One LLID per ONU!

(Comments to clause 56)

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Clause 56 - Goals and objectives

- **56.1.1 Goals and objectives**

"The goals and objectives of this clause are the definition of a point-to-multipoint Ethernet network utilizing an optical medium.

Specific objectives met include:

a) Support of P2PE as specified

⇨ **b) Support multiple LLID per physical ONU**

c) Support dynamic allocation and deallocation of such LLIDs

d) Support a mechanism for single copy broadcast

e) Flexible architecture allowing expansion of reporting capabilities

f) Flexible architecture allowing dynamic allocation of bandwidth

g) Negotiation of PMD parameters allowing flexibility in design of PMD

h) Use of 32 bit timestamp for timing distribution

i) MAC Control based architecture

j) Registration process allows for vendor extensions

k) Ranging of discovered devices for improved network performance

l) Continuous ranging for thermal compensation"

Proposed change to 56.1.1

- Motivation: The objective to support multiple LLID per physical ONU does not add any clear value, and in contrary introduces many technical flaws. At the ONU, the LLID should represent nothing more than the ONU_ID.

- Proposed change:

- *Replace:*

  b) Support multiple LLID per physical ONU

  With:

  b) Support a single LLID per physical ONU

Basic Questions

- **Two basic questions:**

Is the multi-MAC/multi-LLID ONU model…

1. **…a justified deviation from the 802.3 layering model?**
2. **…a Viable Model??**

The Logical Link ID (LLID)

- The LLID facilitates same-PON, **ONU-ONU** bridging through P2PE
- One 2-byte Logical PON Tag in each frame's preamble
  - PON Tag = 1-bit mode indicator + 15-bit LLID
- At the OLT PON port:
  - 1 LLID : 1 MAC : 1 Bridge port
  - → multiple LLIDs/OLT required for P2PE
- At the ONU PON port:
  - 1 LLID : 1 MAC : 1 Bridge port
  - → 1 LLID/ONU required

  -OR-
  - 1 LLID : 1 MAC : ??
  - → **multiple LLIDs/ONU?? Why?**

Why a single LLID per physical ONU?

- Greatly simplifies model:
  - Single MAC stack at the ONU PON port
  - Bridge/L2 switch at the ONU
    - ONU follows the typical Ethernet switch model
    - Supports intra-ONU bridging
    - Allows management of SLA (per-VLAN min/max BW + priorities)
  - No `number_of_ports` negotiation overhead in MPCP
  - Limited MPCP granting overhead = F{#ONUs*Guardband}
  - EPON Bridging strategy:
    - ONU-ONU bridging via OLT Bridge
    - Intra-ONU bridging via ONU bridge

Why not multiple LLIDs per physical ONU?

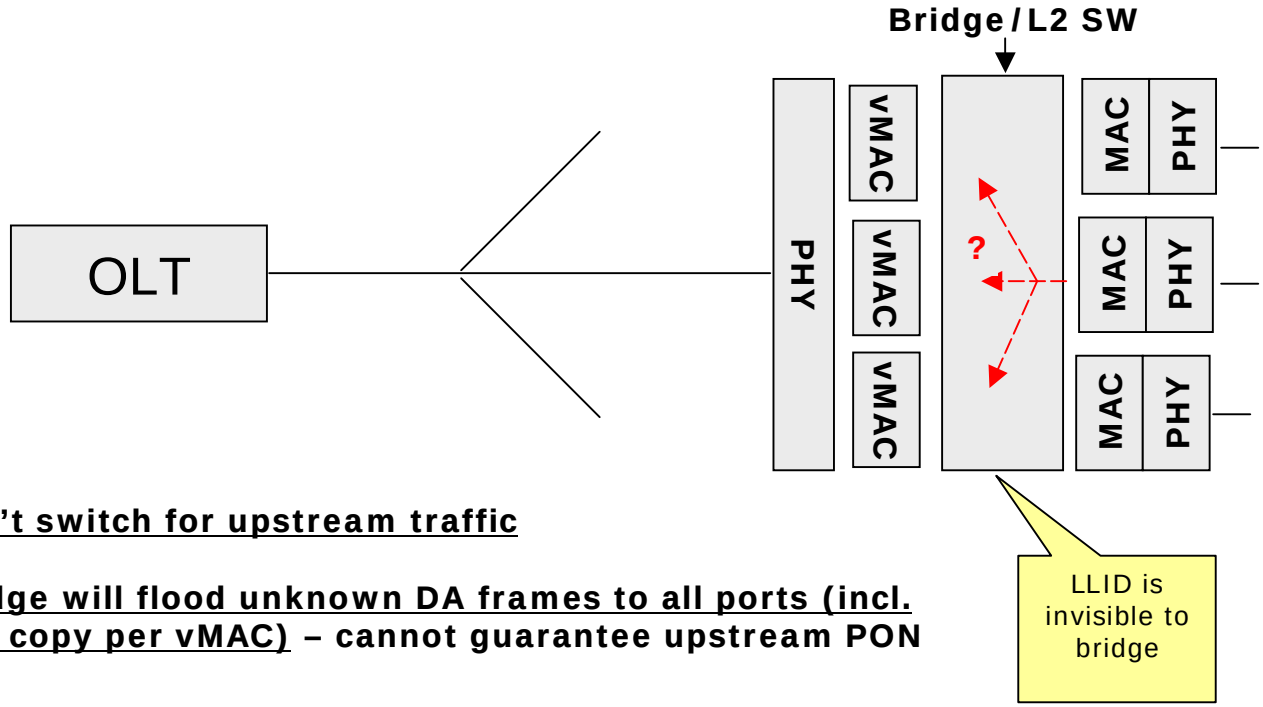
- Because the Multiple LLID/ONU model is simply not viable!

1. A Multi-port ONU requires a bridge/L2 switch. Without it…
   - Downstream single copy broadcast breaks at ONU MAC
   - Cannot support intra-ONU bridging
   - Complicates standard SLA management (min/max BW + selective discarding)
2. This bridge only works with a single MAC at the PON port
3. Severe scalability problems:
   - MPCP granting overhead = F{#LLIDs*Guardband}
4. No LLID visible above the OLT (no LLID → VLAN / MPLS continuity)
5. 'Multiple LLIDs per physical ONU' is equivalent to assigning multiple MAC addresses to a single hardware instance
6. Per-port statistics are readily available with basic switch today

Multi-LLID Architecture

This is not implementation-specific, as we have no choice but two options:

Option 1. 802.1D Bridge in ONU

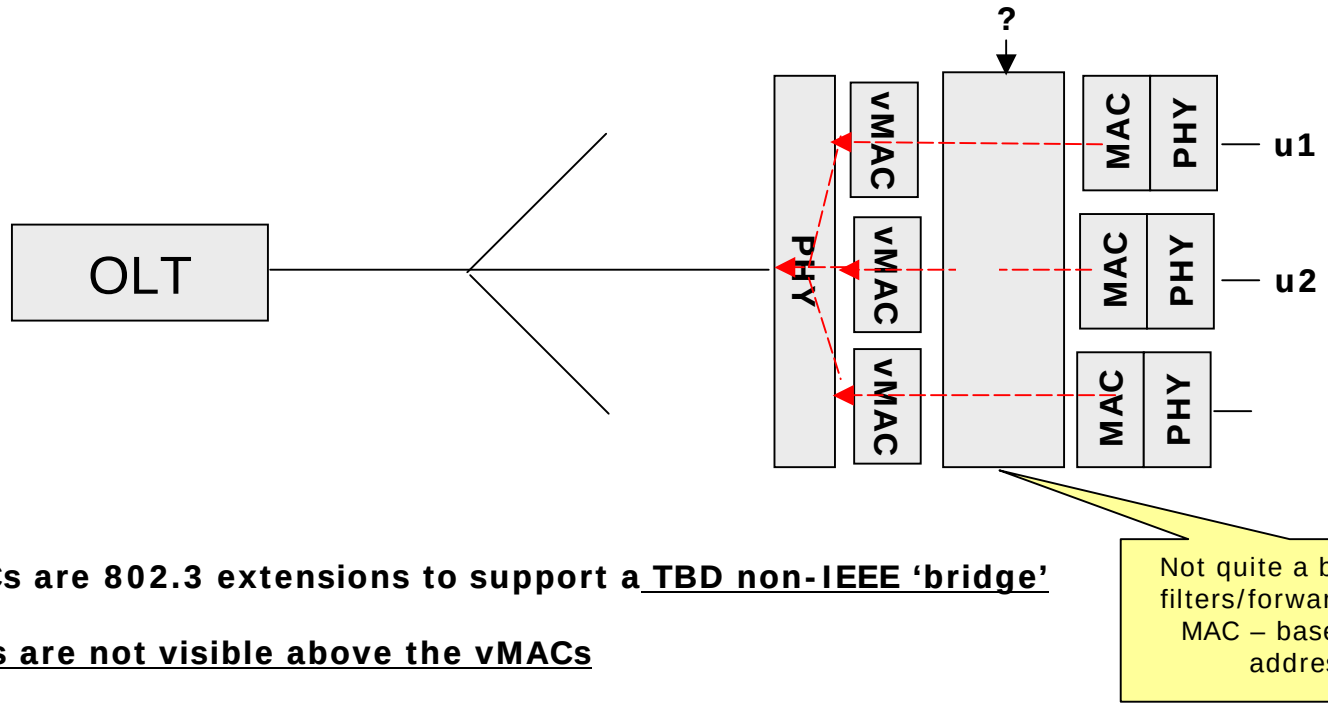


1. **Can't switch for upstream traffic**
2. **Bridge will flood unknown DA frames to all ports (incl. one copy per vMAC) – cannot guarantee upstream PON BW**

Does not work

Multi-LLID Architecture

Option 2. No 802.1D bridge… but new 'bridge' in ONU

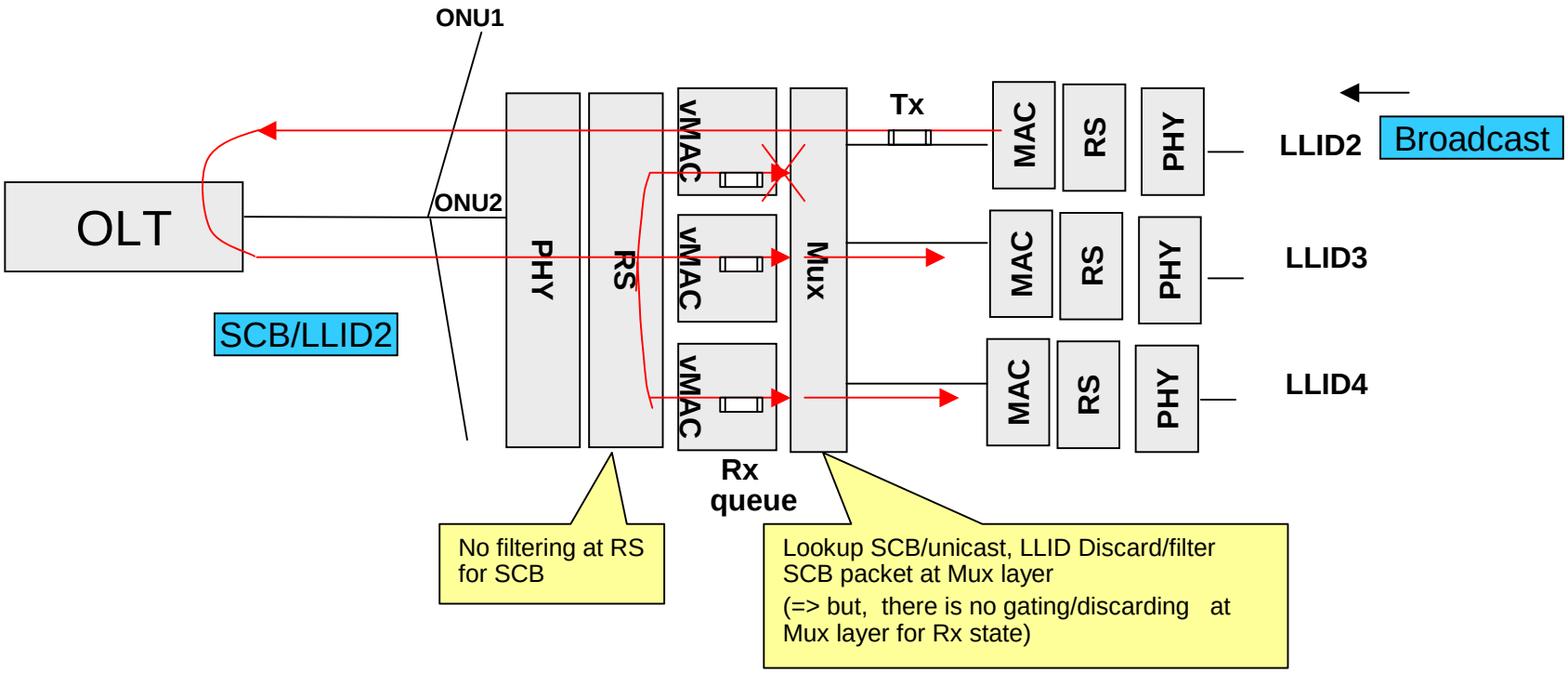


1. **vMACs are 802.3 extensions to support a TBD non-IEEE 'bridge'**
2. **LLIDs are not visible above the vMACs**
3. **Model cannot support intra-ONU bridging (u1 to u2)**
   → Requires reflection at OLT bridge (at cost of PON BW)

Does not work

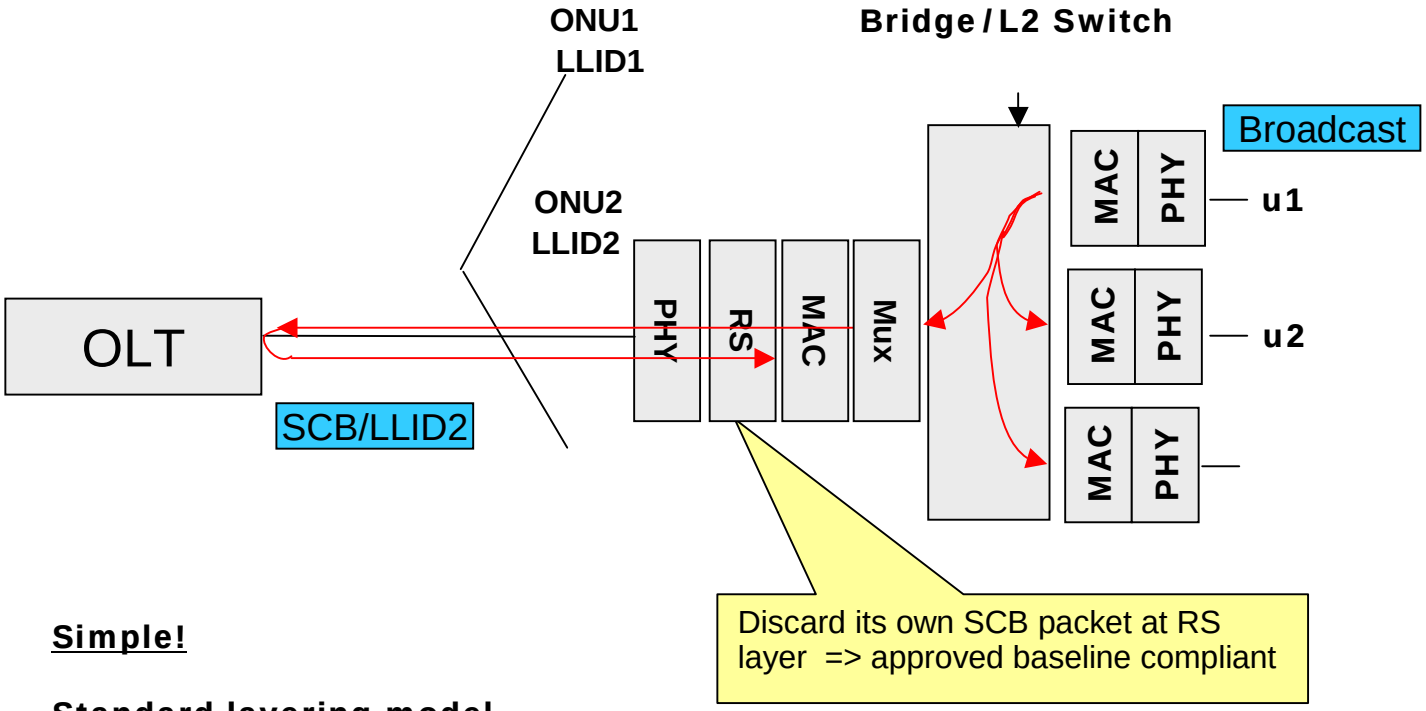
Multi-LLID Architecture & Broadcast

(Option 2. No 802.1D bridge)



Does not work

Single LLID Architecture



1. **Simple!**
2. **Standard layering model**
3. **No upstream switching problem**
4. **supports intra-ONU bridging (u1 to u2)**
5. **No SCB problem**

Works!!!

Scalability

- Multiple LLIDs/ONU model ignores realities of Ethernet optics/electronics at the physical layer

- Serious scalability problem
  - limited to several 100s LLIDs per PON in TDM cycle
  - Refer to <gummalla_p2mp_1_0702.pdf> page 9 (Vancouver)

QOS is an end-to-end concept!

- Requires end-to-end segregation
- A DSL network utilizes end-to-end VCCs
- Equivalently, an Ethernet network uses VLANs
- The OLT is not the ‘end’ of the network
  - LLIDs terminate at the OLT; no continuity into the Metro network!
- VLANs are supported throughout the Ethernet network and provide an interface to the IP network
- Optionally, MPLS can be explored for L3 QOS continuity
  - E.g., VLANs map into MPLS (Draft Martini)

Observations - I

- **The multiple MAC/multiple LLID approach at the ONU PON port is an <u>unjustified deviation</u> from the 802.3 standard**
  - A single LLID per ONU sufficiently serves the purpose of P2P Emulation, data filtering, and privacy service for a P2MP shared media system
  - Along with VLANs, it can support service segregation with prioritization and rate limiting
    - Additionally, MPLS can provide L3 QOS continuity
  - Similar method works well in P2P 802.3 (which is what we're emulating!)
  - Let's keep Media Access Control and service scheduling functions separate!

Observations - II

- **Moreover, it is <u>not a Viable model</u>**
  - It is a short-sighted attempt to mimic 802.1 functions in 802.3
  - It introduces serious problems with:
    - QOS continuity (LLID stops at OLT)
    - Link efficiency (GATE/Guardband overhead)
    - Scalability (# simultaneous LLIDs/cycle)
    - ONU complexity ('bridge emulation')
    - OLT complexity (# of MACs, MPCP clients)
    - MPCP complexity (dynamically manage LLIDs)
  - The 'bridge optional' multi-port ONU assumption is not realistic
    - Limits QOS service capabilities
    - Intra-ONU bridging via OLT bridge consumes PON BW
    - Requires emulation of 'Bridge' functions at 100's Mbps speeds
    - **A low cost Ethernet switch at the ONU yields the cheapest, most practical solution**