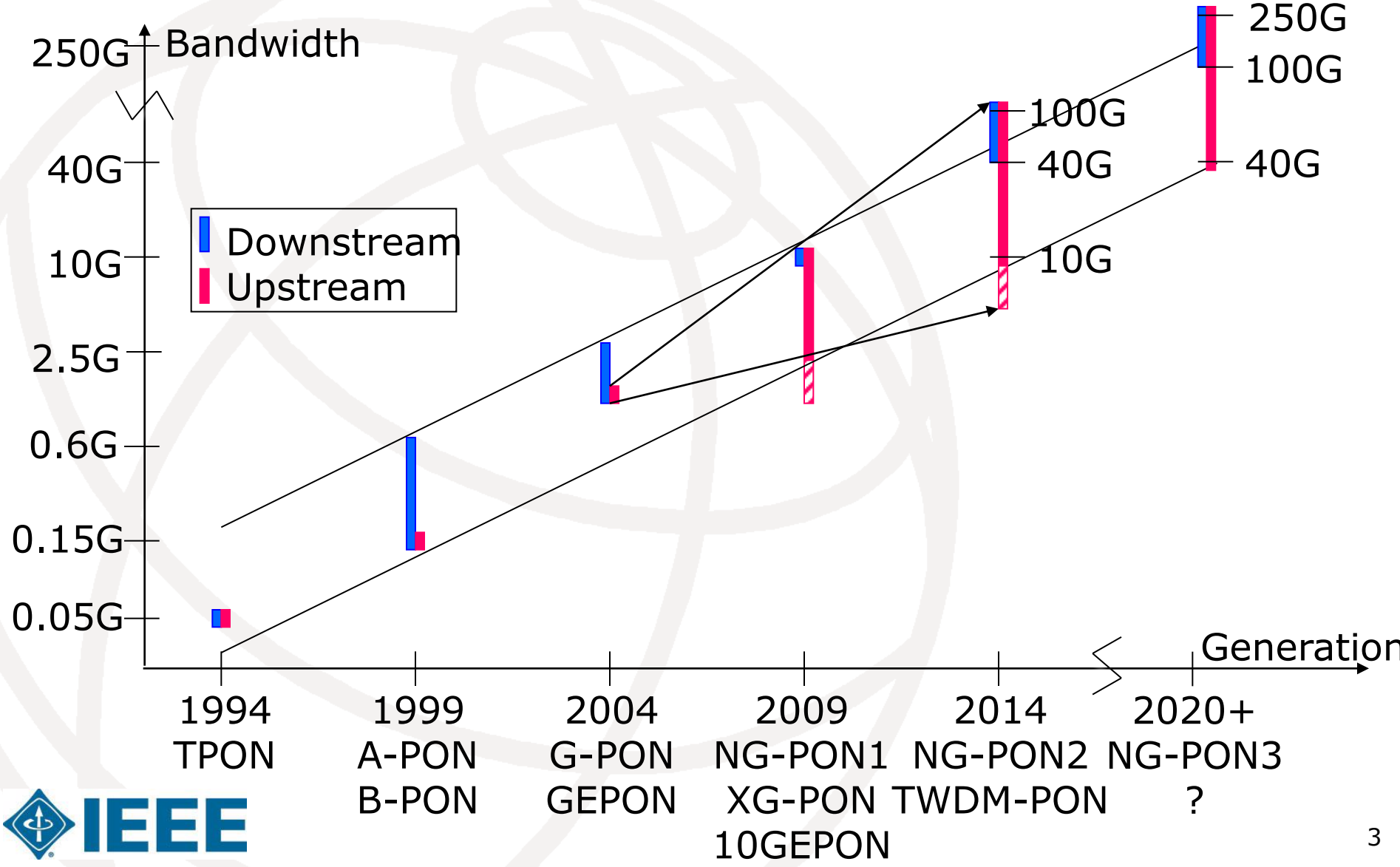
Rapporteur Q2/15

VP Access R&D, Futurewei

Agenda – PON Evolution

- G-PON
- NG-PON1 = XG-PON
- NG-PON2 = TWDM-PON
- Other topics

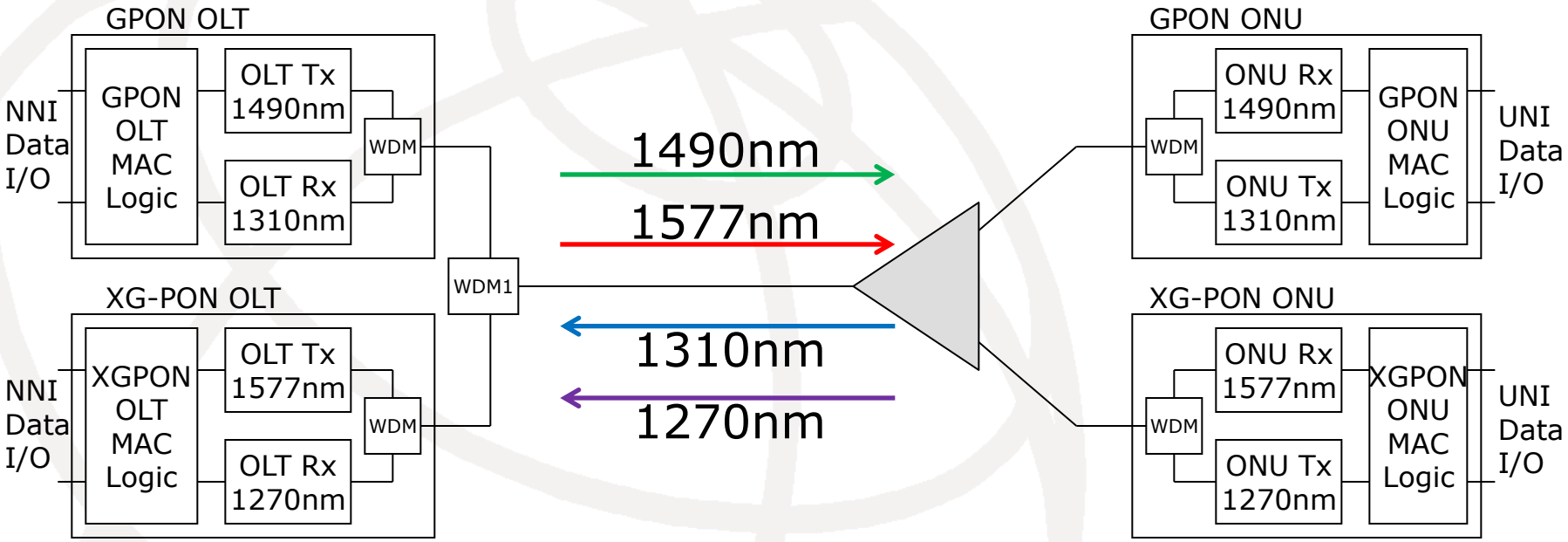
Capacity Trend for PON



G-PON: Widely deployed

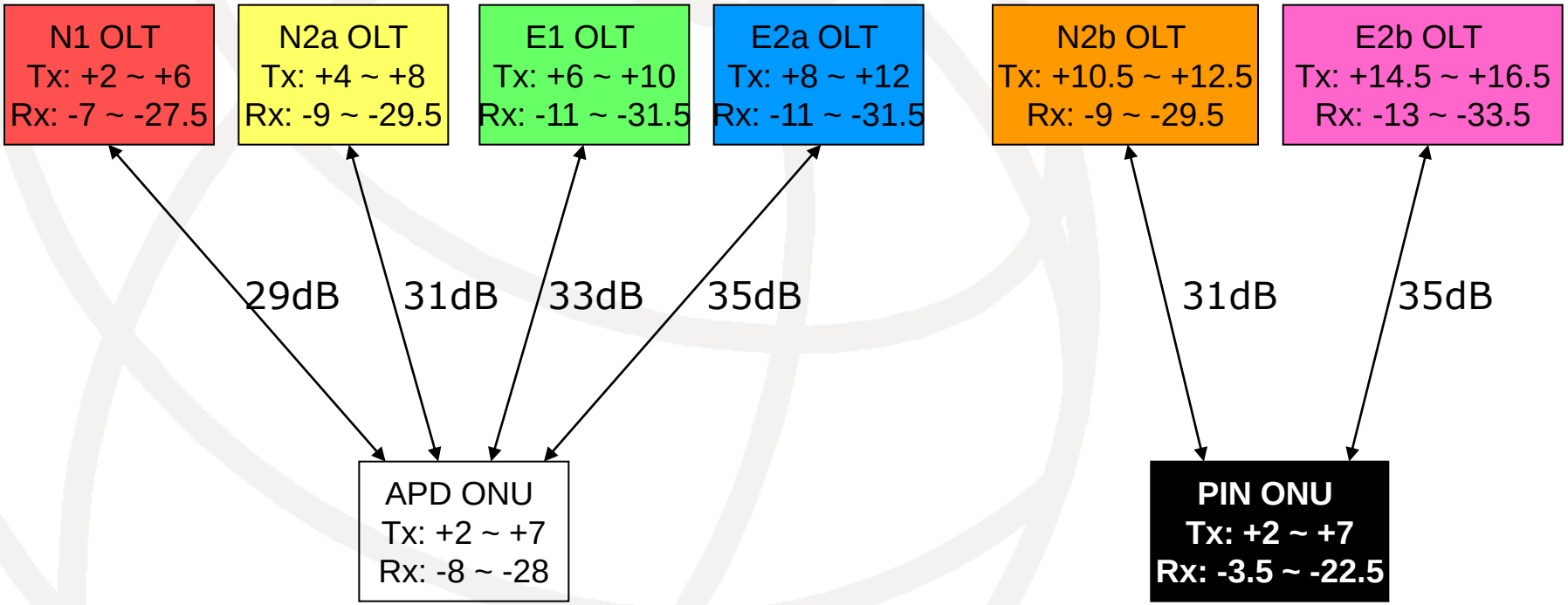
- System defined in the G.984 series
  - G.984.1: System requirements
  - G.984.2: PMD specifications
  - G.984.3: TC specifications
  - G.984.4: OMCI - Subsumed by G.988
    - Now used for all ITU PONs and P2P systems
  - G.984.5: WDM matters for the future
  - G.984.6: Reach extension
  - G.984.7: Long reach
  - Plus supplements…
- Standards considered stable and mature
- Minor optional enhancements continue even now

XG-PON1 system (G.987 series) coexisting with G-PON



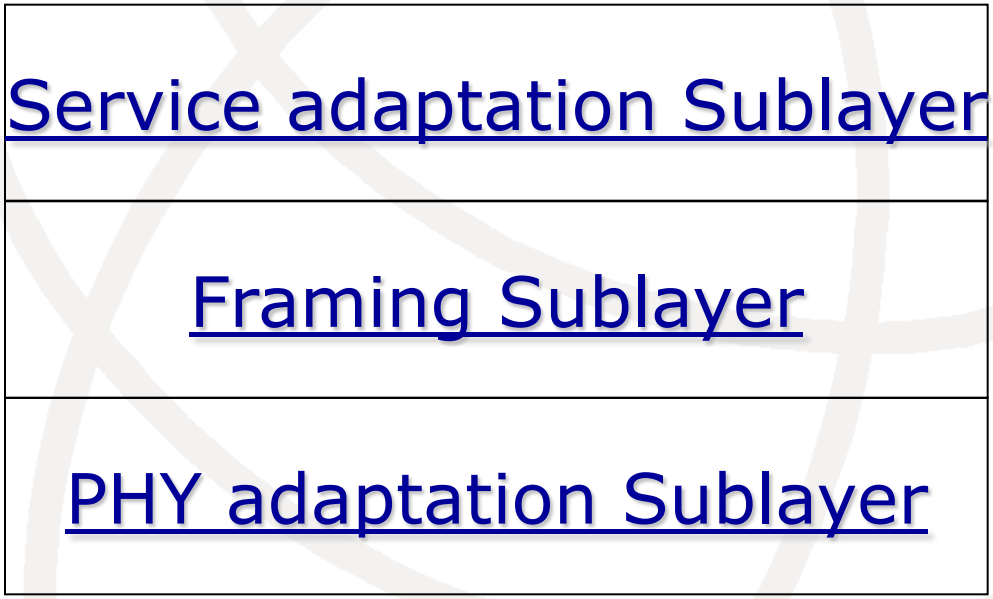
XG-PON1 PMD specifications: G.987.2

- Six OLT types and two ONU types
- Four loss budgets in all



XG-PON TC layer structure : G.987.3

- The XG-PON TC layer is broken into 3 layers
  - Simplified implementation
  - Improved extensibility



Encapsulated users data
Interfaces with Framing layer

Implements essential TDMA
Control and signaling

Encapsulates frame and
Interfaces with PHY layer

First XG-PON trial in the world

World's First XG-PON Trial

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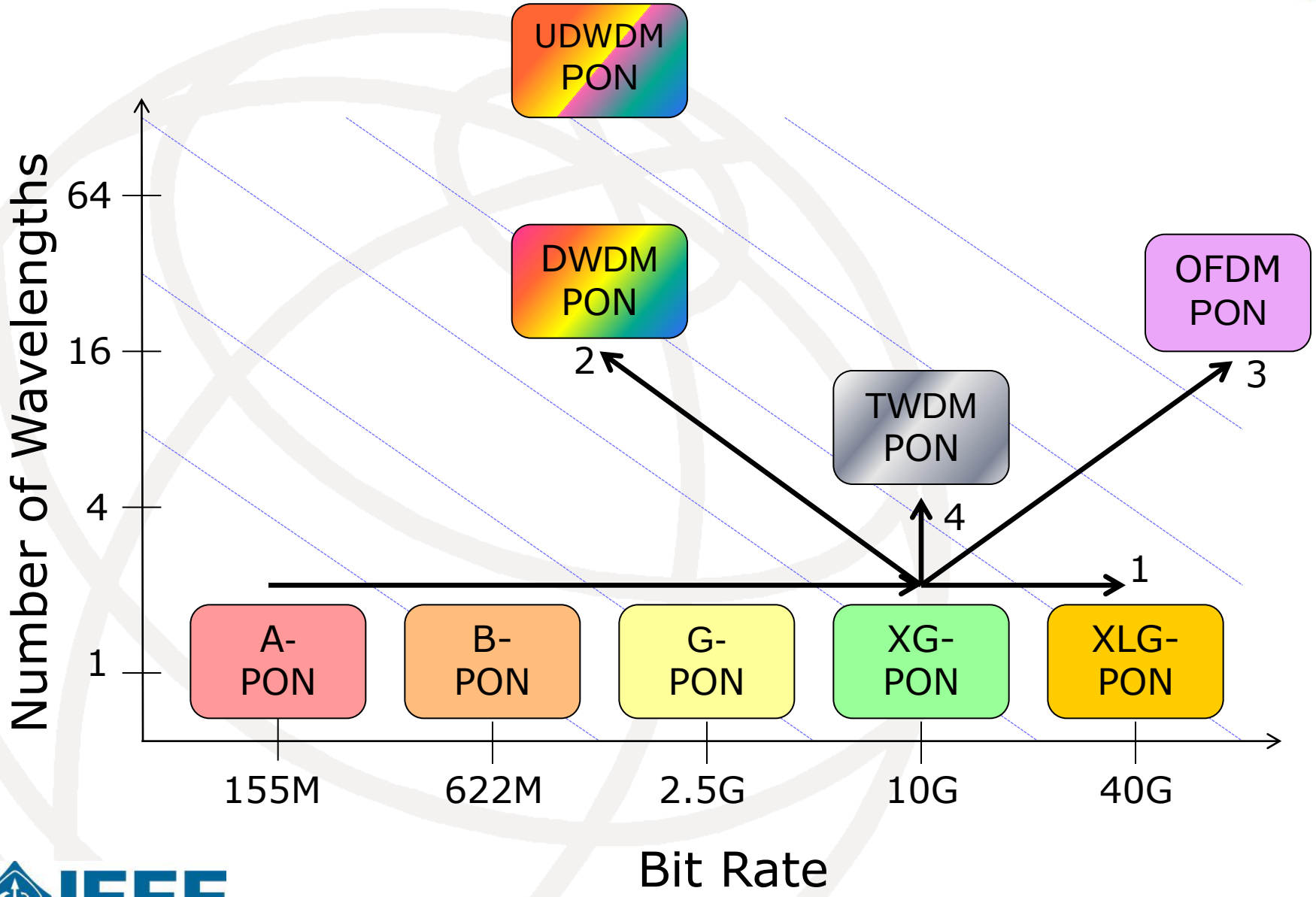
March 2010

NG-PON2: Technology Map

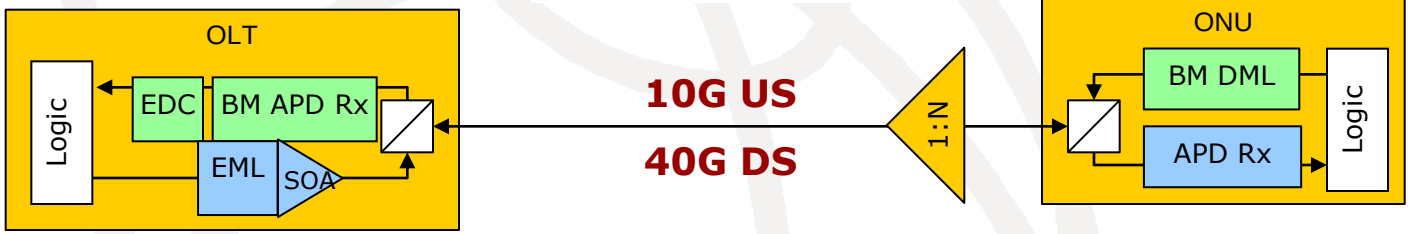


1. XLG-PON 40G/10G TDM PON

10G APD BMR
- re-use 10G EPON PR-30
- Add BM EDC to gain 2 dB

40 km reach
40 km diff. distance
31 dB loss budget

10G DML Tx
- re-use 10G EPON PR-30



40G integrated EML + SOA
- Integration driven by XG-PON N2b
- 40G duobinary modulation (electrical)
- +10 dBm output

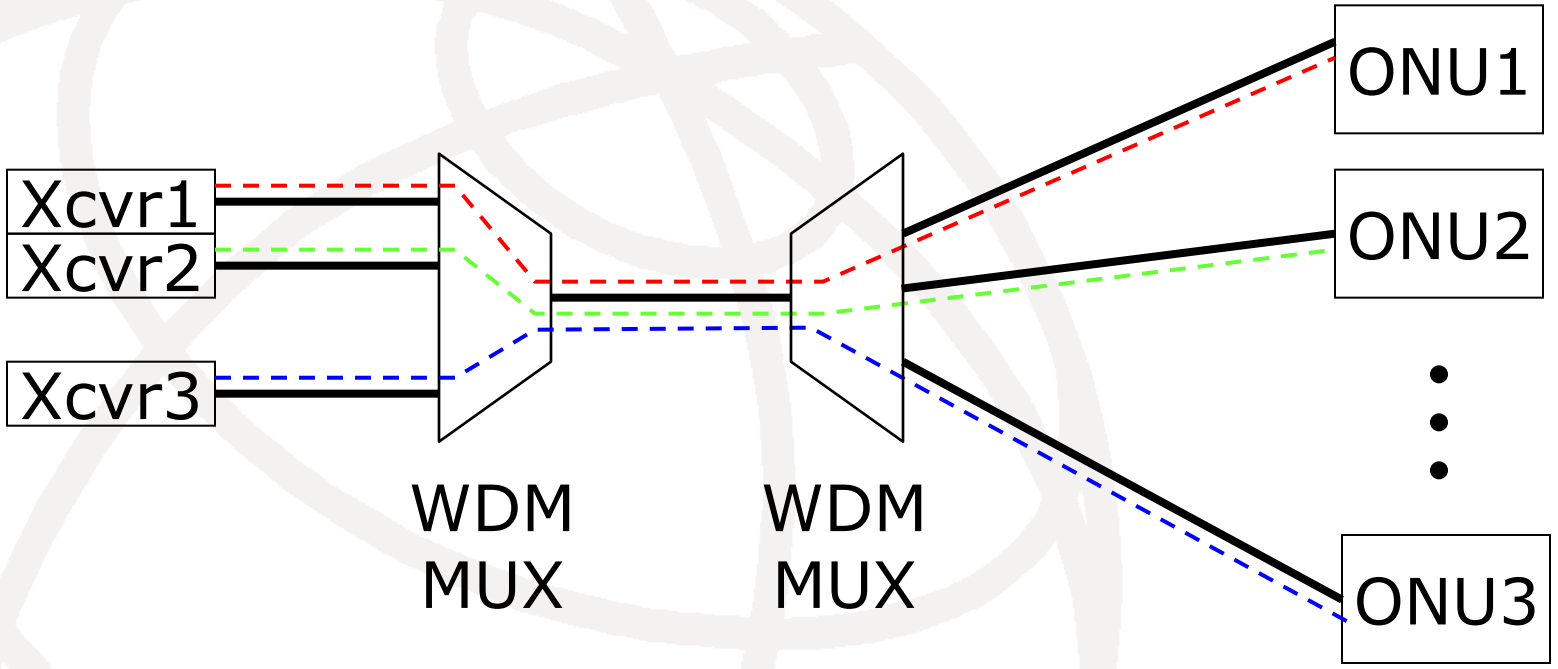
Downstream in O-band
- Mitigates CD
- Coexists with legacy (X)GPON

Duo-binary modulation
- reduced BW allows use of 20 GHz APDs
- further mitigates CD by 3x

20 GHz APD Rx
- Duobinary demodulation (electrical)
- Efficient FEC (e.g. LDPC)
- -22 dBm sensitivity

Bit-interleaving protocol
- Dynamic bandwidth
- User-rate ONU electronics

2. WDM mux-based WDM PONs: Passive Photonic Loop

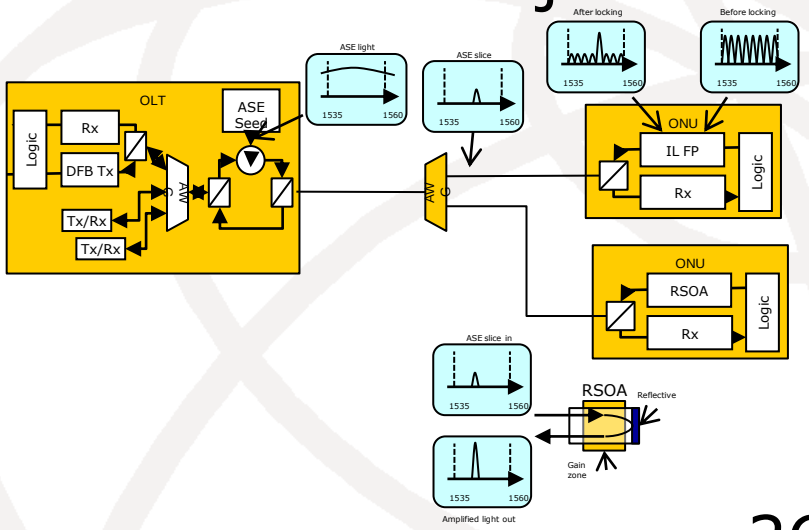


Colorless ONU type 1

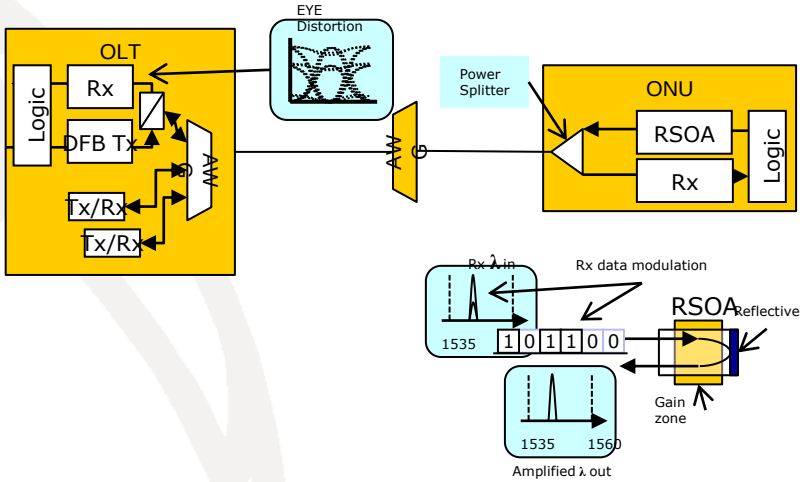
- ONU receives only one downstream wavelength
- ONU must transmit on the correct upstream wavelength

2A-C. Wavelength Injection types

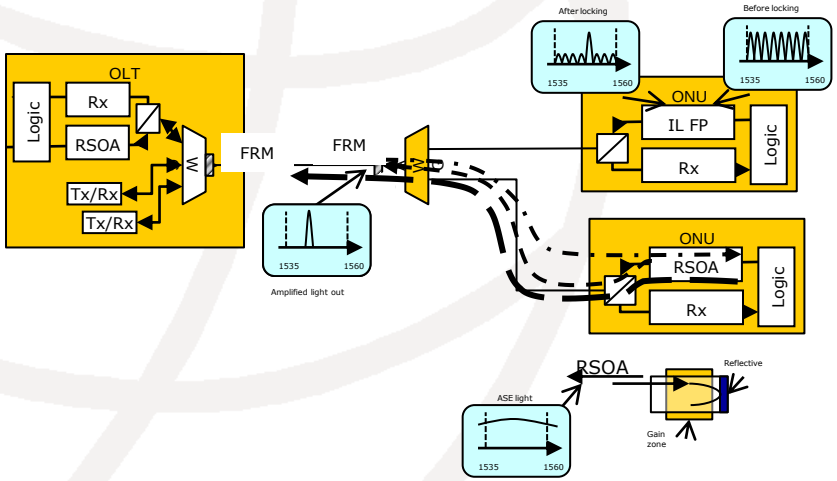
2A. External Injection



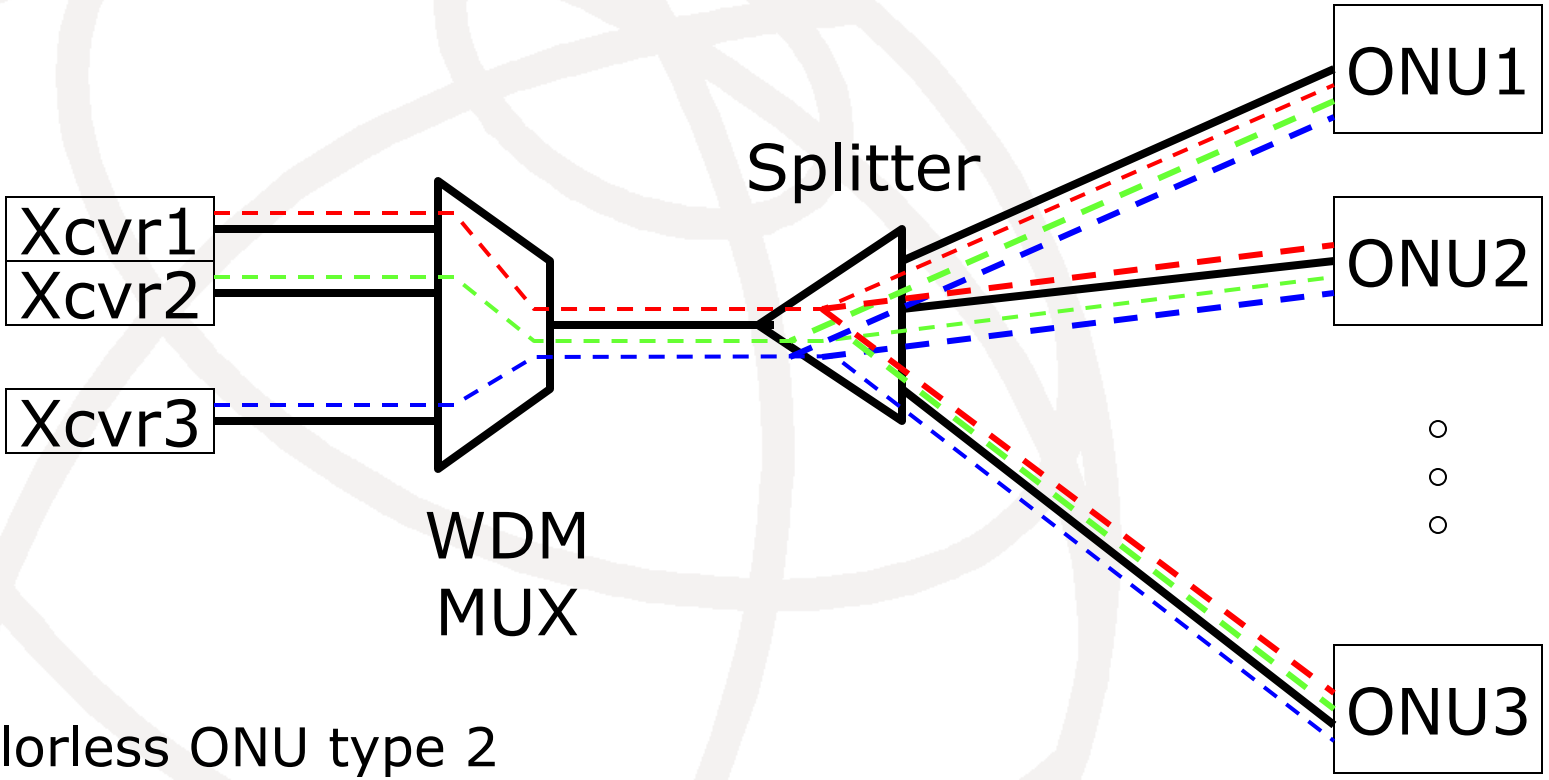
2B. Wavelength Reuse



2C. Self Seeded



2. Splitter-based WDM PONs: Lambda Net

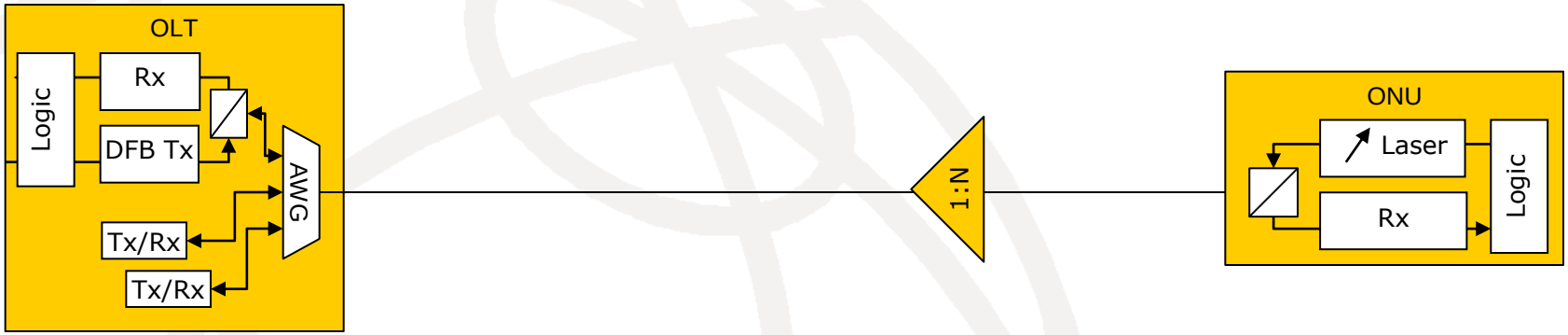


Colorless ONU type 2

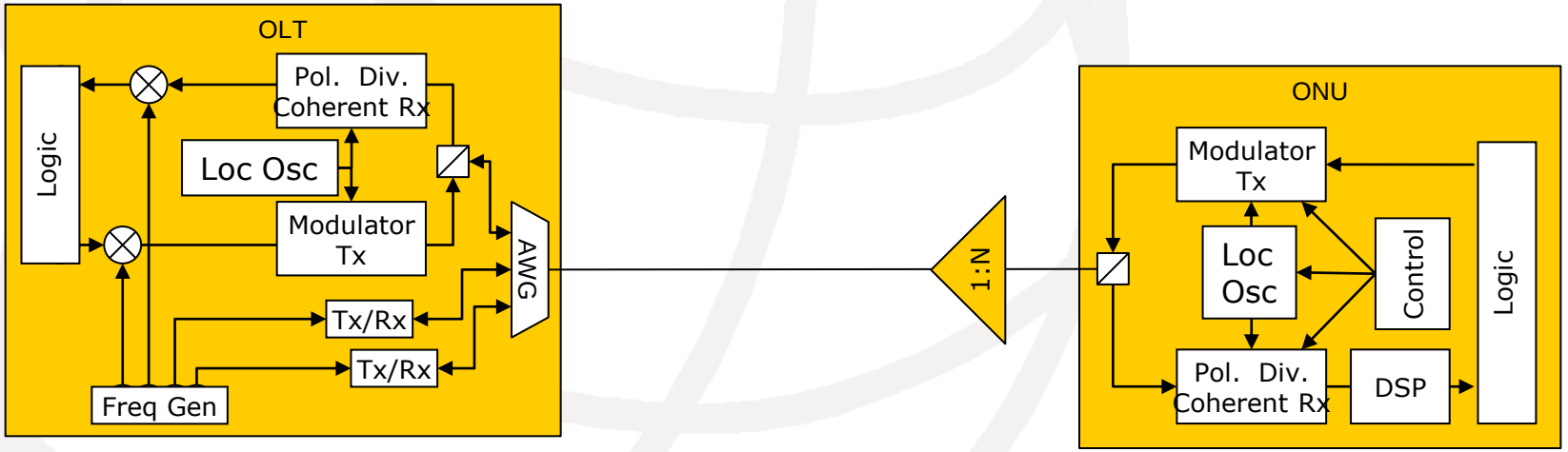
- ONU must tune to the correct downstream wavelength
- ONU must transmit on the correct upstream wavelength

2D-E. Tunable ONUs

2D. Conventional tuned lasers and filters

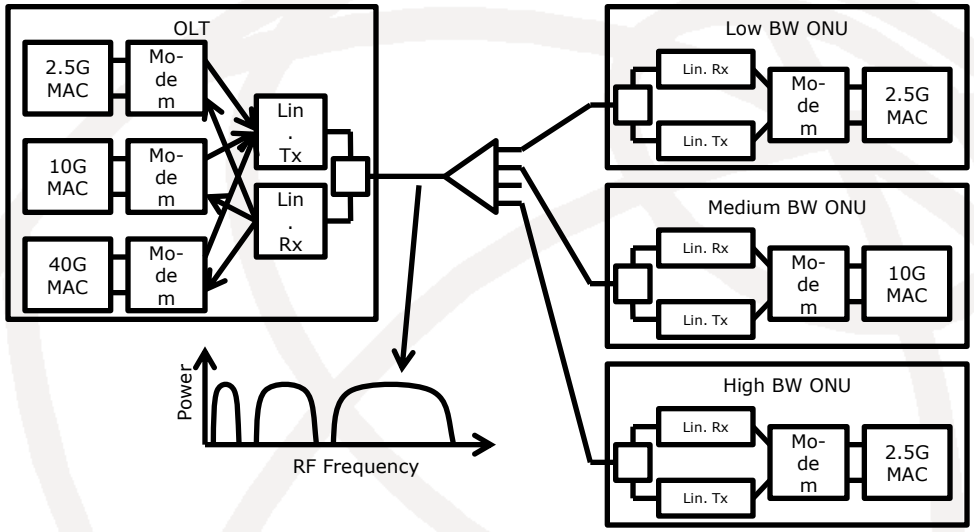


2E. Coherent receiver and modulator

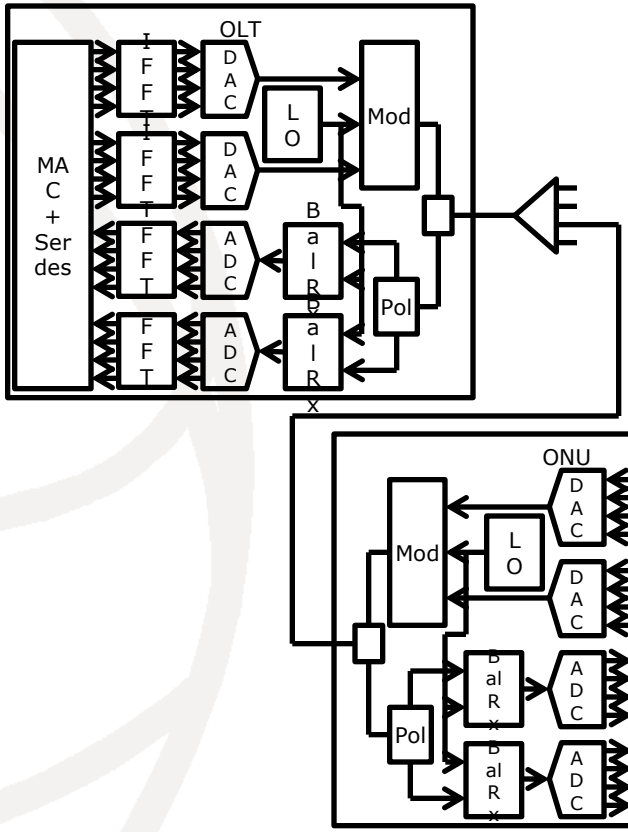


3. [[O-]O]FDM PON

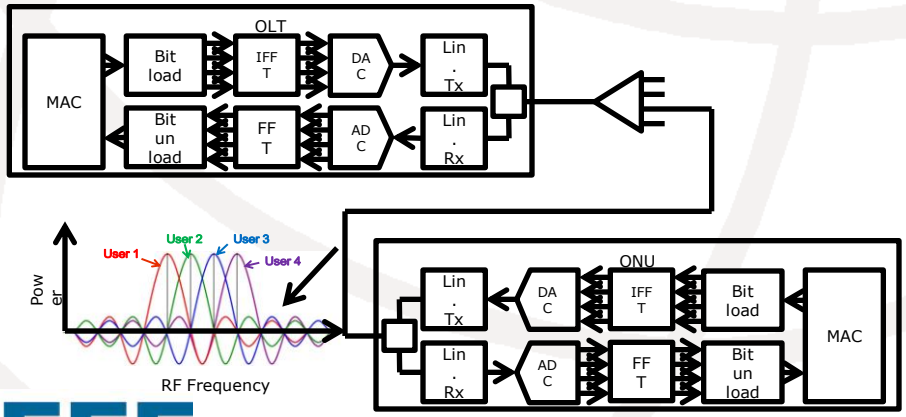
3A. FDM-PON



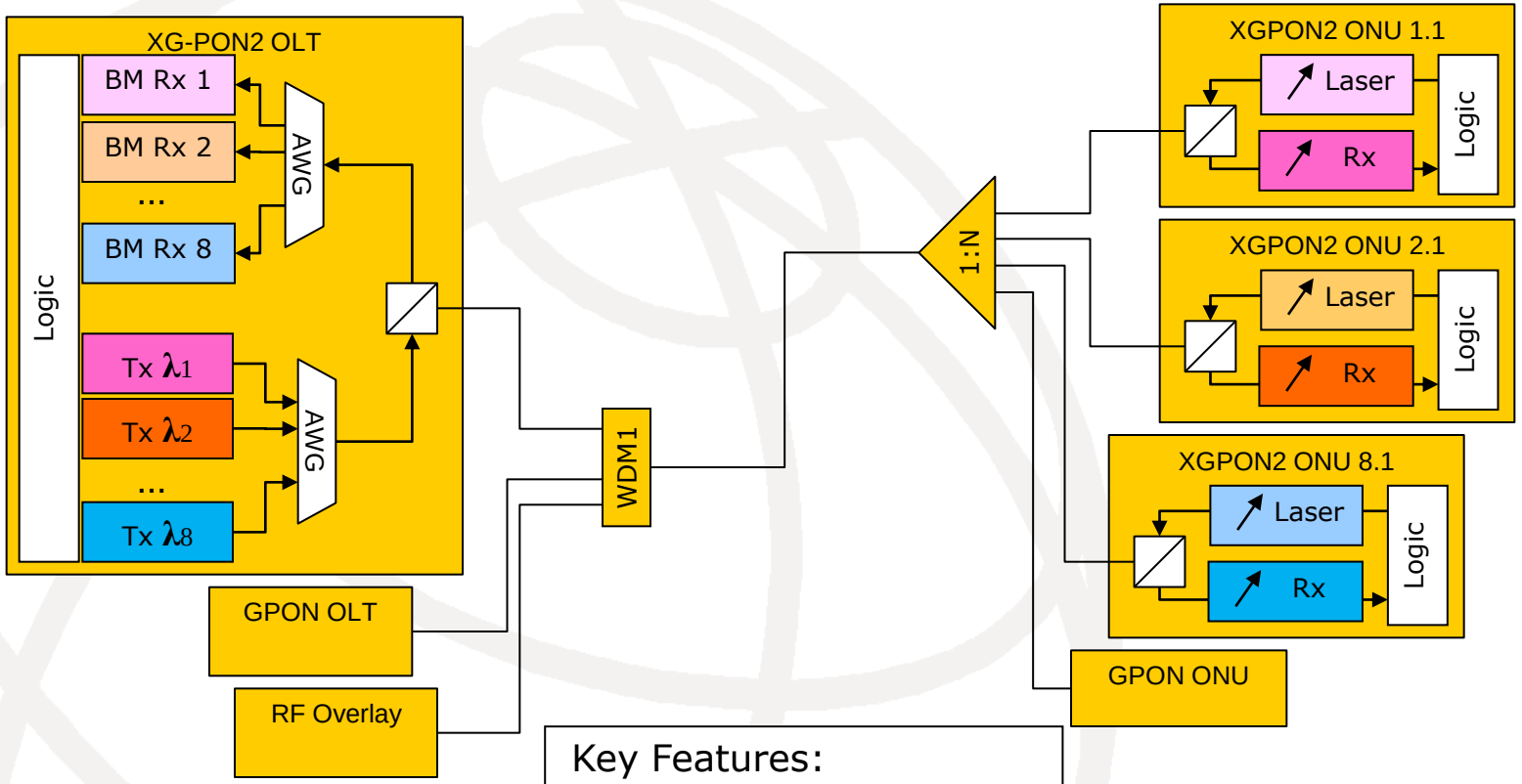
3C. O-OFDM-PON



3B. OFDM-PON



4. TWDM PON (XG-PON2)



Key Features:
- Builds on XG-PON1
- Uses splitter based PON

- Advantages
  - ✓ Reasonable costs
  - ✓ Up to 80 Gbps
  - ✓ Coexists with deployed GPON

- Challenges
  - − Tunable Receivers and Transmitters at ONU
  - − Spectrum allocation

NG-PON2 architecture scorecard

40G Serial
ALU

IL-WPON
LG-E, ETRI

RU-WPON
ERIC

SS-WPON
ALU, HW

Tun-WPON
ADVA

UD-WPON
NSN

OFDM-PON
Fuji, ITRI, Hisense, NeoP, Vit, ZTE

[WDM]-[O]-OFDM-PON
NEC

[O]-OFDM-PON
ALU

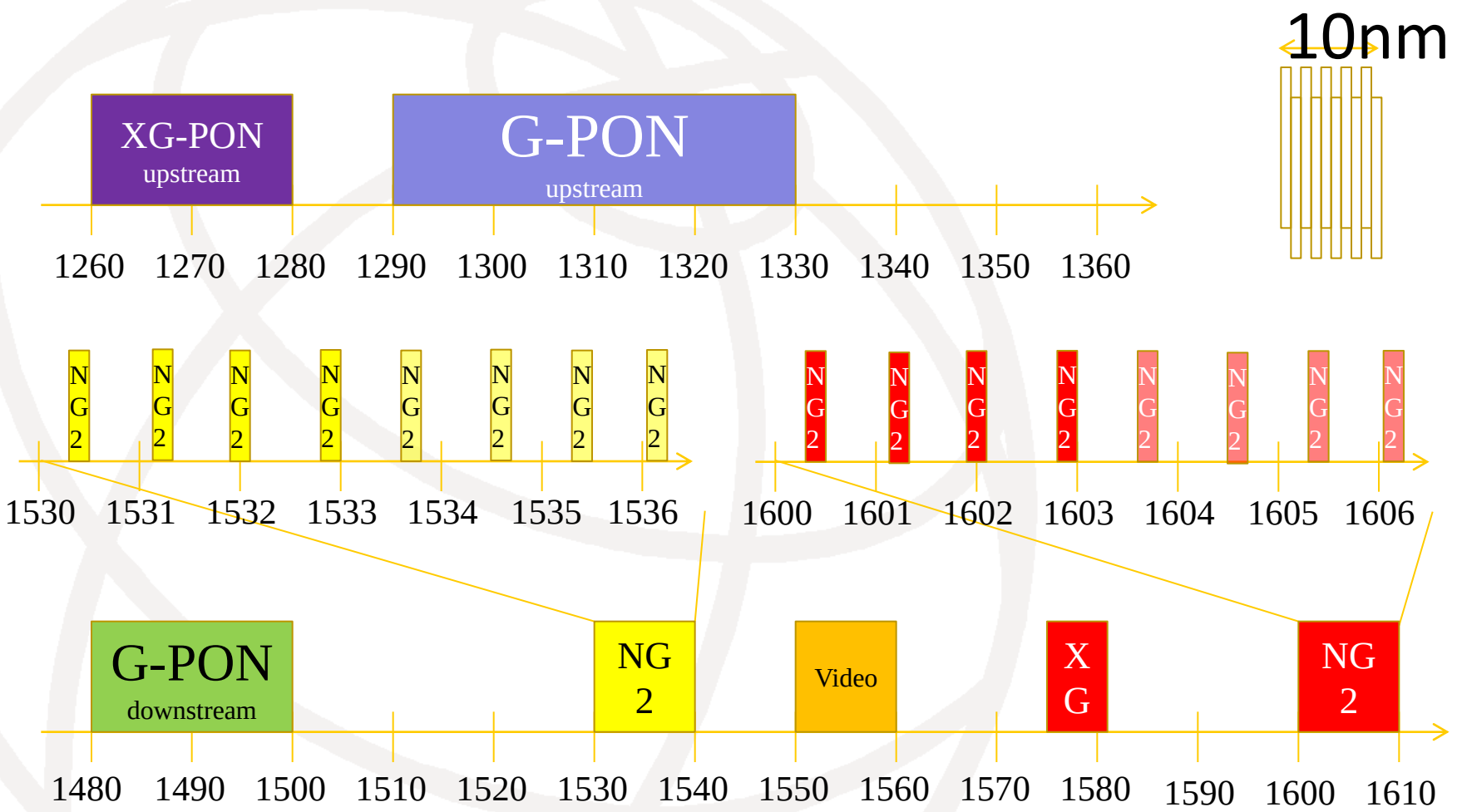
TWDM
ALU, BL, CX, HW, MIT, OKI, PMC, ZTE

Green = Selected!
Yellow = Optional enhancement
Red means not this time

Approved TWDM system requirements

- Base system: 40G downstream, 10G upstream
  - 4 channels in each direction
  - Compatible with G-PON, XG-PON, and RF video overlay
  - 20km @ 1:64 split ratio fully passive plant capable
- Optional extra capabilities
  - 8 channels in each direction
  - 10G upstream
  - DWDM overlay
- Standardization is expected to complete July 2013

NG-PON2 spectrum (rough consensus)



TWDM standards arrangement

- G.ngpon2.1 = Requirements
  - Consented at Sep 2012 meeting
- G.ngpon2.2 = Physical medium dependent layer
  - Draft in progress
- G.ngpon2.3 = TC layer
  - NG-PON2 specific TC features
- G.987.3 = Transmission convergence layer
  - 10G upstream to be added to this base standard
- G.multi = Wavelength control layer
  - Draft already started in Q2/15
- G.988 = ONU management and control interface
  - Standard in force, can be easily reused for TWDM

Other topics

- G.epon
  - Applies OMCI (G.988) to EPON
  - Relevant to P1904.1 Package B systems
- G.multi
  - Describes generic multi-wavelength control in PON access systems
- G.poc
  - Study of integrated PON-G.fast systems
  - Objective of reducing DP complexity

Thank you