LLIDs (PHY_IDs) in EPONs

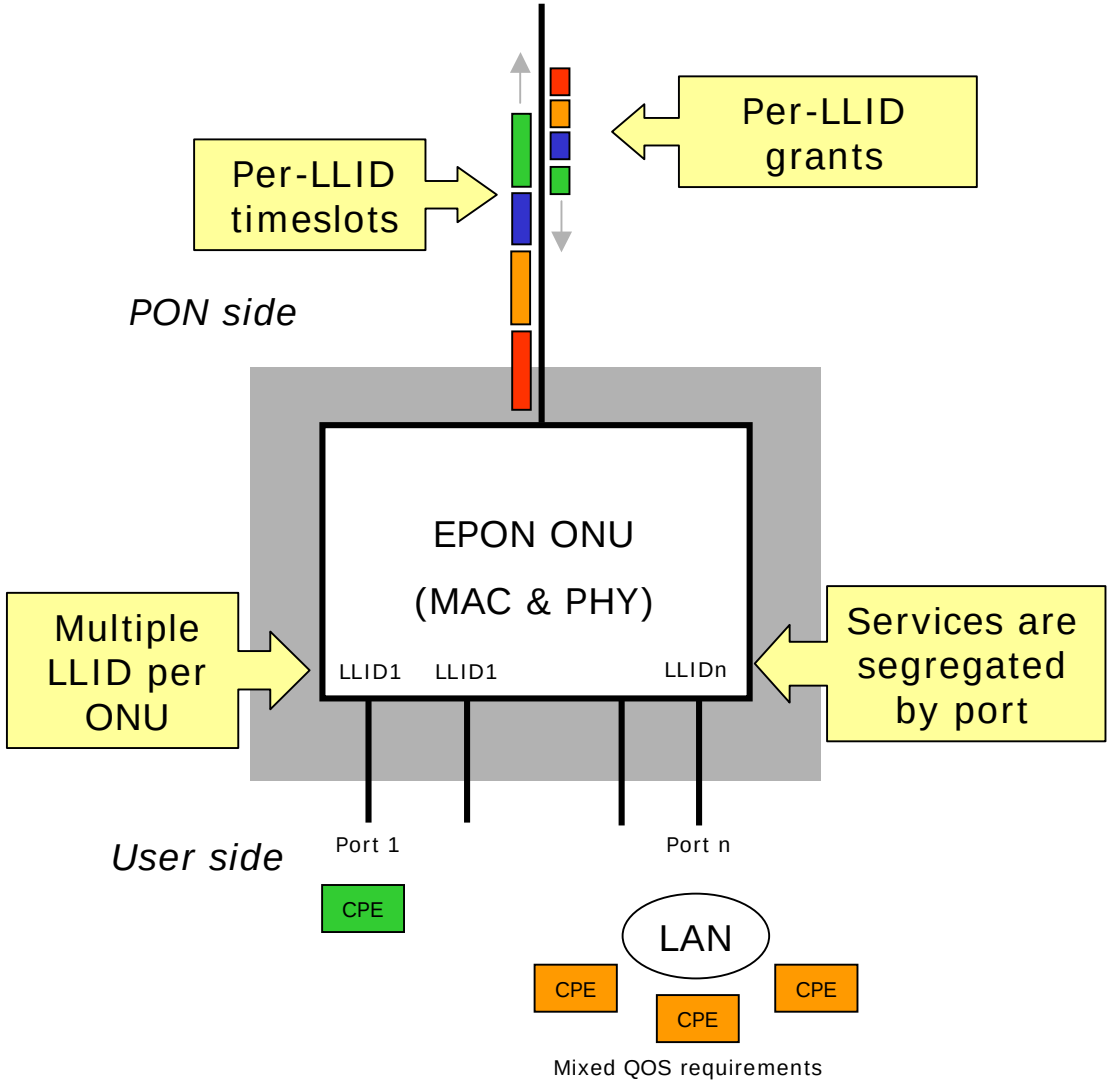
Vincent Bemmel, Alloptic

Logical Link Identifiers (LLIDs)

- **What they are:**
  - Introduced **for 802.1D Bridge compliance**
  - Identification of an ONU from a Bridging perspective (P2PE)
  - 1:1 association between single ONU and OLT Bridge port
    - Allow for filtering of ONU-ONU bridged traffic
  - Carried in the preamble in either direction on the PON
    - Stripped off before frame enters MAC
  - A.k.a. “PHY_IDs”, etc.

- **What they are <u>not</u> (and shouldn’t try to be):**
  - Required for OAM processing
  - Required for per-User port service segregation
  - N:1 association between single ONU and OLT Bridge port
  - ONU User port IDs, CPE IDs, etc.
  - Passing through MACs, bridges, switches, and beyond the PON segment
  - An alternative to VLANs

Current proposal for ONU…



Many Questions…

- Does LLID represent ONU.. or user port?
- Why not use VLANs for segregation?
- How are LLIDs exposed above the OLT?
- What does the layering architecture really look like?
- How does this model scale?
- etc…

?

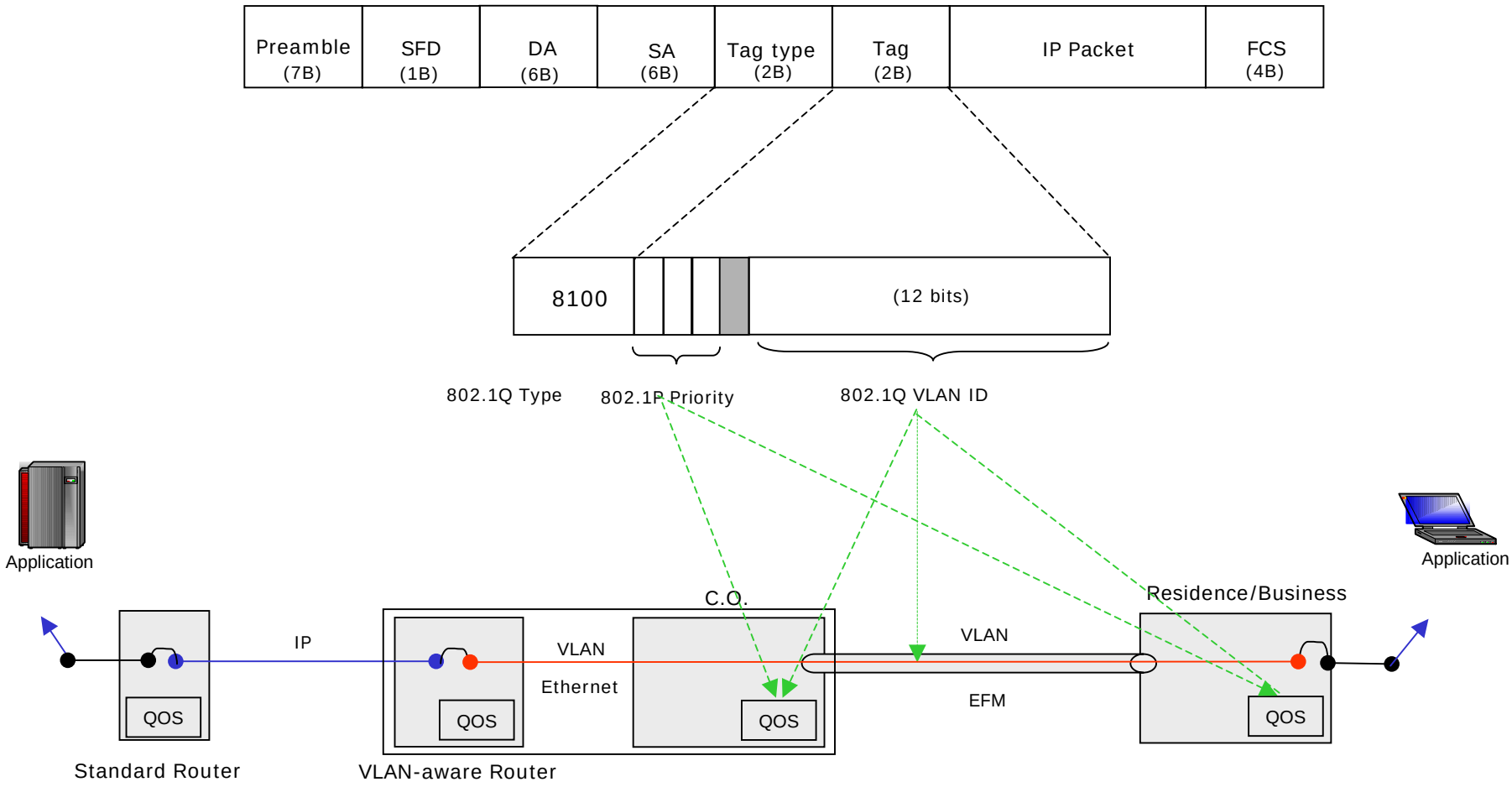
Traffic Segregation & QOS

- Key mechanisms for consistent QOS:
  - Packet classification
  - Traffic & service segregation
  - Prioritization
  - BW management, traffic management, rate limiting, …
- 802.1Q VLANs
  - Only standardized way to segregate traffic in Ethernet networks
  - Span multiple Ethernet segments
  - Encapsulated into Ethernet frames
  - VLAN tags directly map to IP networks in VLAN-aware routers
  - 802.1P priorities are exposed to L2 → effective BW management
  - VLAN tags can be used to classify packets
  - …but addressing space is limited to 4K ☹
  - …no standard for 'transparent VLAN' to date ☹

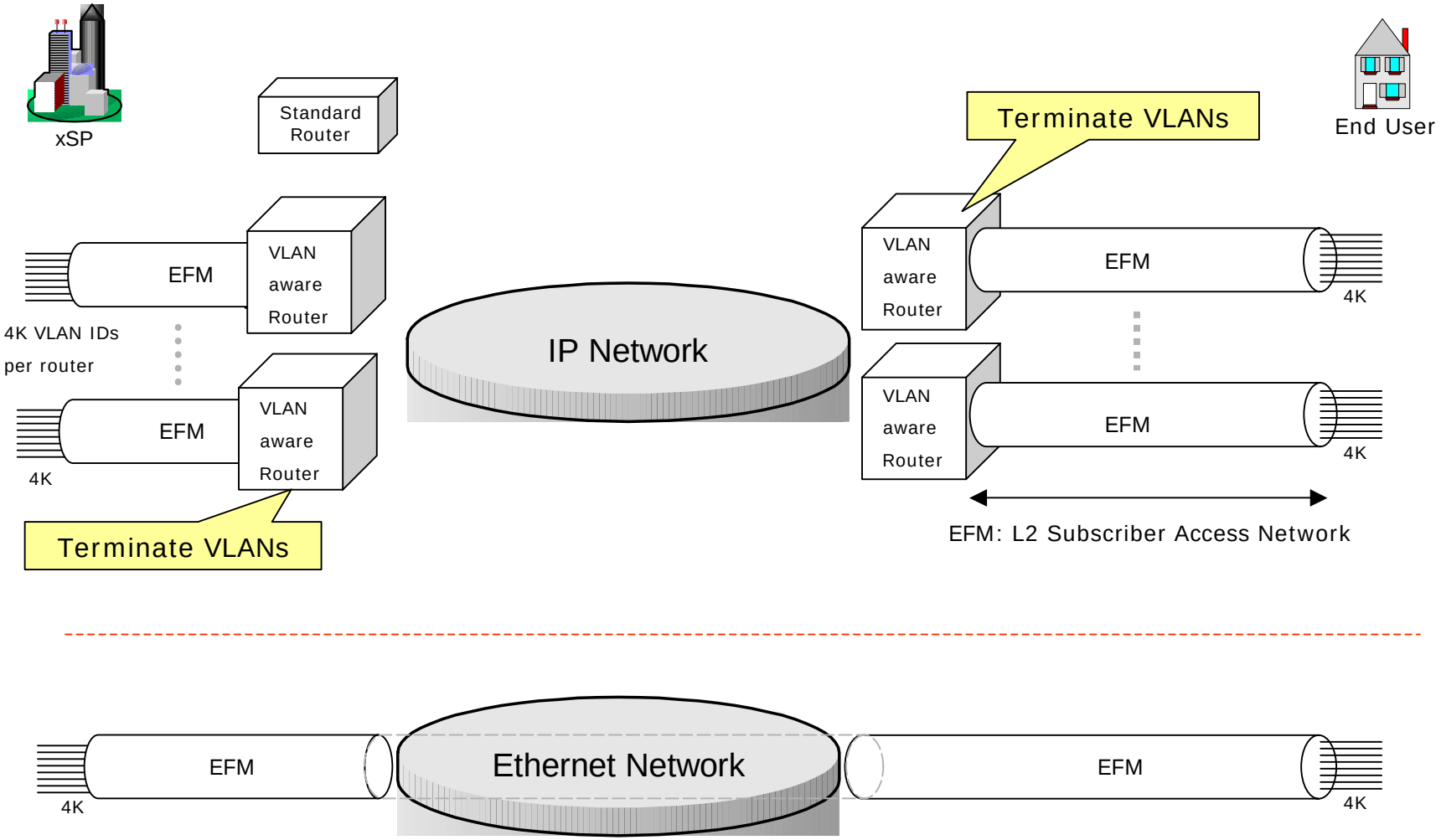
General issue with all Ethernet in MAN/WAN

Address this in 802.1Q!

A closer look at VLANs



EFM & VLANs


xSP
Standard Router
End User
Terminate VLANs
VLAN aware Router
EFM
4K
4K VLAN IDs per router
IP Network
VLAN aware Router
EFM
4K
Terminate VLANs
EFM: L2 Subscriber Access Network
EFM
Ethernet Network
EFM
4K
4K

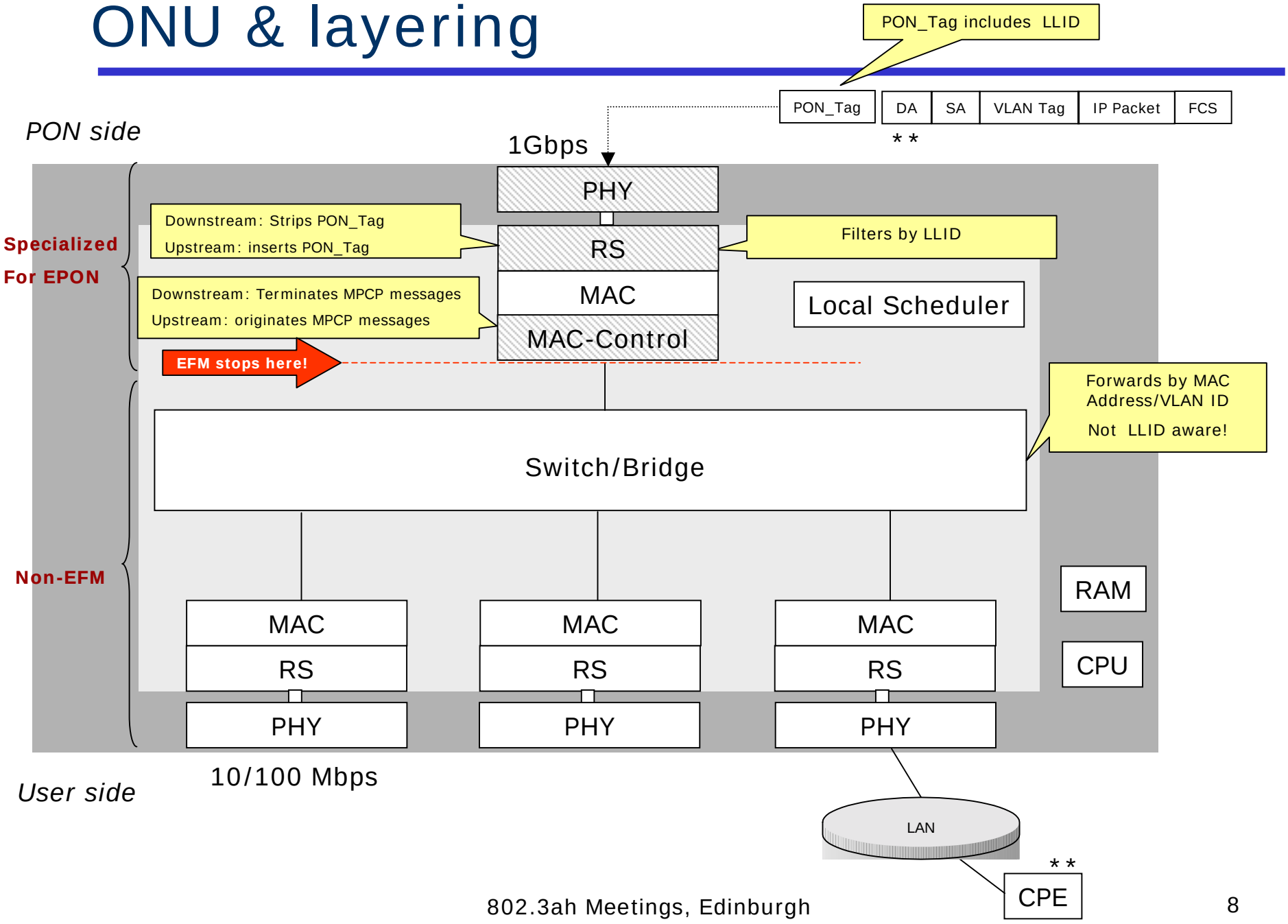
ONU functions

- Common functions:
  - Traffic segregation
  - Rate limiting
  - Prioritization

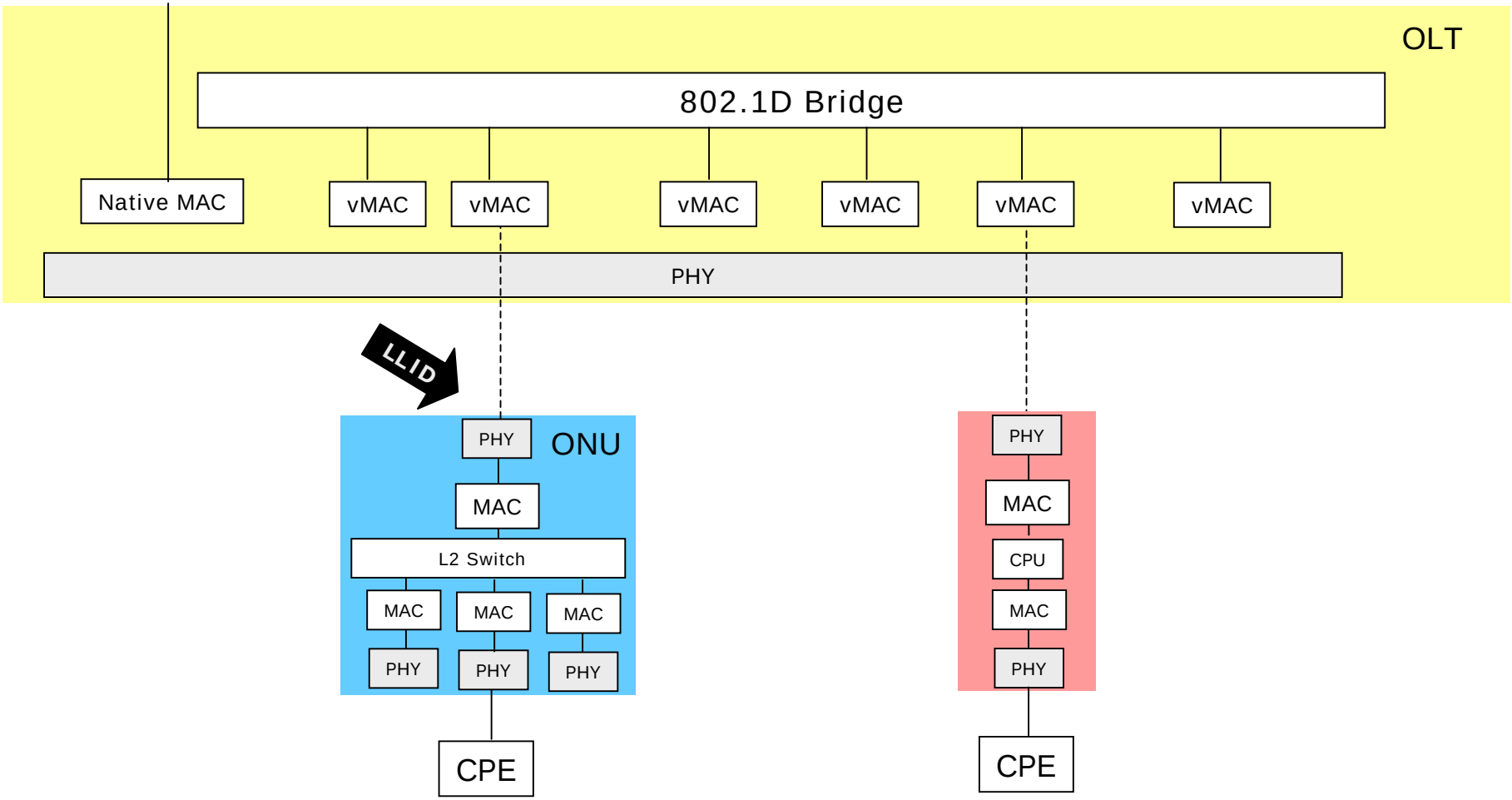
- Rate limiting at Gbps speeds is out of the realm of microprocessors

- Switching chips with Gbps interfaces are relatively expensive
  - Prioritization & rate limiting included at no significant add'l cost
  - Most are VLAN-aware
  - Prices will continue to fall

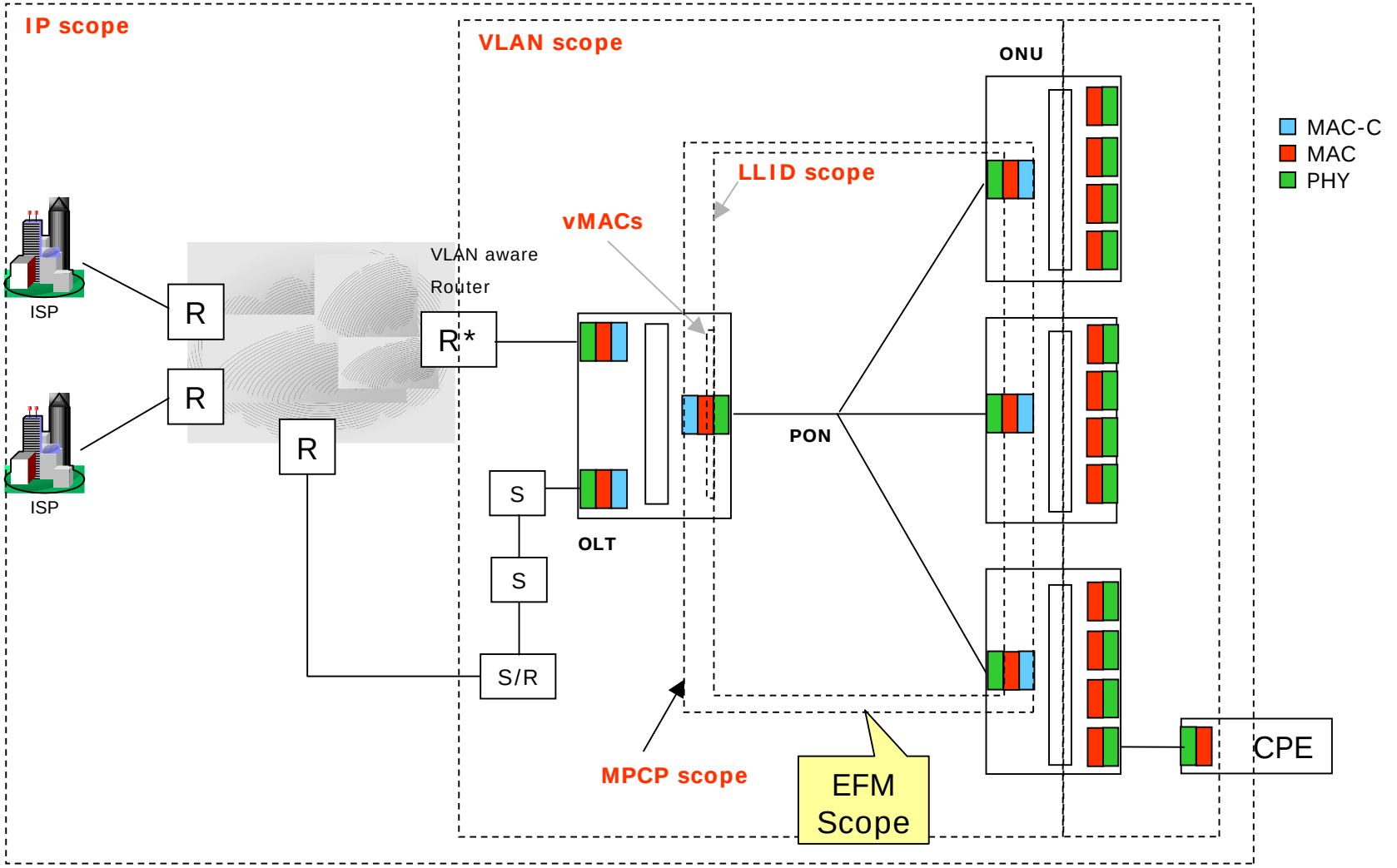
ONU & layering



P2PE and ONUs

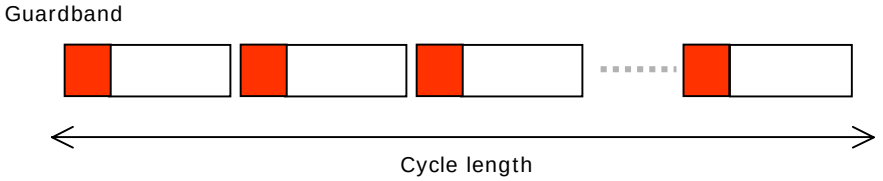


Addressing scope



Scalability

- Another reason why multiple LLIDs per ONU is a bad idea…
- Overhead seriously limits scalability of uniform Cyclic service (e.g., TDM POTS)
- **Downstream GATE overhead** =
  [(((number of ONUs)*(avg # LLIDs per ONU) / Cycle length)*64*8 bps) / 1Gbps] * 100%
- **Upstream Guardband overhead** =
  [(number of ONUs)*(avg # LLIDs per ONU)* Guardband length / Cycle length] * 100%



Upstream efficiency is very important – our customers expect BW close to 1Gbps!!

		Downstream GATE Overhead (%)		Upstream Overhead (%)				
				1ms cycle		2ms cycle		
#ONUs	# PHY_IDs	1 ms cycle	2 ms cycle	1 usec guard	2 usec	1 usec	2 usec	3 usec
16	8	6.6	3.3	12.8	25.6	6.4	12.8	19.2
32	8	13.1	6.6	25.6	51.2	12.8	25.6	38.4
32	24	39.3	19.7	76.8	153.6	38.4	76.8	115.2
64	24	78.6	39.3	153.6	307.2	76.8	153.6	230.4

MDU

In summary

- Service segregation is not an 802.3 function…
- 802.1Q VLANs can address this in an elegant way today
  - VLANs are visible to L2 and provide an interface to higher layers
  - VLAN-based traffic segregation, prioritization and rate limiting are available in most Gbps Ethernet switching chips
  - VLAN limitations need to be addressed in 802.1Q, not 802.3
- A **single LLID per ONU** is sufficient for 802.1D compliance & EPON scheduling
  - LLID is only visible within the EPON segment, & below the MAC
- LLIDs are no alternative to VLANs!!
- Multiple LLIDs/ONU introduce serious scalability limitations
  - unnecessarily boost up the cost (requires smaller guard bands)