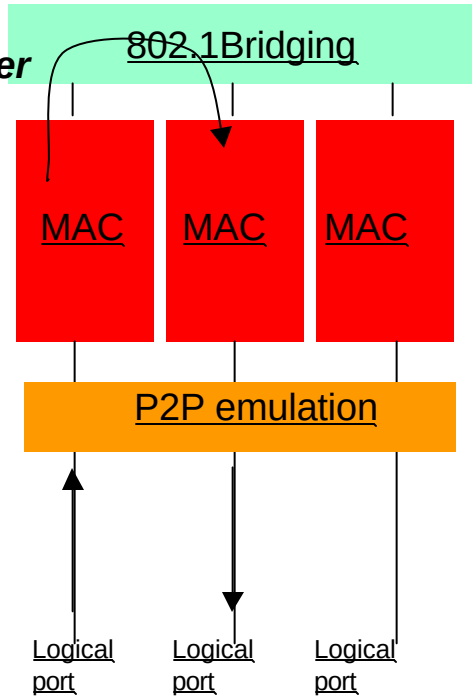
EPON
P2P Emulation and Shared Media Emulation Layer Model and Behaviors

Hiroshi Suzuki, Cisco Systems
Onn Haran, Arial Maislos, Passave

802.1's view of 802.3 Ethernet: P2P or Shared Media

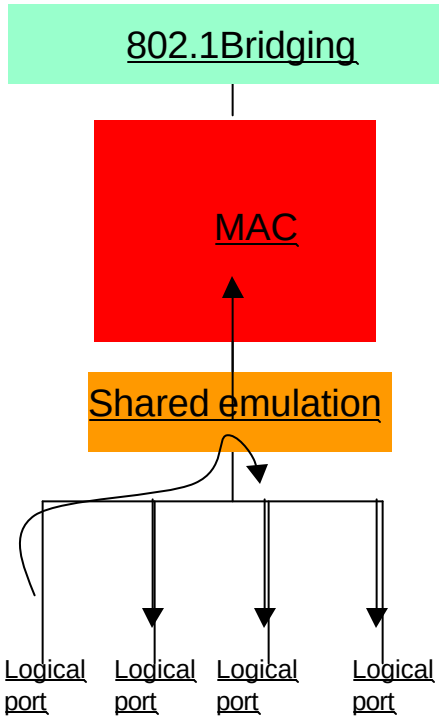
Forwarding among ONUs only at higher layer



Transmit and demux frames to each MAC corresponding Logical PHY ID

Transmit own Logical PHY ID, receive only matching ID

P2P Emulation



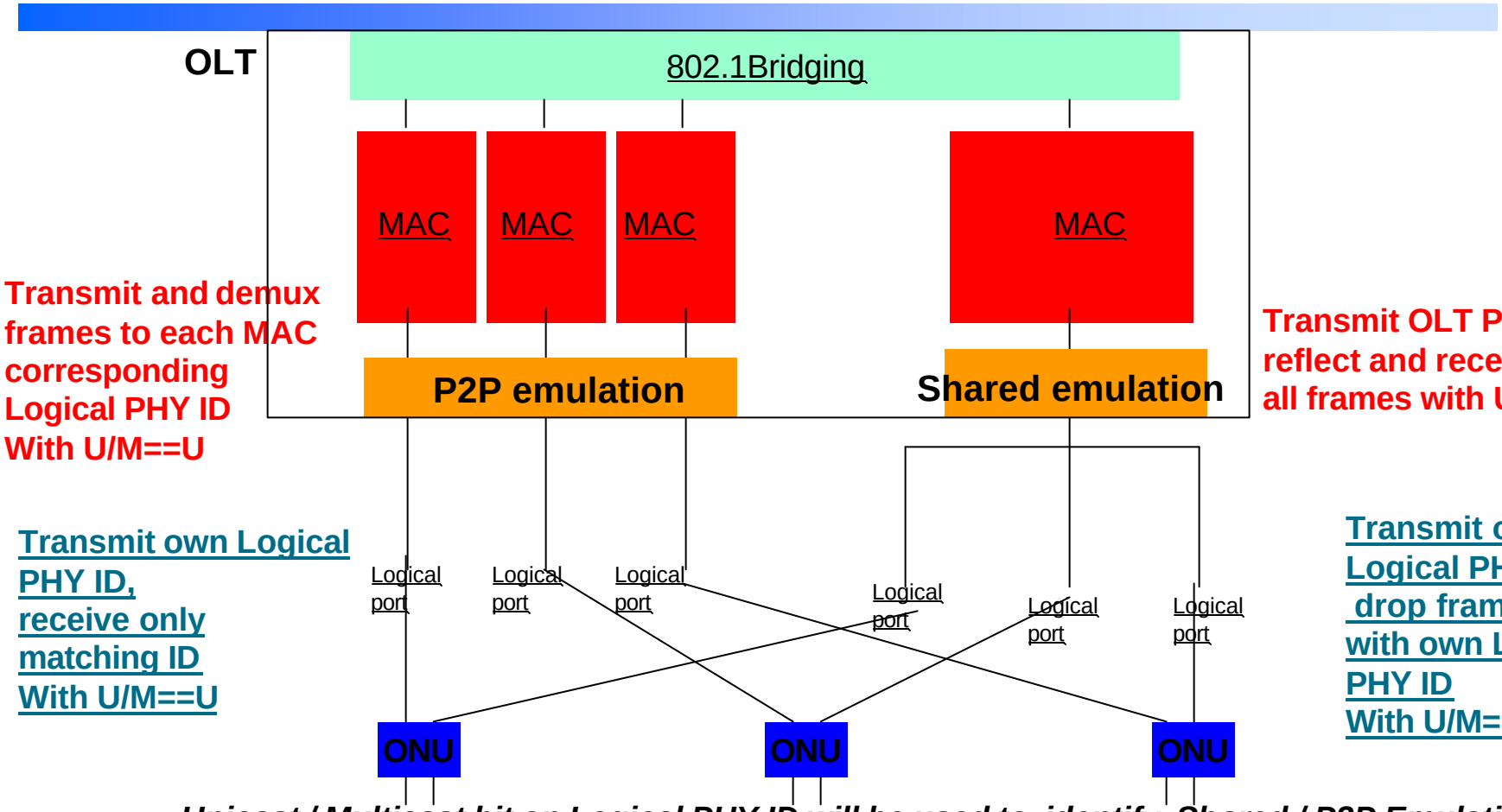
Transmit OLT PHY ID, reflect and receive all frames

Everybody sees all frames except own

Transmit own Logical PHY ID, drop frames with own Logical PHY ID

Shared Media Emulation

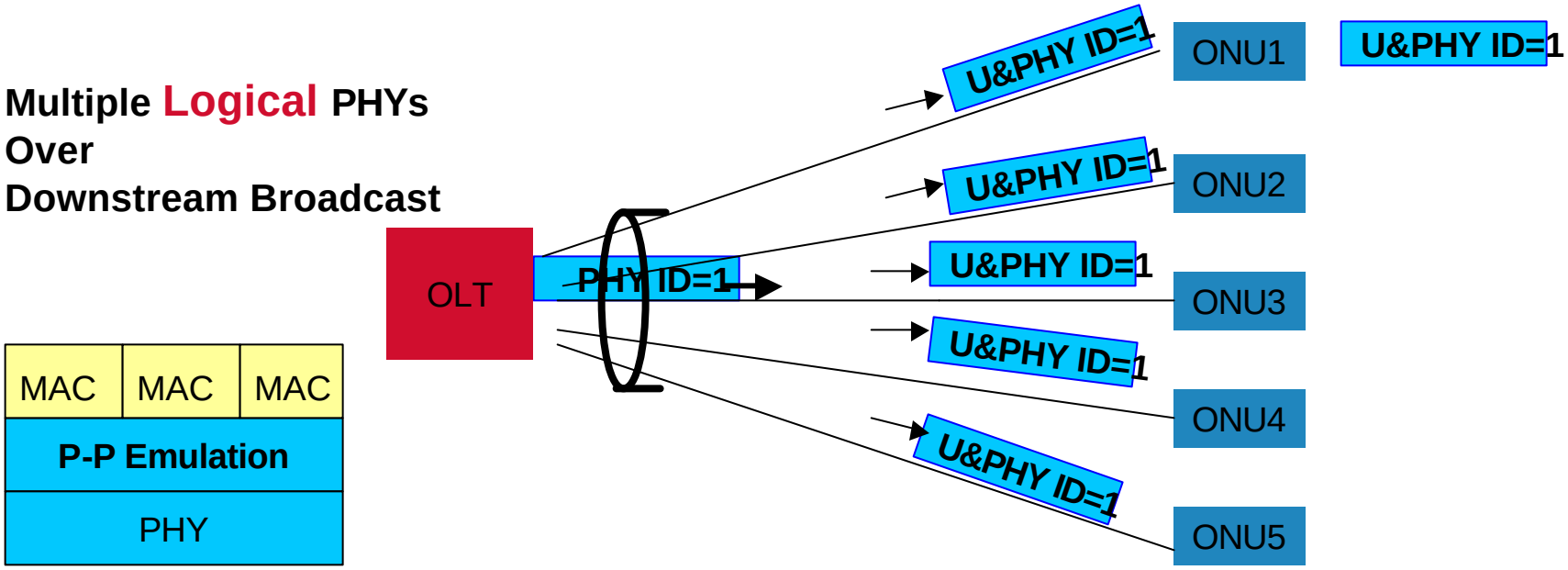
P2P and Shared Media Combined Mode



-Unicast / Multicast bit on Logical PHY ID will be used to identify Shared / P2P Emulation
-An ONU may support both options or only one operational mode.

How Point to Point Emulation works

Many “Point to Point Link” Emulation over EPON

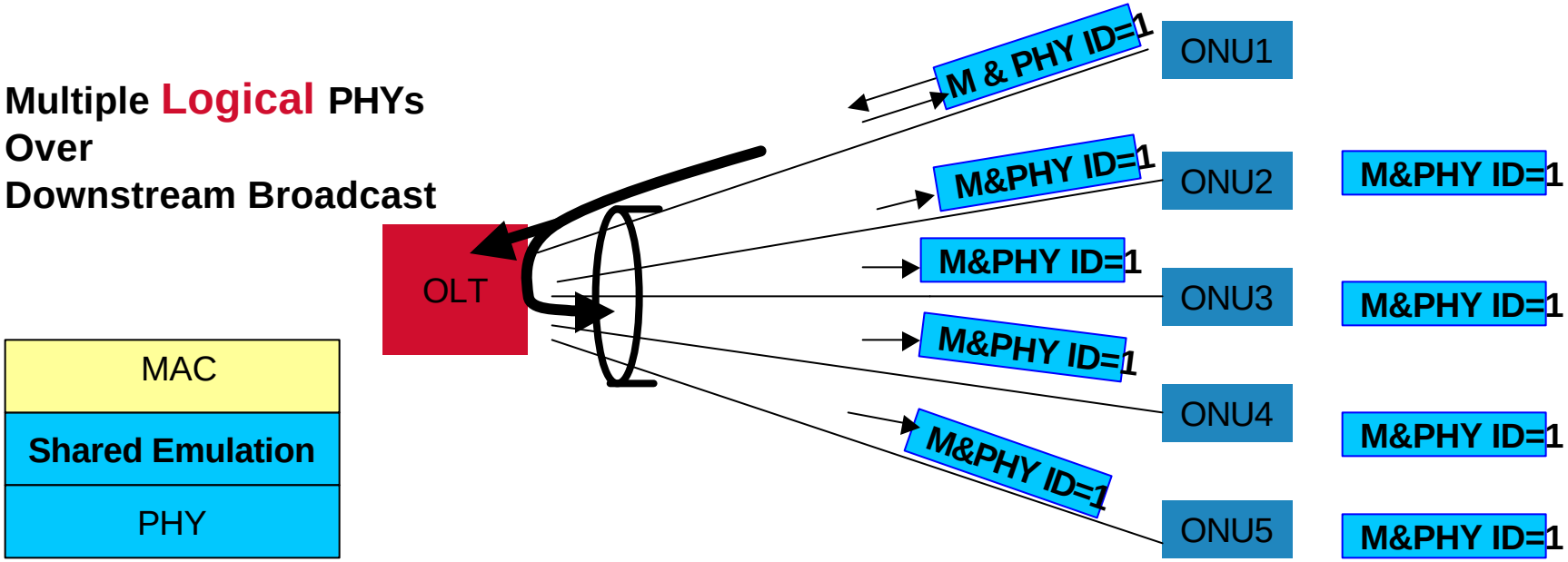


-ONU to Transmit Frames with own Logical PHY ID as Source ID with U/M==U
-ONU to Receive Frame with U/M==U &Logical PHY ID matching with owns
-OLT to Transmit and demux frames to each MAC
corresponding Logical PHY ID with U/M==U

How Shared Emulation works

"Shared Media Link" Emulation over EPON

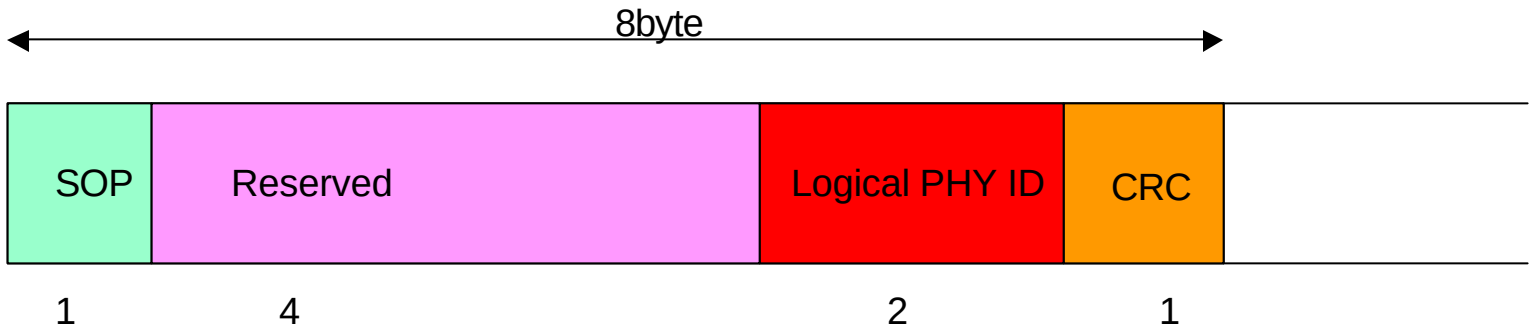
Multiple Logical PHYs
Over
Downstream Broadcast



-Transmit Frames with own Logical PHY ID as Source ID with U/M==M
-ONU to drop downstream frames with owns Logical PHI ID with U/M==M
-ONU to received downstream frames with Logical PHY ID =! Owns with U/M==M
-OLT to receive and reflect ALL frames with U/M==M

Logical PHY ID Format

- **8 byte Preamble to carry:**
  - **2byte : Logical PHY ID**
  - **2-4byte : Reserved**
  - **1byte : CRC**
- **2 byte Logical PHY ID = 1bit mode indicator + 15 Bit PHY Ids**
- **Mode indicator: P2P / Shared Emulation**
- **CRC8 protected**



When passing a frame to MAC, convert back to the normal preamble.

Logical Phy ID Semantics

- **Assumptions**
  - -P2P and Shared media type has to be recognized by Logical Phy ID
  - -P2P
    - Downstream: Source is always OLT, Need to identify Destination
    - Upstream: Destination is always OLT, Need to identify Source
  - -Shared
    - Destinations: Every Shared media MAC instances, except the source
    - Source:Need to identify source
- **Logical Phy ID { Emulated Media Type, PHY Tag }**
  - -Emulated Media Type: U/M bit = P2P or Shared Media
  - -PHY Tag : allocated for each “PON entity” (Logical MAC & port instance)
    - -P2P UpStream: Source ID
    - -P2P Downstream: Destination ID
    - -Shared Media: Source ID

Assertions

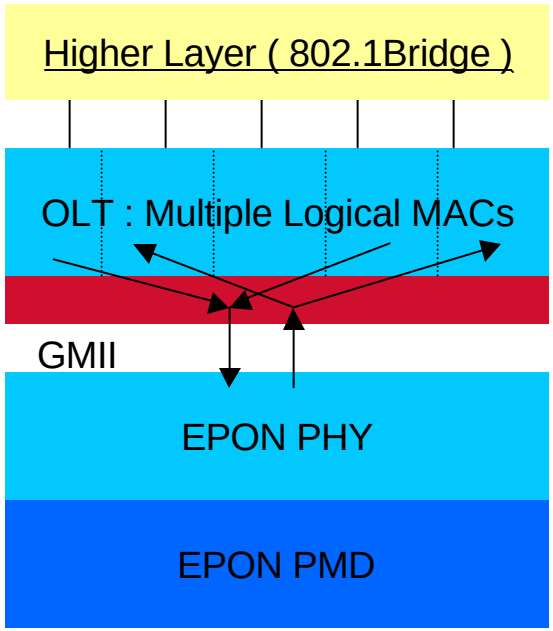
- **Assertions**
  - -Each PHY tag is allocated for each PON entity (Logical MAC & port instance)
  - -OLT and Each ONU will have at least one and may have multiple PON entities
  - -# of P2P links under one EPON = # of P2P MAC instances of all ONUs (=N)
  - -# of shared link under one EPON = zero or one
  - -# of Phy Tag needed under one EPON = N + 1 (OLT)
  - -P2P ONU PON entity shall receive a frame with {P2P, Destination ID = Owns }
  - -Shared ONU PON shall receive a frame with {shared, Source ID = others }
  - -No P2P ONU PON entity shall receive a frame with { P2P, Destination ID = others }
  - -No shared ONU PON entity shall receive a frame with {shared, Source ID = its own }
  - -No P2P ONU PON entity shall receive a frame with { shared, * }.
  - -No Shared ONU PON entity shall receive a frame with {P2P, * }

Why P2P/Shared emulation "below MAC" ?

- For 802.1D bridging among EPON ONUs, ONU MUST filter out downstream frames without MAC address table which might be "obsolete".
- Only solution : P2P emulation or shared media emulation below MAC.
- PCS sub Layer in PHY vs Reconciliation Sublayer (RS) in MAC

  RS is better place for multiple logical MAC mux/demux implementation

P2P Emulation
OLT view

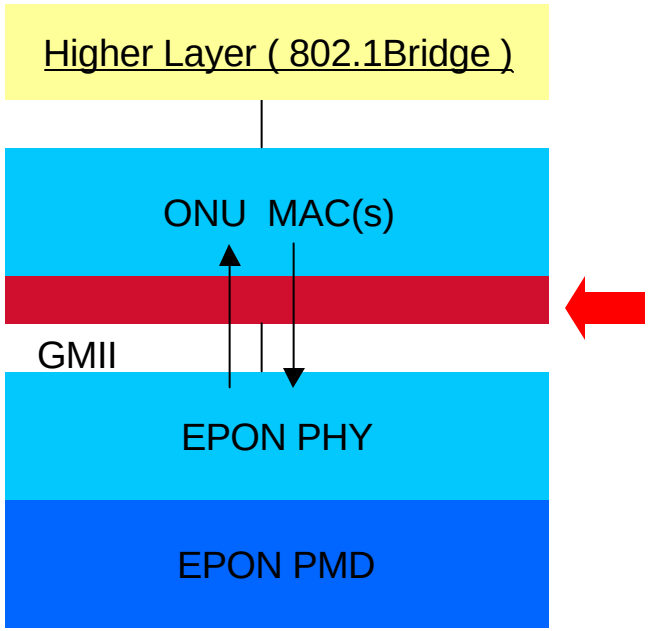


- **P2P Emulation on RS layer**
  - **Mux/Demux Frames by Logical PHY ID**
  - **Downstream TX control among multiple MAC**

OLT Must support Multiple Logical MACs corresponding to individual Logical PHY ID / ONUs P2P at RS layer to multiplex and demultiplex frames from/to individual Logical MAC.

Forwarding among ONU happens at Higher Layer ONLY
Multicast to ONUs happens at Higher Layer ONLY and needs multiple transmission to ONUs

P2P Emulation
ONU View

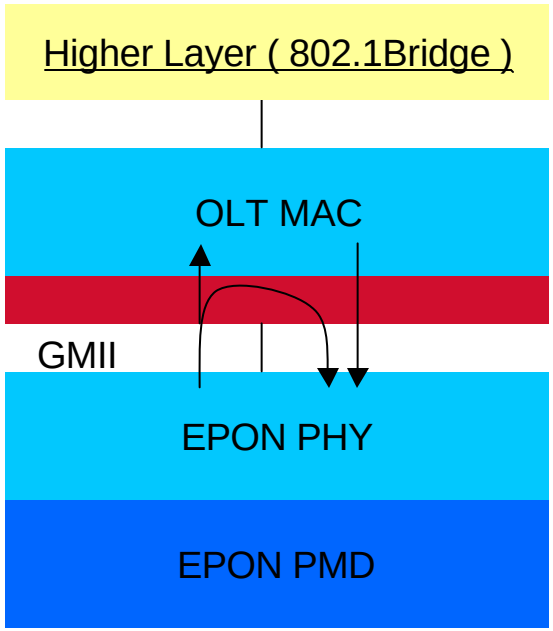


- **P2P Emulation on RS layer**

ONU may support multiple PON entities (logical MACs) with corresponding Logical PHY Ids

When ONU have multiple PON entities, Mux/Demux behavior needed at ONU as well.

Shared Emulation
OLT View

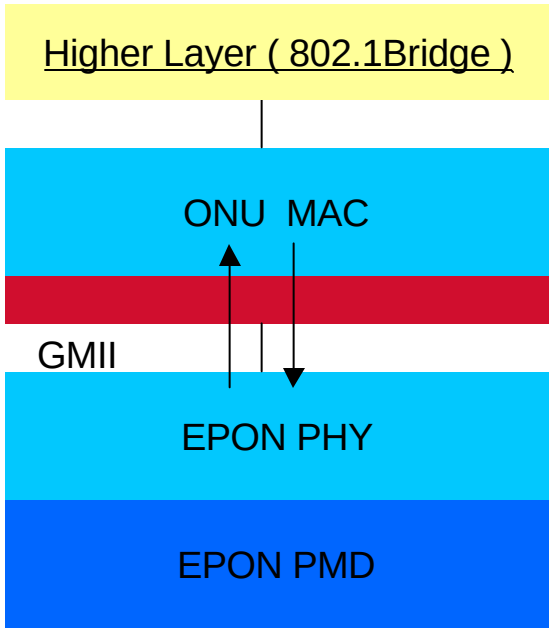


- **Shared Emulation on RS layer**

Tx Control among upstream reflect & downstream TX

OLT needs only one MAC instance to support shared emulation.
Transmit control needed between Downstream Reflect & Transmit

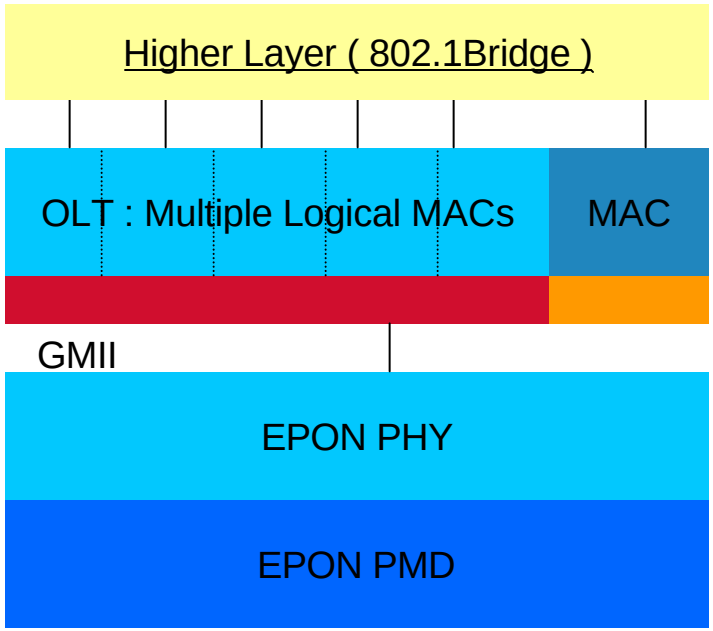
Shared Emulation
ONU View



- **Shared Emulation on RS layer**

ONU needs only one MAC instance to support shared emulation

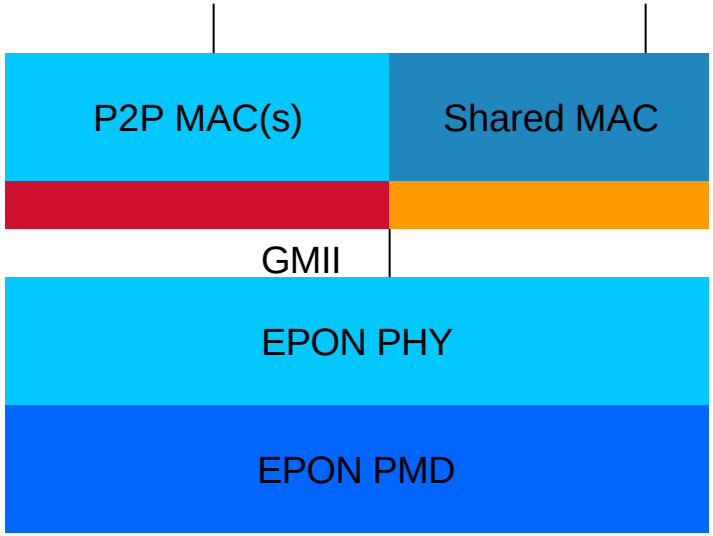
P2P Emulation & Shared Emulation OLT view



- **P2P Emulation & Shared Emulation on RS layer**

OLT Must support N+1 Logical MACs (N-P2P MACs & 1-Shared MAC)
OLT can bridge multiple Logical MAC ports

P2P Emulation & Shared Emulation ONU view



- **P2P Emulation & Shared Emulation on RS layer**

ONU may support both P2P MAC(s) & 1-Shared MAC.

P2P MAC(s) and shared MAC connect to the same layer 2 adjacency. Therefore only 1 port may be enabled at the ONU unless multiple VLANs or multiple routed ports are supported by the ONU system.

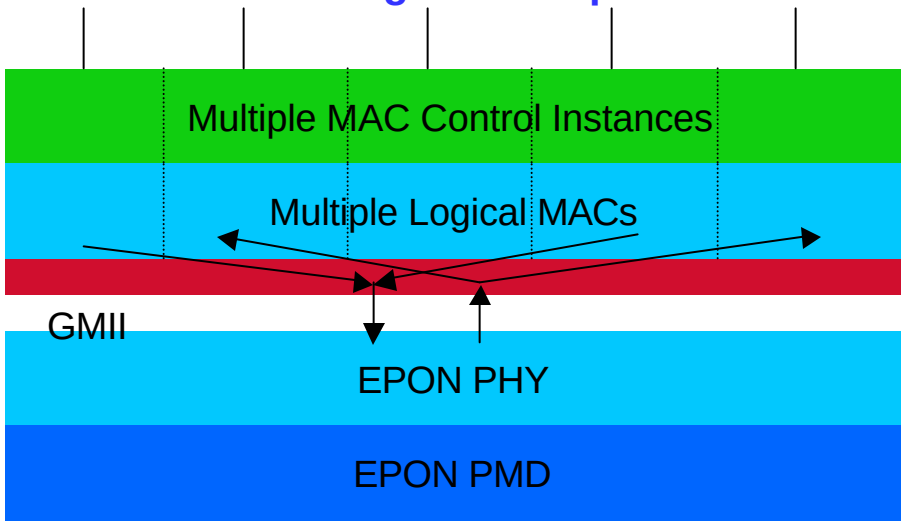
MAC Control Sublayer

- **Registration and EPON Time Slot Multiple Access Protocol**
- **Individual control instances for Individual MAC/Logical PHY ID instances**

  Each Control Instance manages Registration/Time Slot Control for each MAC instances corresponding Logical Phy ID

- **Coordination among multiple MAC control instances**

  Coordination is needed for the registration phase with default PHY ID



MAC Control Sublayer for Default PHY ID / Registration port

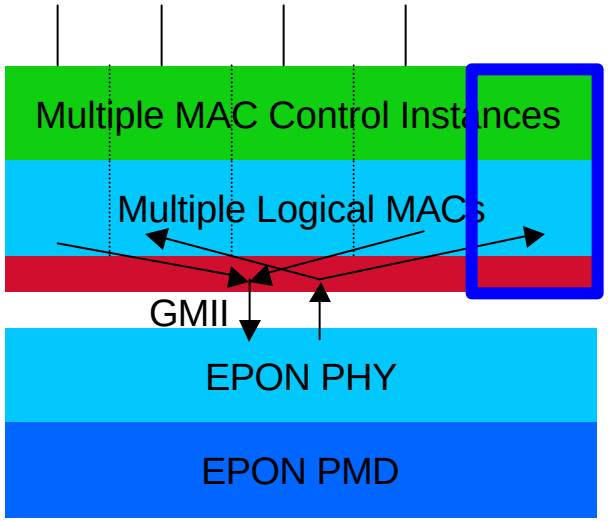
- **Registration uses a special logical port with "Default Logical PHY ID"**

  This is a configuration / registration mode BEFORE forming P2P or Shared Emulation and BEFORE timeslot allocation for each ONU

  Frames with Default Logical PHY ID on preamble

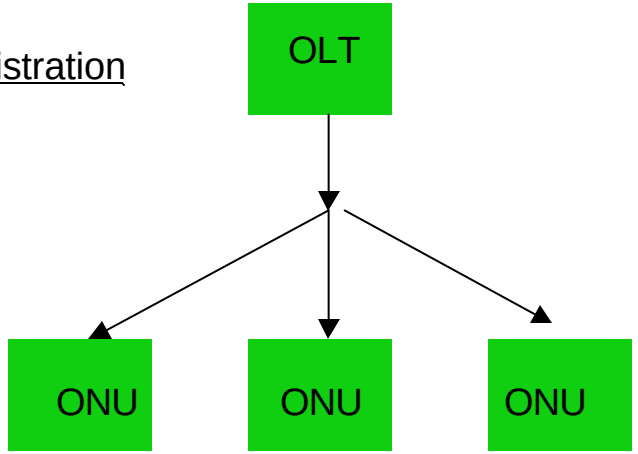
  -Downstream (OLT to ONU) frame to be received by ALL ONUs.

  -Upstream (ONU to OLT) "request" needs Response from OLT & Timeout & Retry



MAC Control Instance for Registration

Default PHY ID



MAC Control Sublayer over Default PHY ID & Allocated PHY ID

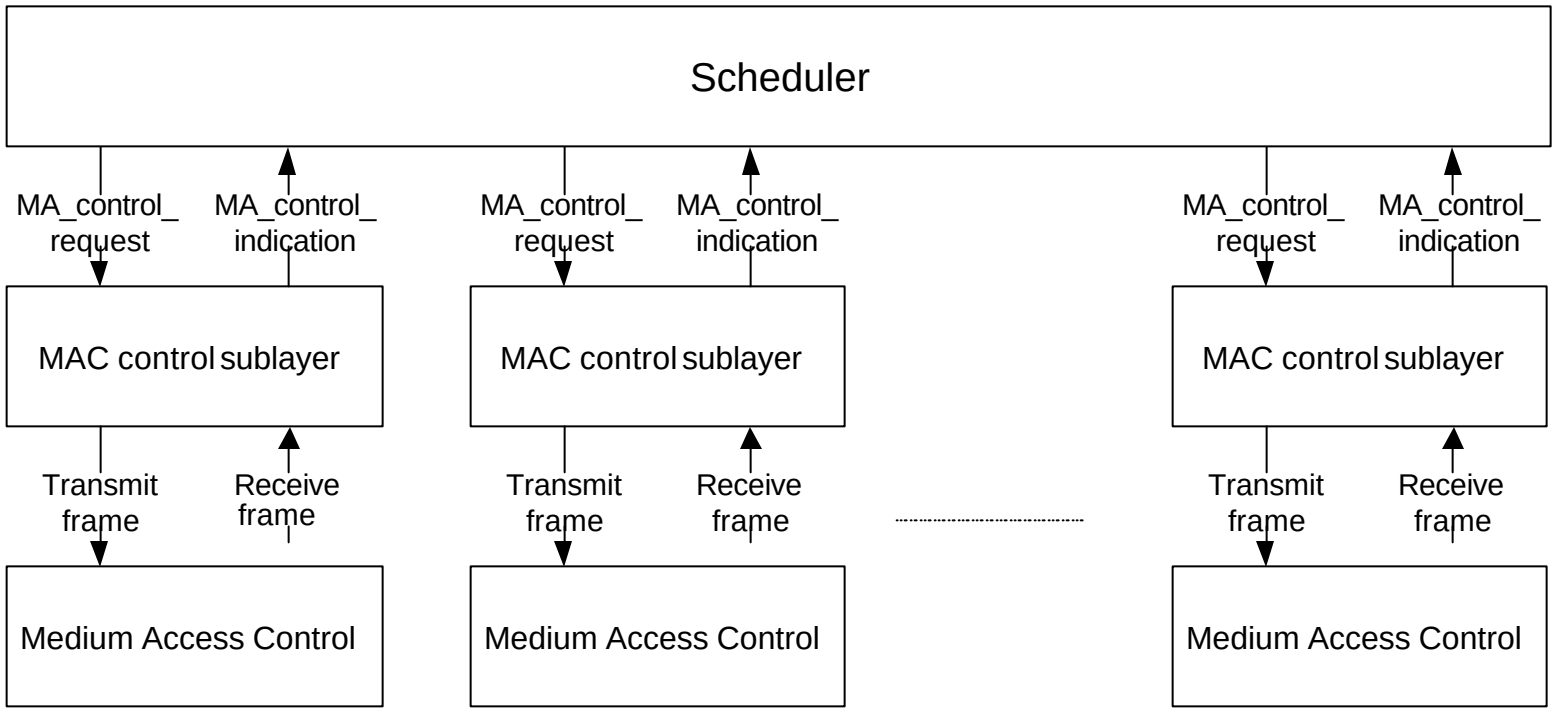
-Registration frame uses Default PHY ID

- **-OLT to query all ONUs to trigger registration**
- **-Unregistered ONUs request PHY ID allocation with his MAC address**
- **-OLT allocates Logical PHY ID(s) to each ONU with its MAC address**

-Once Logical PHY ID is allocated for each MAC/PHY instances, then all other frames use the allocated Logical PHY ID on preamble

- **-Time Slot Allocation (MPCP) frames uses allocated Logical PHY ID**
- **-802.3x Pause Frame uses allocated logical Phy ID (only P2P)**

OLT Control layering



Shared media control

- **Grant**
  - The grant should be received by only a single virtual MAC
  - ONU uses destination address to filter grants
- **Request**
  - The source of request should be identified
  - Source address is used for this purpose

MAC control primitive

- MAC control primitives require only a minor change
- MA_control_indication should include source MAC address field
- Beside that, compatibility to current specification is maintained

Down Stream Packet Transmit Control

- **Down Stream Packet Transmit Control**

  -P2P Emulation : Mux multiple MAC instances to downstream at OLT

  Simple Round Robin

  -Shared Emulation: Upstream Reflect & Downstream TX

  -Utilize downstream time-slot allocated for shared reflected traffic

  -When Shared & P2P concurrent mode, OLT better to give higher priority to shared emulation than P2P emulation to minimize buffer.

- **Local flow control from Emulation Sublayer to each MAC Instances needed**

Open Issues

- **Only one shared media link under EPON ?**
- **Bridging operation rule in concurrent P2P / Shared emulation ONU ?**

Summary

- P2P emulation, Shared emulation Options
- Layer model and behavior described
- Registration protocol: Separate presentation (Onn)