A proposal to decouple connectivity from media access

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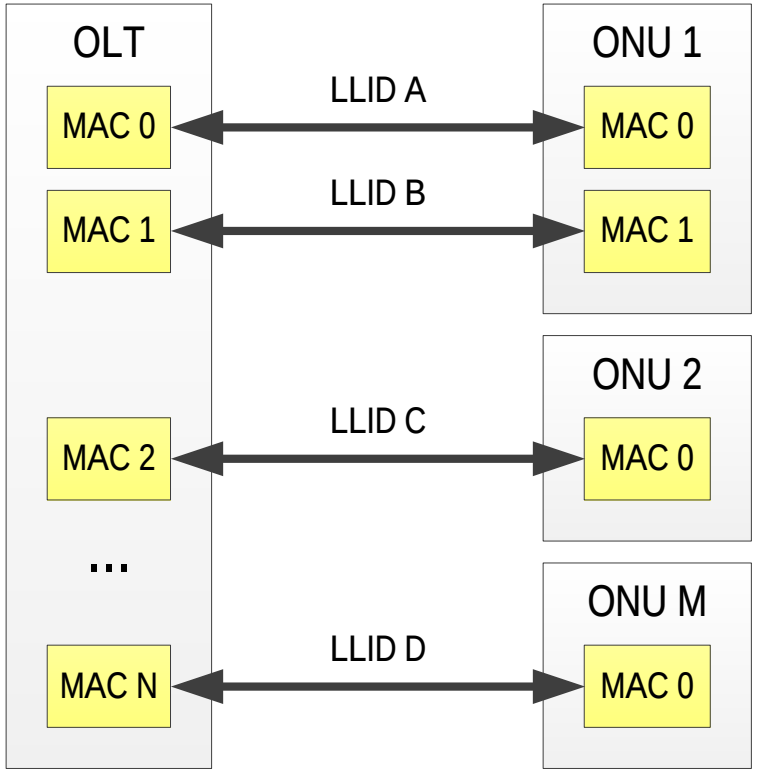
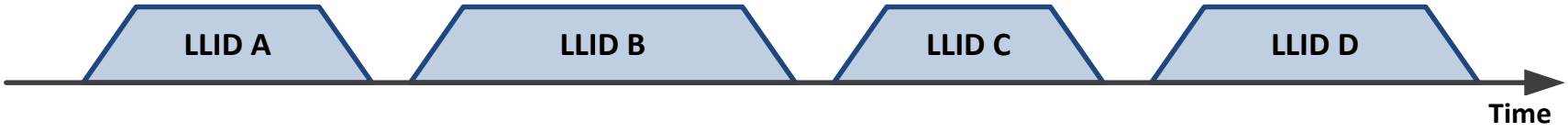
Duality of LLID

- LLID as a Connectivity Element
  - LLID represents a logical point-to-point link (for point-to-point emulation over shared medium)
  - Employs a tag in the preamble to segregate traffic belonging to different services, subscribers, etc.
  - Analogous to VLAN, but with zero-overhead and local to PON (user data still can be double-tagged).



- LLID as a Media Access Element
  - Reporting and Granting is done per LLID
  - Significant overhead per each access to the media
    - Laser on/off, sync time, burst delimiters, GATE/REPORT messages



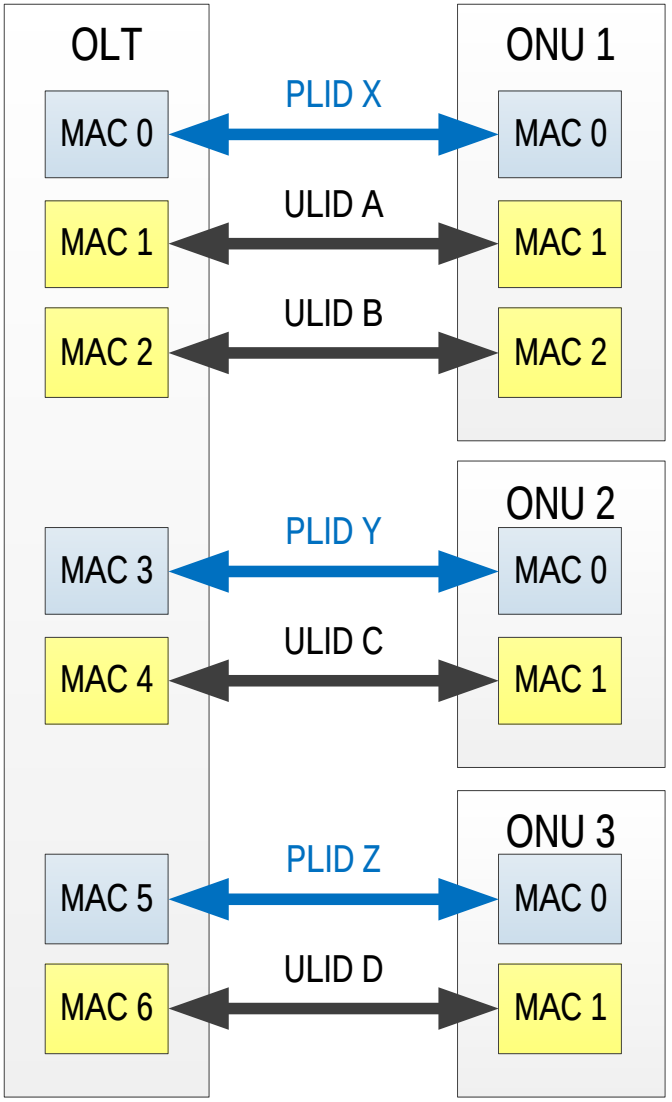
Why Duality of LLIDs is a problem?

- To serve a large number of subscribers and support multiple services, it is desirable to support a very large number of LLIDs per NG-EPON
  - Full 2^{16} range is reasonable and useful
- To eliminate excessive overhead, it is desirable to reduce the number of elements accessing the media to a minimum
  - Minimum number of elements accessing the media is the number of physical ONUs

Proposed solution: PLID

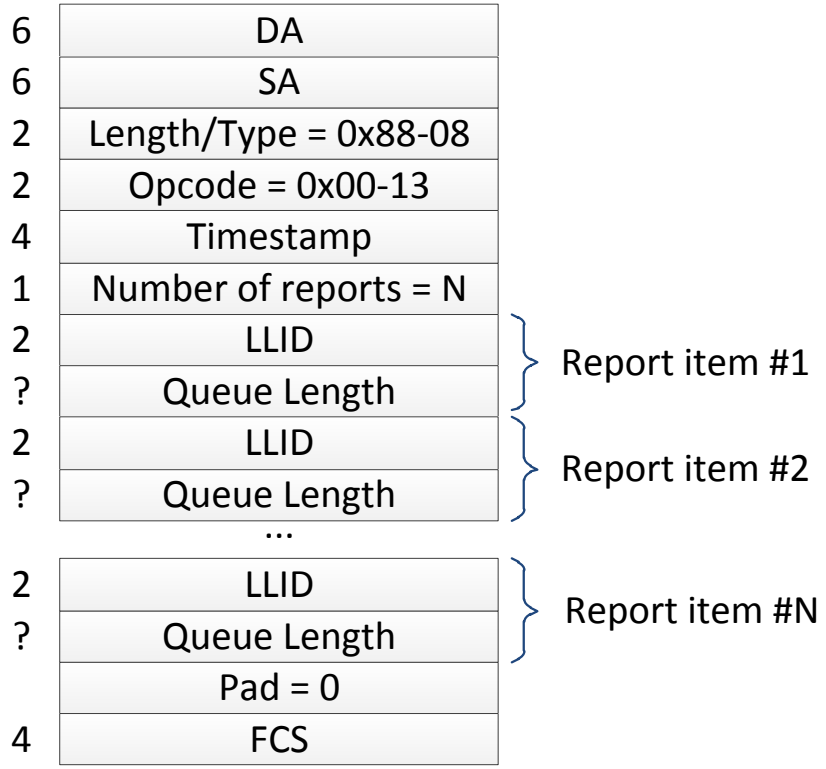
- Separate LLIDs into two sub-classes:
  1. ***User Link ID (ULID)*** – logical link between a pair of MACs in OLT and ONUs used to carry user traffic
  2. ***Physical Layer ID (PLID)*** – logical link between the OLT and a physical ONU
- ULIDs and PLIDs share the same 2^{16} space

Tag Value	Pool Size	Description
0x0000	1	Broadcast PLID used for broadcasting administrative traffic (MPCPDU, OAMPDU) to all ONUs and for ONU discovery.
0x0001 – 0x0FFF	4095	Values represent PLID. The number of PLIDs is limited by number of physical ONUs on the PON.
0x1000 – 0xEFFF	57343	Values represent unicast (bidirectional) or multicast (downstream only) ULIDs.
0xF000 – 0xFFFE	4095	Reserved
0xFFFF	1	Broadcast ULID is used for broadcasting user traffic. This ULID is not used for PON administrative traffic or for discovery.



Proposed solution: REPORT2

- Definition of a new **REPORT2** message
  - Transmitted with PLID tag in the preamble
  - Represents all LLIDs in a given ONU
  - For each non-idle LLID, reports the total amount of queued data
  - Only the LLIDs that have queued data are reported
  - One 64-byte REPORT2 message can accommodate up to N report items.
    - If the ONU has more than N LLIDs with data, increase the size of the REPORT2 message or send multiple messages?



Term “LLID” means either “PLID” or “ULID”

Proposed solution: GATE2

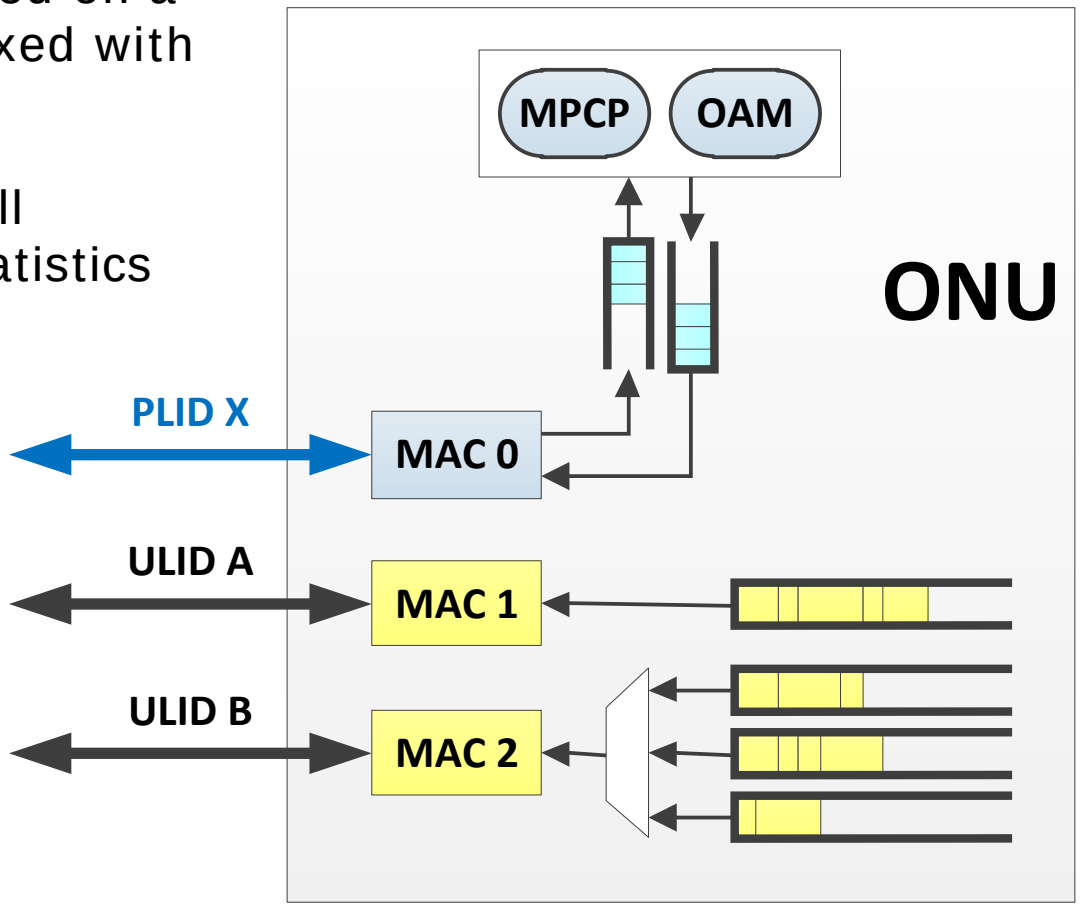
- Definition of a new **GATE2** message
  - Transmitted with PLID in the preamble
  - Applies to all LLIDs in a given ONU
  - **Channel Number** - a bitmap representing the wavelength channel(s) to transmit on.
  - **Start Time** – grant start time (resolution is TQ?)
  - **Grant Length** – grant duration in FEC codewords (with or without burst overhead?)
  - Remaining fields tell the ONU how many bytes to transmit for each LLID
    - If the ONU has more than N LLIDs, increase the size of the GATE2 message or send separate messages (resulting in separate grants or a single concatenated grant)?

6	DA	
6	SA	
2	Length/Type = 0x88-08	
2	Opcode = 0x00-12	
4	Timestamp	
1	Channel No.	
4	Grant Start Time	
?	Grant Length	
1	Number of grants = N	
2	LLID	Grant item #1
?	Queue Length	
2	LLID	Grant item #2
?	Queue Length	
	...	
2	LLID	Grant item #N
?	Queue Length	
	Pad = 0	
4	FCS	

Benefits of this proposal

Segregation of user data and network control

- A PLID never carries user traffic
- All OAMPDUs, MPCPDUs, and future Wavelength Control Protocol data units (WCPDUs) are exchanged on a given PLID and are never mixed with user traffic on ULIDs.
- ULID byte/frame counters will represent true user traffic statistics
- A PLID has a dedicated pair of vMACs at the OLT and each ONU



Improved Discovery / Registration

- **Current situation**
  - Every LLID goes through registration process, so the OLT/NMS can learn RTT and MAC address
    - All RTTs from the same physical ONU are the same
- **New proposal**
  - Only ONUs (PLIDs) are discovered/registered via the normal MPCP discovery process.
  - Once PLID is registered, multiple unicast or multicast ULIDs are assigned via eOAM → no time/bandwidth is wasted for discovery
    - Mechanism to assign LLIDs already exists in 1904.1
  - Near-zero penalty/cost per ULID → A very large number of ULIDs can be assigned per ONU
  - Assignment of an ULID is near instant → ULIDs can be assigned statically or dynamically per service/session.
  - The size of a discovery window can be reduced because much fewer instances (PLIDs) compete for discovery
  - Once all connected ONUs are registered, the discovery attempts can cease altogether
    - PLIDs would remain registered, while ULIDs are assigned and revoked as needed.

Improved PON Efficiency

- **Current situation**
  - Every LLID exchanges GATE/REPORT messages.
  - Every LLID establishes an OAM connection and in absence of OAM queries, exchanges keep-alive OAMPDUs
- **New proposal**
  - GATEs/REPORTs are exchanged only on PLID and apply to all ULIDs in the ONU → Overall number of GATE/REPORT transmissions is reduced.
  - OAM connections are established on PLIDs only → No unnecessary OAM keep-alives on any ULIDs

Discussion points from the call on 8/18/2016

1. For self-install situations, discovery windows may need to be issued periodically, but with a much decreased frequency.
2. Polling Period
   - Only PLIDs (ONUs) are being polled.
   - There is only one polling period per ONU.
   - Polling period of a PLID should be determined by the most strict latency requirement of any of the ULIDs in the ONU.
3. MAC addresses in ONU
   - MAC addresses are conserved!!!
     - ULIDs only carry L2 user traffic that originates outside of ONU.
     - ULIDs do not need to have a unique MAC address
   - ONU needs only one MAC address, which will be associated with PLID
     - PLIDs MAC addresses need to be globally unique, so that multiple PONs can be managed by a common management master.

Thank You