

Operator Consensus for NG-EPON

Phil Miguelez

Comcast

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Introduction

- The technical deliberations within the 802.3ca Task Force are beneficial and necessary to define the best technology and system design direction to meet the PAR objectives
- Achieving the goal of incremental data tier rates from 25Gb to 100Gb while striving for a low cost design implementation that will enable the rapid adoption of the standard is extremely difficult and complex
- The eventual end users of the standard are not yet participating
- The majority of active participants on the Task Force today are primarily from the vendor community

NG-EPON Operator Survey

- The Task Force current deliberations involve critical pathway decisions affecting spectrum allocations and mux plans
 - 1+3 versus 1+4 wavelength plan solutions
 - O, S, C, or L band channel allocations and impacts of FWM, TDP, etc.
- Starting at the CableLabs Summer Conference, Comcast has reached out to a number of MSO PON system operators to get their views on NG-EPON requirements and determine if there is consensus on the desired wavelength plan solution
- The following slides provide a summary of the talking points used to generate the individual MSO conference call discussions
- All operators were asked to provide an email support statement

Operators Contacted



IEEE 802.3ca Objectives

**IEEE 802.3ca
100G-EPON**

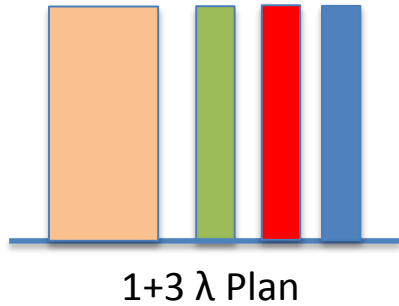
**Symmetric 25 Gbps
Symmetric 50 Gbps
Symmetric 100 Gbps**

- Task Force initiated January 2016
 - IEEE 802.3ca (NG-EPON)
 - Next meeting in Fort Worth, TX 9/12-16
- PAR Objectives
 - Provide a spec that supports MAC data rates of 25 / 50 / 100 Gbps
 - Provide compatibility with 10 GEPON
 - 29 dB optical loss budget
 - Network coexistence
- Specification Goals
 - Low cost 25/10 or 25/25 Gb channel
 - Incremental WDM solution for 50 / 100 Gb

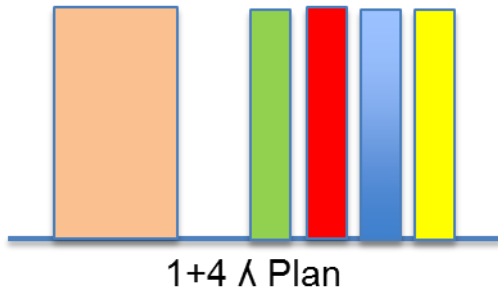
Current Technical Discussion Status

- Preferred approach is TDM combining of WDM channels
 - No tunable optics
 - O-Band upstream ONU lasers
- Strong desire to standardize a low cost initial 25 Gb channel while simultaneously providing a path to future 50/100G WDM
 - WDM muxing losses will reduce available optical budget by up to 5 dB
 - Loss mitigation requires higher cost lasers and / or optical amplification
 - Mitigation burdens the cost of 1st channel deployments
- Task Force split between 2 potential options (1+3 or 1+4)
 - Vendors preference targets lowest cost 25 Gb 1st ch configuration
 - Operator preference favors simple optical design, clear path to 100 Gb

Technical Decisions – Channel Plan Selection

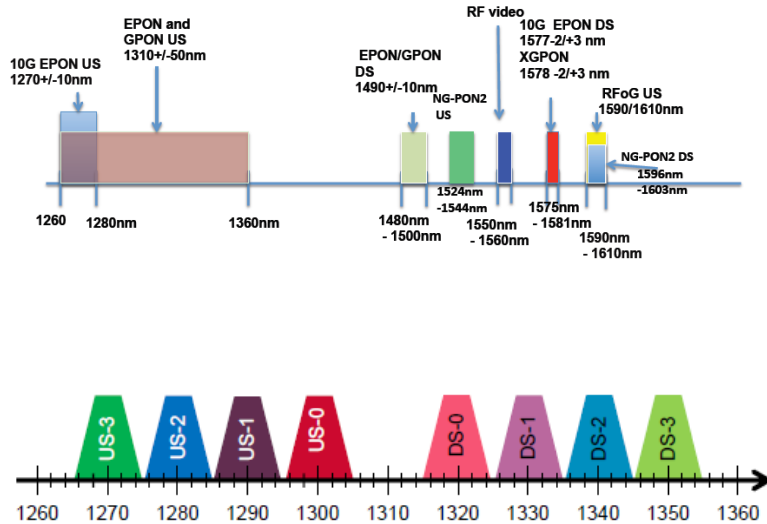


- 1+3 Wavelength Plan
 - Four co-located 25 Gb channels with WDM combining provides incremental 25/50/75/100 Gb data rates
 - First channel BW can be selected for lowest cost
 - Potential for BOSA package, simplifies ONU optics
 - Mux/Demux loss mitigation requires higher power cooled lasers, and increased complexity (optical amp)
 - 25 Gb = Ch 1, 50 Gb = Ch 1+2, 100 Gb = Ch 1+2+3+4



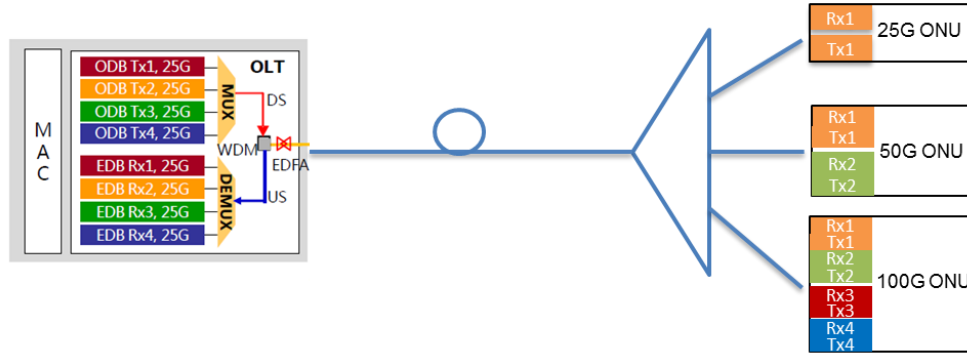
- 1+4 Wavelength Plan
 - Dedicated 25 Gb channel plus 4 WDM 25 Gb channels
 - Allows low cost uncooled O-Band 25 Gb 1st channel
 - WDM channels could be allocated to O, S, C, or L band
 - Defers cost and complexity to 50 / 100 Gb solution

Technical Decisions – Spectrum Allocation



- O-Band preferred for US channels
 - Take advantage of data center device volumes and development efforts to reduce CPE optics cost
 - Avoids fiber dispersion issues
 - Available spectrum allows channel spacing to minimize FWM impairments
 - 1 dB per 10 km higher fiber loss
- O / S / C / L bands are all potential candidates for DS channels
 - OLT density and scalability benefits from traditional pluggable packaged lasers

NG-EPON Standard Technical Challenges



- Added mux needed for higher speed ONU's greater than 25 Gb
- Mux loss mitigation adds cost to every channel implementation
 - Higher power lasers, optical amplification, specialized optical passives, etc.
- Higher modulation data rates entail larger transport penalties
 - Higher dispersion power penalty, higher SNR threshold
- Result is considerably higher cost and complexity to meet 29 dB optical power budget required for coexistence with 10G EPON

Network Application Realities

- Fiber construction costs are the major obstacle to FTTH growth
 - Classic PON reference design is 20 km for a 32 hp split ratio
 - Fiber intensive network plus requires numerous fiber hubs
 - High port costs due to low service group size
 - Pole attach / make ready and UG trenching costs are prohibitive
- Many secondary hubs can not support added PON equipment
 - Resulting backhaul to the primary hub or HE exceeds optical power budget
- Operator networks migrating to Distributed Access Architecture
 - Many network links are 10 km or less
 - PON Extenders and R-OLT allow extended reach and 8:1 fiber utilization
 - Scalable alternative to mainframe OLT's
 - Reduces pressure on Hub density, allows Hub consolidation

NG-EPON Specification Proposals

Operator requirements for NG-EPON Standard

1. Confirm a 4 channel wavelength plan specification (1+3)
2. Confirm use of O-Band upstream channels
3. Change reference ODN link to 10 km
 - Mitigates mux loss issue while maintaining 29 dB optical power budget
 - Allows lower cost ONU and simplifies network design
 - Aligns with Distributed Network Architecture industry direction
4. ?

Proposal 1: Confirm a 4 channel wavelength plan specification (1+3)

Supporters

- Phil Miguelez  COMCAST
- James Zhang  中国电信
CHINA TELECOM
- Matt Pedersen  Charter
COMMUNICATIONS
- Robert Kuse  COX
- Masashi Suzuki  J:COM
- Bob Beaver  ROGERS

Opposed

Abstain

- Matt Sheppard  LIBERTY GLOBAL

Proposal 2: Confirm use of O-Band upstream channels

Supporters

- Phil Miguelez 
- James Zhang 
- Matt Petersen 
- Robert Kuse 
- Masashi Suzuki 
- Bob Beaver 
- Matt Sheppard 

Opposed

Proposal 3: Change reference ODN link to 10 km

Supporters

- Phil Miguelez  COMCAST
- James Zhang  中国电信
CHINA TELECOM
- Masashi Suzuki  J:COM
- Bob Beaver  ROGERS.

Opposed

- Robert Kuse  COX.
- Matt Sheppard  LIBERTY GLOBAL
- Matt Petersen*  Charter
COMMUNICATIONS

* 10 km links meet all of Charter's application requirements but concerned about ODN definition in the standard



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