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# **EPON Compatibility with Peer-Peer, 802.1D Bridging, Pause Operation and Link Aggregation**

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# Scope of this presentation

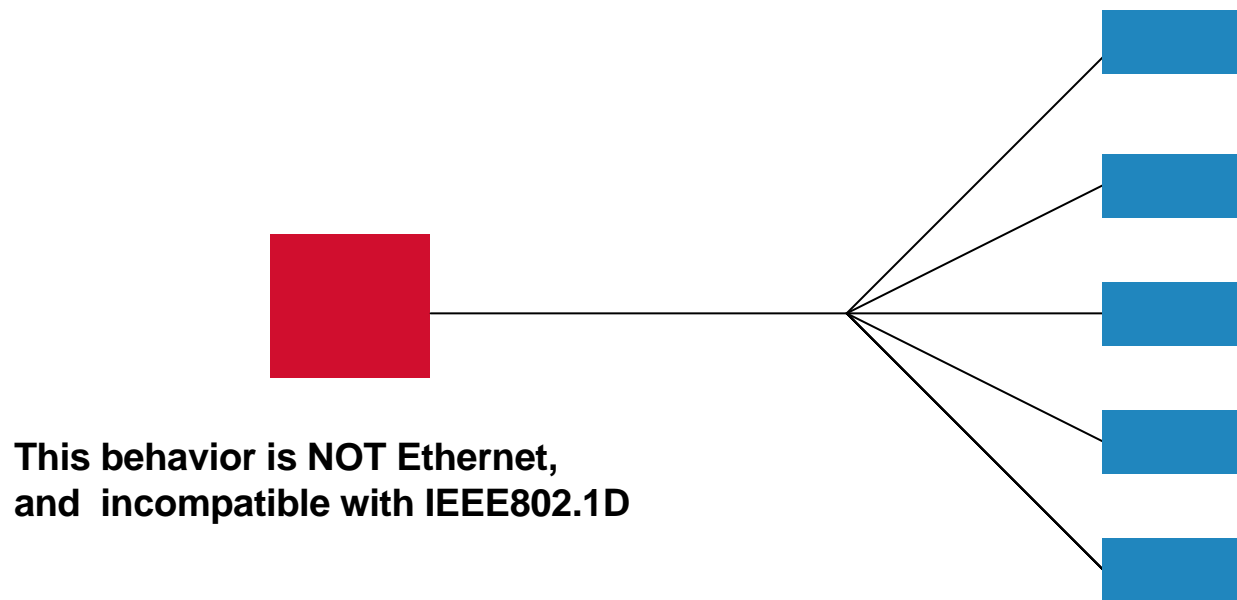
- In EFM May 2001 meeting, Study Group Chair asked the group to investigate whether EPON can meet the compatibility criterion from 802.3 5 Criteria
  - 802.1D bridging, Peer to Peer key concept, Pause Operation and Link Aggregation.
- Authors acknowledge that most service providers do require or need 802.1D bridging capability in a EPON environment.
- Objective of this presentation is to show how EPON can meet 5 Criteria of 802.3.

# List of Requirements

- **802.1D Bridging Compatibility**
  - Shared link ( Broadcast media both upstream and downstream )
  - Or, P-P Link ( Unicast media both upstream and down stream )
- **Peer to Peer Key Concept**
  - Enables stations to communicate directly on a point-to-point, or point-to-multipoint, basis without requiring them to communicate with any intermediate switching nodes...
- **802.3 Clause 31 Annex 31B Pause Operation**
  - Downstream Pause to stop one ONU sending to OLT
  - And, Upstream Pause to stop OLT sending to one ONU
- **802.3 Clause 43 Link Aggregation**
  - Allow a MAC Client to treat multiple ports as if a single port

# EPON Physical Topology

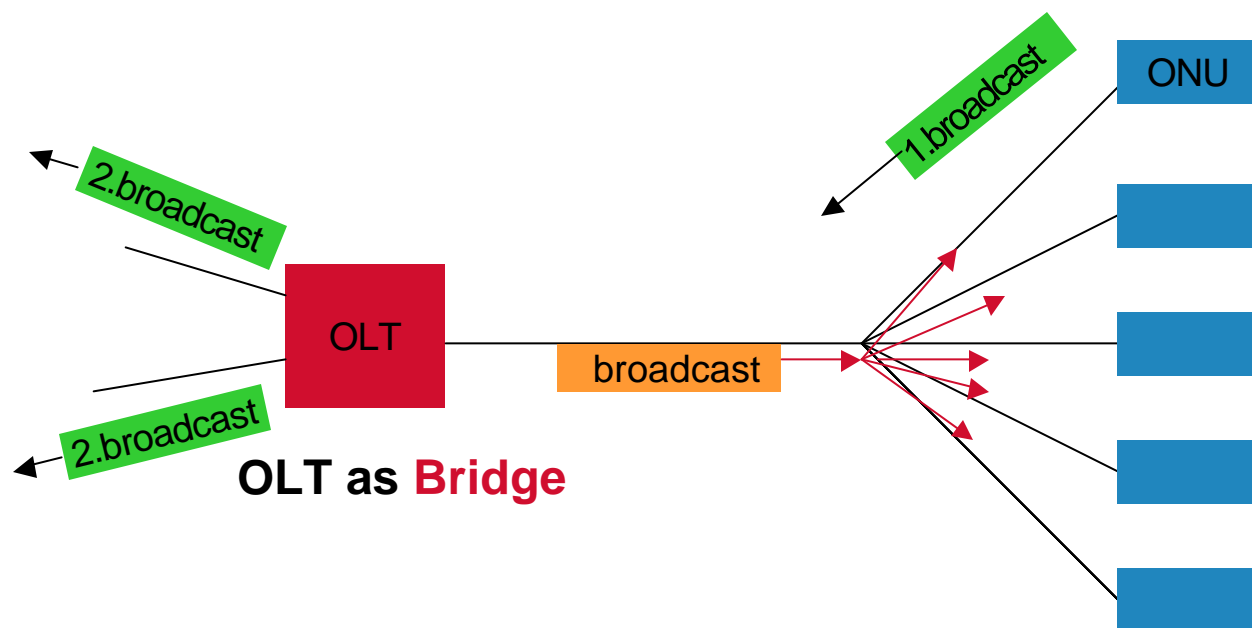
**P-MP Downstream, but P-P upstream....**



This behavior is NOT Ethernet,  
and incompatible with IEEE802.1D

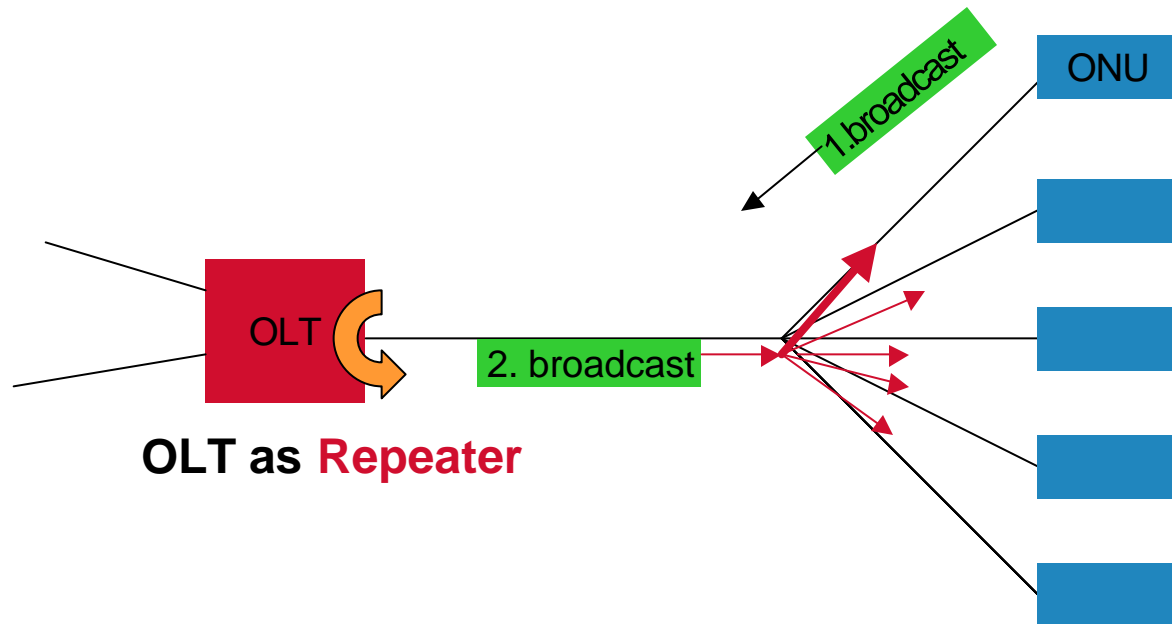
***802.1D Needs "Ethernet" to be either "Shared Medium" or "P-P links"***

# 802.1 Bridging by EPON ?



- If ONU treats upstream as P-P, ONU MAC does **not** expect his Frames back to him.
- Can OLT at Bridge mode send back frames to particular ONUs at PHY layer ?
- How to support multiple bridged domains in P-MP Downstream ?

# 802.1 Bridging by EPON?



- If OLT acts as Repeater, ONU must filter out his frames by PHY
- 10Km Distance at Gbps in EPON prevents classical PHY level detection

# A Requirement to EPON

- **Shared Media**

**Both Upstream and Downstream: P-MP**

*A simple repeater by OLT does not work.*

*ONU must detect and discard own frames at PHY layer.*

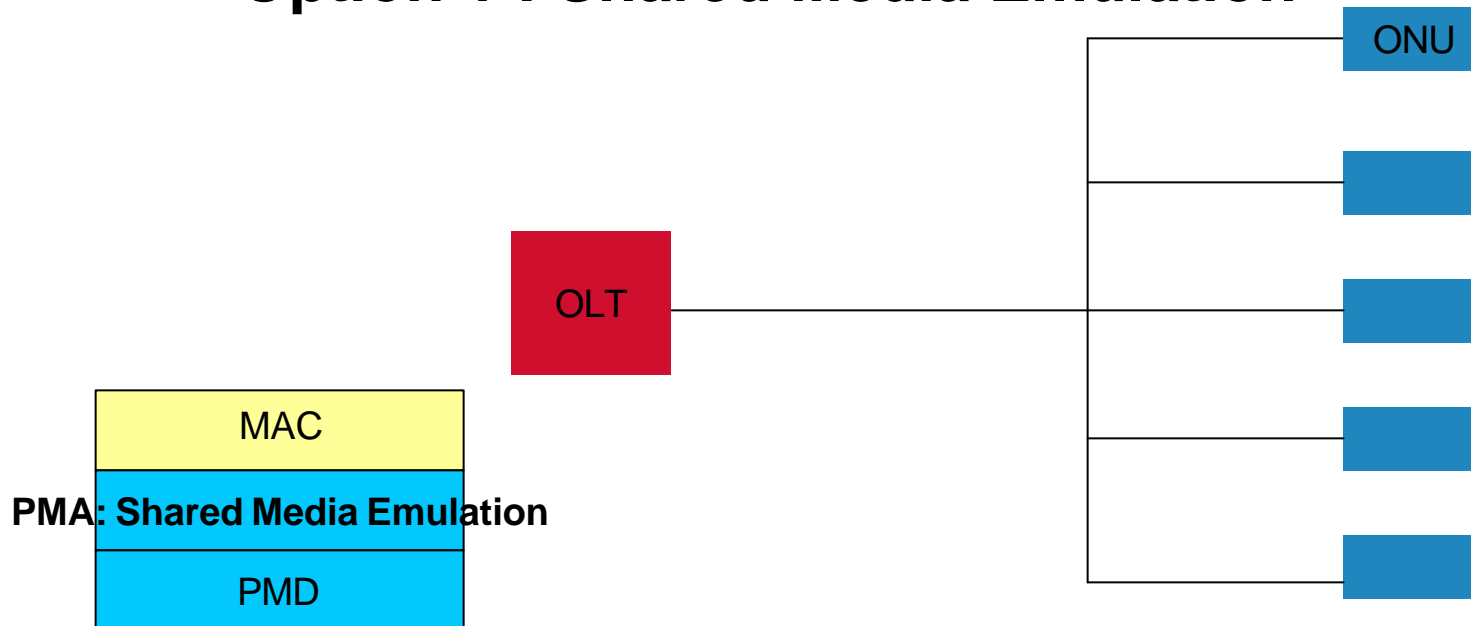
- **Or, Many P-P Links**

**Both Upstream and Downstream: P-P**

*How to emulate Many P-P Links by a P-MP link ?*

# 1) Logical Topology for MAC

## Option 1 : Shared Media Emulation



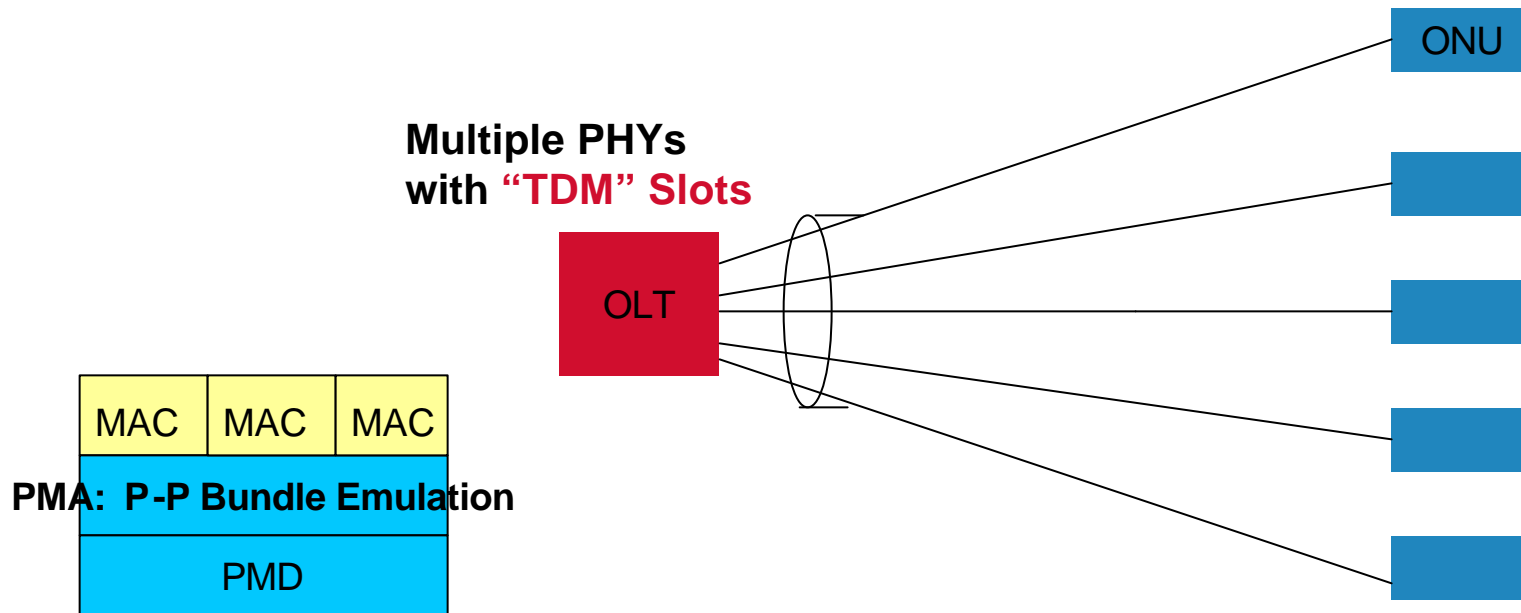
### Shared Media Emulator in PHY Layer ( OLT as repeater )

- Everybody sees every frames
- Frames to carry Logical PHY ID at “PHY layer”
- Downstream frames to be filtered out by Logical PHY ID



## 2) Logical Topology for MAC

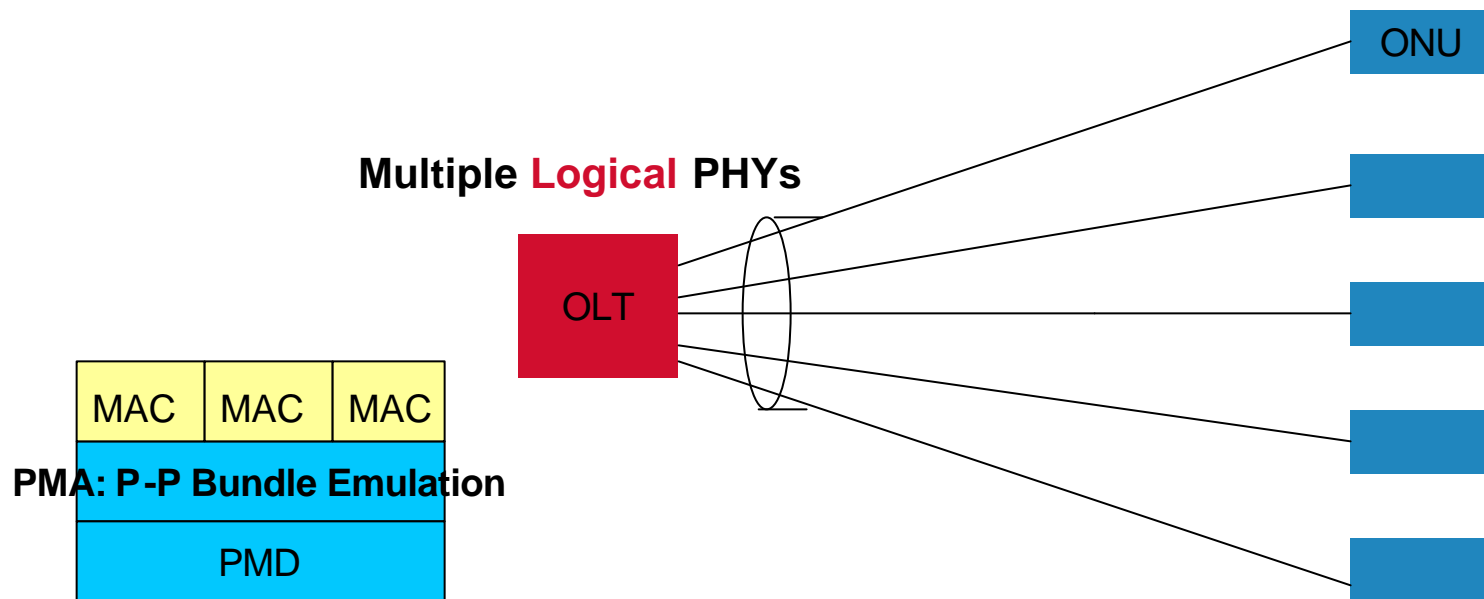
### Option 2 : Many Point to Point Links with “TDM”



- Both UP and DOWN are TDM slot separated.
- Downstream frames to be filtered out by TDM Slot

# 3) Logical Topology for MAC

## Option 3 : Many Point to Point Links by **Frame Mux**

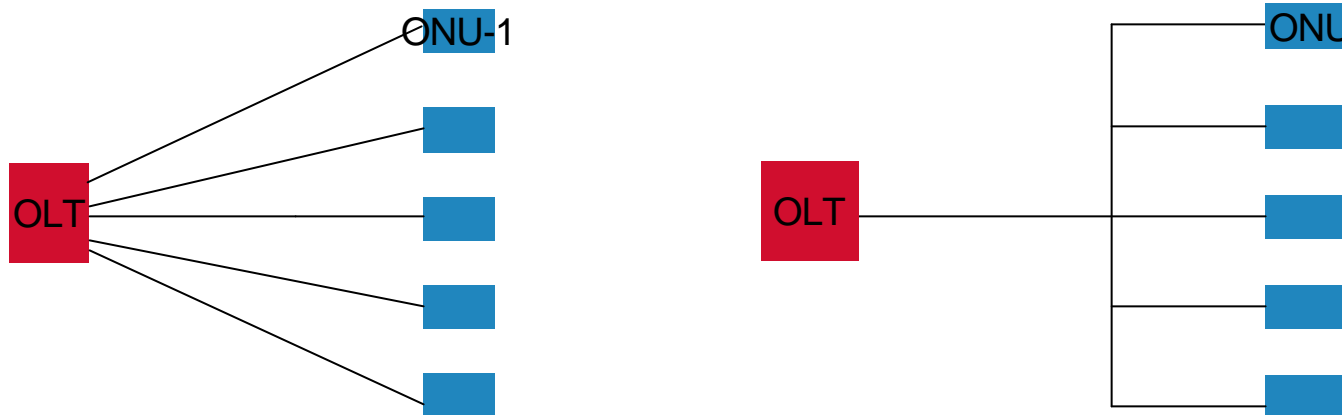


- Frames to carry Logical PHY at “PHY layer”
- Downstream frames to be filtered out by Logical PHY ID

# Peer to Peer

**-Shared Media Emulation meets Peer to Peer Req.**

**-P-P Emulation meets Peer to Peer Req.**



# Comparison

Options	Head End	Pros	Cons
1) Shared Media Emulation	Repeat all upstream frames to all downstream  ( ONU to filter frame by logical PHY id)	Single IF at OLT	Downstream BW is affected by Upstream  Logical PHY ID needed on frames  Not compatible with 802.3ad, RSTP
2) TDM based P-P Bundle Emulation	Downstream TDM slot allocated to each ONU	No ID needed on frames  Meet all Compatibility Req items	2 ONUs can not receive the same frames.  Downstream BW is TDM-divided by many ONUs  Multicast frames has to be sent multiple times.
3) Frame based P-P Bundle Emulation	Logical PHY ID to demultiplex frames at PHY level.	Bandwidth efficiency and flexibility  Meet all Compatibility Req items	Logical PHY ID needed on frames

# Logical PHY ID Options

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- Logical PHY ID is for ONU to Filter downstream broadcast frame at “PHY level”
- 4 Possibilities:
  - Source ID
  - Destination ID
  - Bitmap
  - Multiple PHY Group ID

# Considerations on Logical PHY IDs

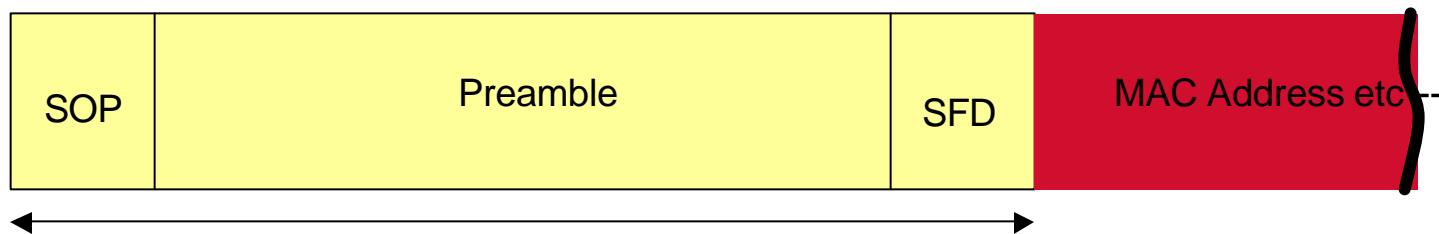
- **If using Source and/or Destination ID , EPON becomes either one shared media or P-P Links**
  - Shared Media Emulation needs Source PHY ID
  - P-P Link emulation needs Dest PHY ID
  - Compatible with 802.1D
- **If using Bit Map or Multi-PHY Group ID, EPON can be configured as any number of shared media or P-P links**
  - Does not fit any existing MAC Ethernet model
  - Bit map may not Scale
  - Multiple PHY Group ID needs configuration
- **Logical PHY ID can be applied to user-side subports of ONUs**

# Where to put Logical PHY ID ?

- **802.1 want Logical PHY ID to be “invisible”**
- **Possible Options**
  - Preamble / IPG : no overhead
  - New EPON PHY Header : some overhead
  - New MAC encapsulation : some overhead, CRC recalc.
  - New MAC control frame ie. 802.3X : big overhead
  - Do NOT use VLAN Tag!
- **Natural & low overhead for frame filtering :**  
**per frame = Preamble**

# Example of Logical PHY ID

- SOP + 7byte preamble to include:
  - Up to 32 ONUs / Addressing options ( 1-4byte )  
[Bit map or Group ID : 32bits ]  
[Src/ Dest bit + Logical PHY ID : ( 8-16bits)]
  - Src Logical PHY ID for upstream or Shared Media
  - Dest Logical PHY ID for downstream
  - Header Error Correction / Detection ( 1byte )



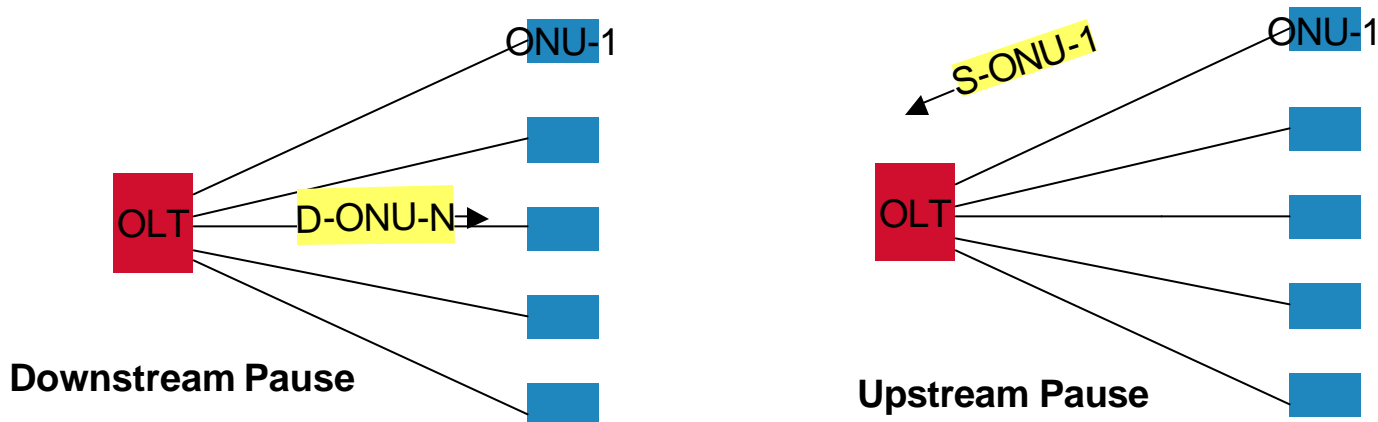


# Registration of Logical PHY ID to each ONU

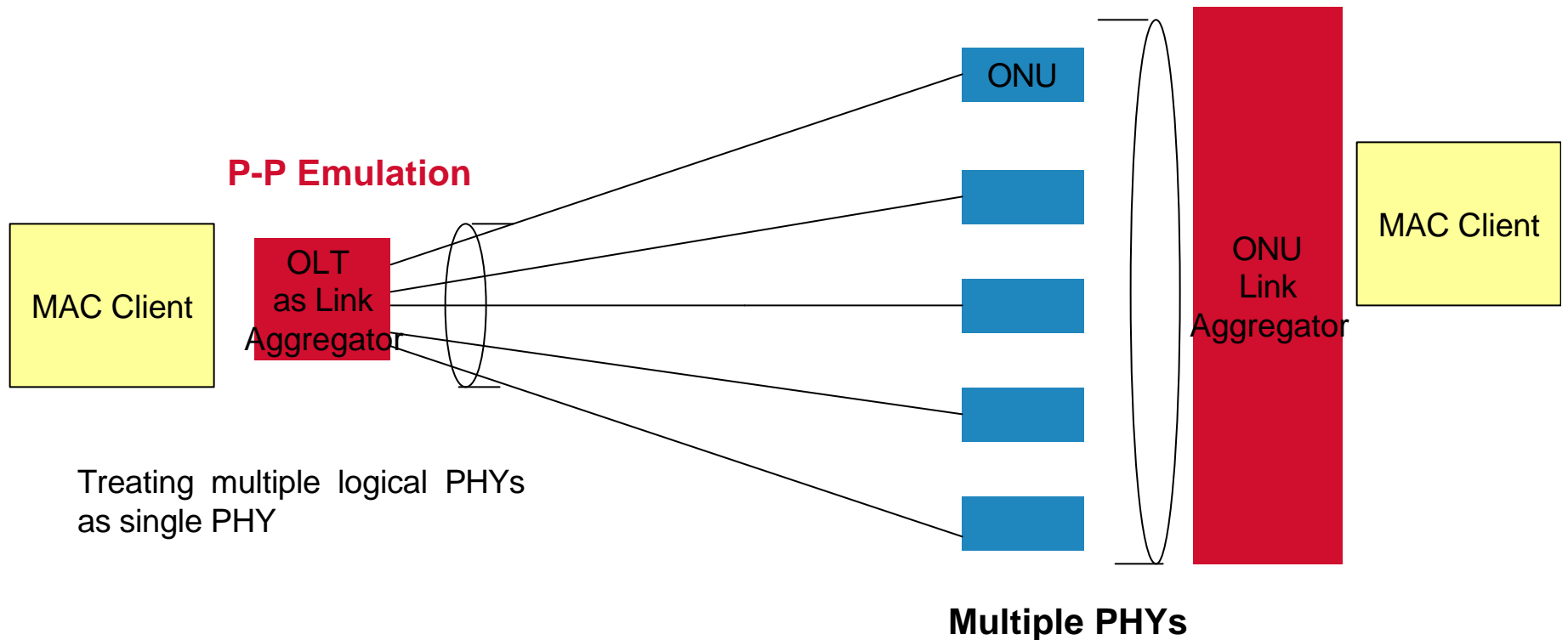
- Auto Allocation at registration phase
- Allocated by ONT based on
  - ONU MAC address and
  - User-side physical port number ( option )

# 802.3 Annex 31B Pause Operation

- Downstream Pause to stop **one Logical PHY** sending to OLT
- Upstream Pause to stop OLT sending to **one Logical PHY**
- Realized by **S/D-Logical PHY ID** at PHY layer in Pause frame
- Also Applied to Pause based Upstream Access Control:  
[http://www.ieee802.org/3/efm/public/may01/unitt\\_1\\_0501.pdf](http://www.ieee802.org/3/efm/public/may01/unitt_1_0501.pdf)

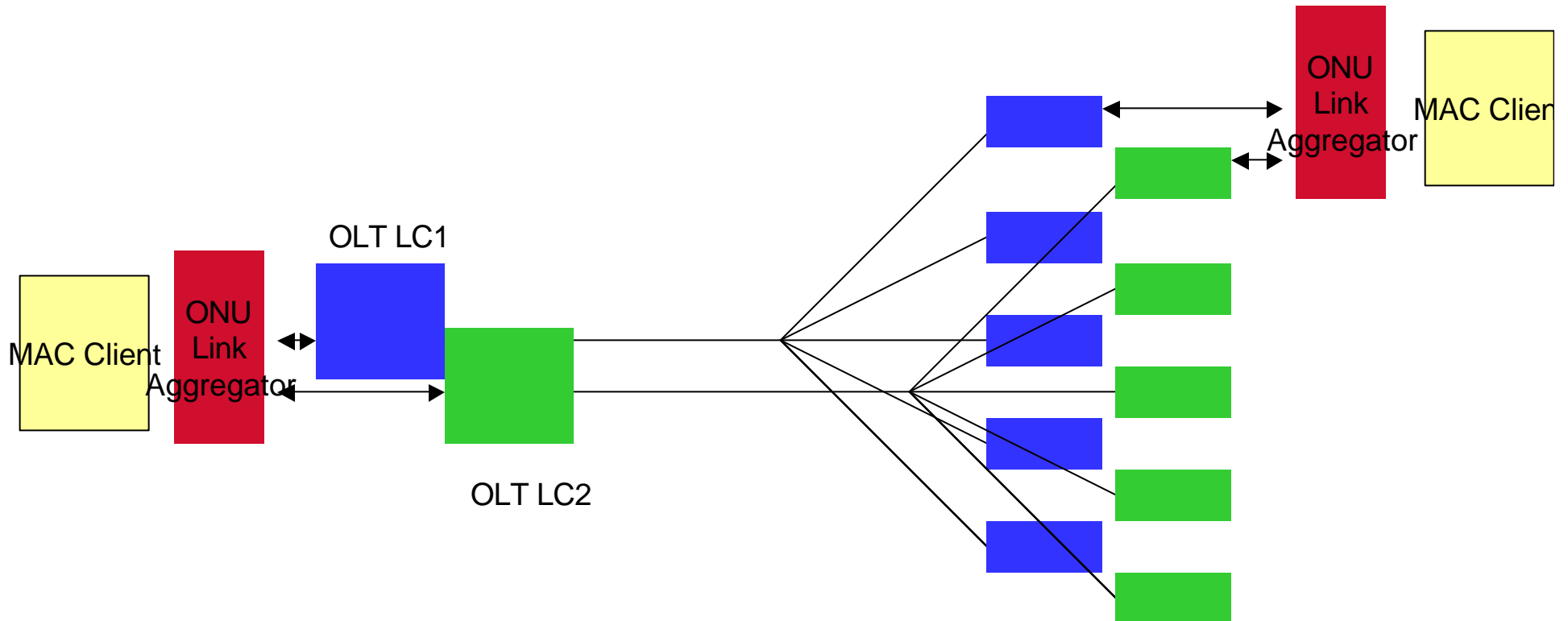


# 1) Link Aggregation using multiple Logical PHY ports



This is possible with P-P emulation. Shared Media Emulation can not do it.

## 2) Link Aggregation using multiple EPON systems



This is possible with P-P emulation. Shared Media Emulation can not do it.

# Compatibility Check List

## Logical PHY Multiplexing /ONU-ID Scheme

- **802.1D Bridging ----- Yes**  
Source ONU to drops bridged frames via logical PHY ID at PHY level
- **Peer to Peer Key Concept--- Yes**  
OLT treats each Logical PHY port to ONU as a separate port =>Every thing is P-P.
- **802.3 Clause 31 Annex 31B Pause Operation ----Yes**  
Pause frame to carry ( & filtered by ) logical PHY ID at PHY Level.  
Both Upstream ( Source PHY ID ) and Downstream ( Dest PHY ID )
- **802.3 Clause 43. Link Aggregation --- Yes**  
-With the P-P Emulation

# Compatibility with EPON Access Protocols

