Granting and Reporting Behavior

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Reporting behavior

- ❑ OLT granting and ONU reporting behavior was discussed and accepted by 802.3ca TF in July 2017 (see Motion #3)
  - https://www.ieee802.org/3/ca/public/meeting_archive/2017/07/remein_3ca_1_0717.pdf

  - However, this behavior is associated with the MPMC Clients, which are out-of-scope for 802.3ca. Therefore, this behavior has not been specified anywhere in 802.3ca.

- ❑ Since 1904.4 is a separate project, we are not obligated to adopt exactly what 802.3ca adopted, however, we must remain compatible with GATE and REPORT formats and semantics specified in 802.3ca.

- ❑ Text in red indicates the OLT and ONU features and behavior proposed for standardization in 1904.4
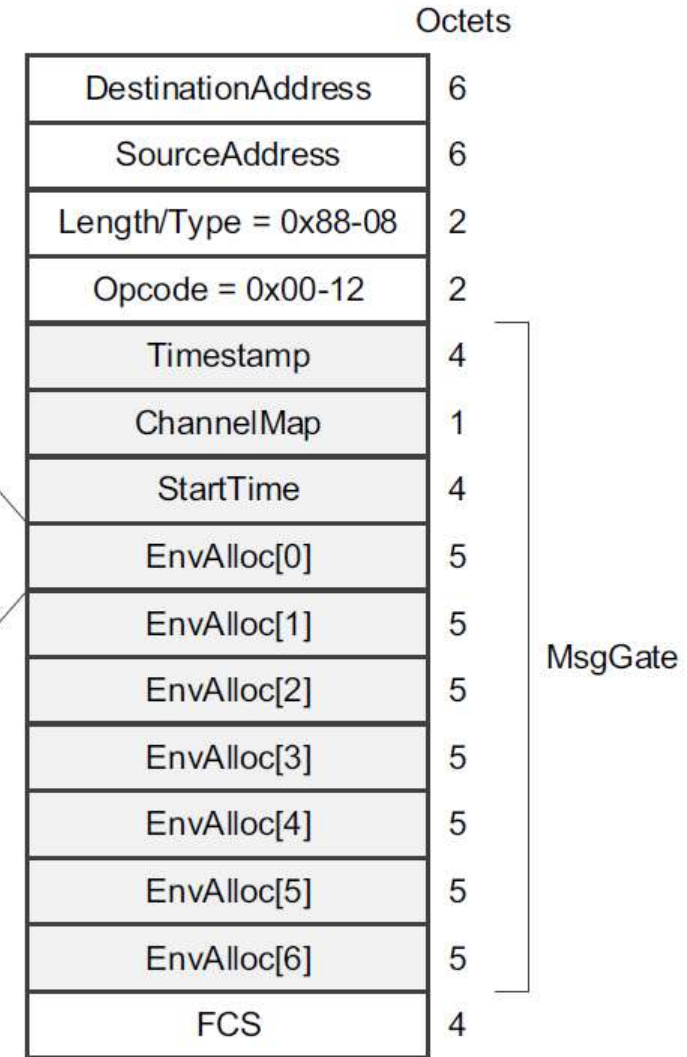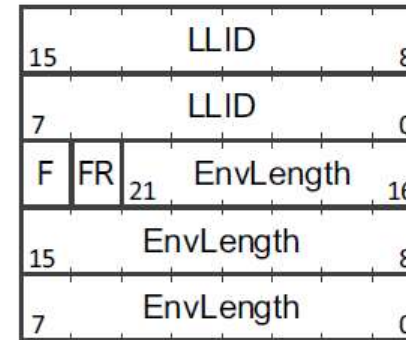
GATE/REPORT behavior specified in 802.3ca

GATE MPCPDU Format

- ❏ Sent to PLID

- ❏ Contains up to 7 Envelope Allocations (aka LLID grants)

- ❏ May be sent on any of the downstream channels listened to by the ONU

- ❏ **ChannelMap** is a bitmap for upstream channels
  - – In case of a GATE for multiple channels, the *EnvLength* is per each channel, not the total.

- ❏ **Force Report (FR)** flag requires ONU to generate a queue report for the given LLID

- ❏ **Fragmentation (F)** flag informs ONU whether it is allowed to fragment a new frame from the given LLID.

- ❏ Envelope length is in units of EQ (8 octets). Maximum envelope duration is
  - – 10.7 ms @ 25 Gb/s
  - – 26.8 ms @ 10 Gb/s

- ❏ A burst may consist of many envelopes and each LLID may be allocated multiple envelopes, if needed.

	Octets
DestinationAddress	6
SourceAddress	6
Length/Type = 0x88-08	2
Opcode = 0x00-12	2
Timestamp	4
ChannelMap	1
StartTime	4
EnvAlloc[0]	5
EnvAlloc[1]	5
EnvAlloc[2]	5
EnvAlloc[3]	5
EnvAlloc[4]	5
EnvAlloc[5]	5
EnvAlloc[6]	5
FCS	4

MsgGate

LLID (15–8)
LLID (7–0)
F | FR (21) | EnvLength (16)
EnvLength (15–8)
EnvLength (7–0)

144.3.4.1 Physical Layer ID (PLID)

The PLID carries messages used to control critical Nx25G-EPON operations, such as ONU registrations and arbitration of ONUs' access to the PON medium. All Multipoint Control Protocol data units (MPCPDUs) are transported using the PLID. A successful ONU Discovery and Registration process, described in 144.3.7.8, results in the assignment of a single unique PLID value to the ONU.

144.3.4.2 Management link ID (MLID)

The MLID carries management traffic flows, such as OAMPDUs (see 57.4) and CCPDUs (see 144.4). Each ONU is assigned a single unique MLID value as part of the ONU Discovery and Registration process, described in 144.3.7.8.

144.3.4.3 User link ID (ULID)

User link IDs (ULIDs) carry subscriber traffic. It is expected that a single subscriber may be assigned one or more ULIDs to allow for separation of traffic classes and types. ULID values are assigned (provisioned) to an ONU using an appropriate management protocol outside the scope of this standard. ULID values need not have a one-to-one binding of an OLT MAC to an ONU MAC. A ULID that binds a single OLT MAC to multiple MACs in different ONUs represents a multicast ULID.

144.3.4.4 Group link ID (GLID)

To assist in traffic management the Nx25G-EPON system supports consolidation of several LLIDs into arbitrary groups using the group link ID (GLID). For example, all LLIDs for a specific subscriber hosted on an ONU servicing numerous subscribers could be grouped together into a single GLID; in another example all LLIDs supporting a specific traffic class (e.g., best-effort traffic) on a multi-subscriber ONU could be grouped together. GLID values are used only for the purposes of bandwidth granting by the OLT and reporting by the ONU. The GLID report contains the sum of all queue lengths of member LLIDs from that ONU. The bandwidth granted to a GLID is distributed among its member LLIDs. The method by which the granted bandwidth is distributed among the member LLIDs is outside the scope of this standard. The actual envelope transmission is identified by a PLID, an MLID, or a ULID value, associated with a specific MAC instance that sourced the data (i.e., the LLID field in the envelope headers may only contain a PLID, MLID, or ULID, but never a GLID).

Provisioning of LLID values

An unregistered ONU shall accept only the envelopes containing the DISC_PLID value in the LLID field. The envelopes with other LLID values shall be ignored.

Upon successful registration, an ONU shall no longer accept envelopes with DISC_PLID. Instead, a registered ONU shall accept all envelopes containing any of the following LLID values:

— The specific PLID value assigned to this ONU during registration

— The specific MLID value assigned to this ONU during registration

— Broadcast PLID (BCAST_PLID)

— Broadcast MLID (BCAST_MLID)

— Any ULID or GLID assigned to this ONU by management[7]

[7]After registration, an ONU may be configured to use multiple ULID or GLID values via management. The method of provisioning of these additional ULID or GLID values is outside the scope of this standard.

REPORT MPCPDU Format

- Sent to PLID

- Contains up to 7 LLID Reports (*LlidStatus*[0…6])

- **NonEmptyQueues:** The number of LLIDs in the ONU with queues that were non-empty at the time of the REPORT MPCPDU transmission.

- **LlidStatus** describes the occupancy of the queue assigned to a specific LLID. Consists of the following sub-fields:

  - **LLID**: Represents the logical link that is being reported. (ESC_LLID signifies an empty LlidStatus structure).

  - **QueueLength**: The length of the queue assigned to the given LLID, including the associated framing overhead (IPG and preamble).

IEEE 1904 Access Networks Working Group, Teleconference

Granting Rules
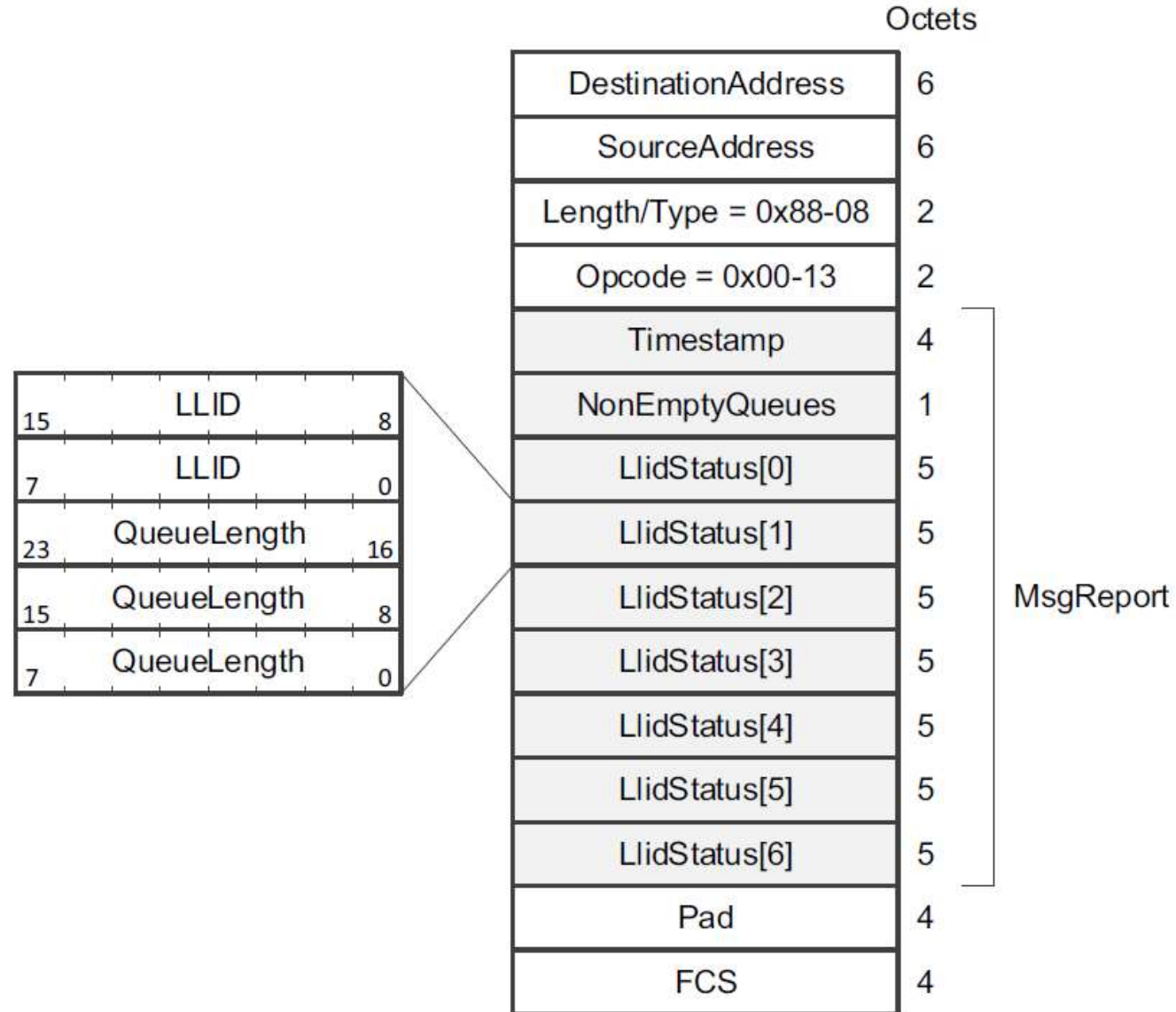
802.3ca, 144.3.1.2

– The OLT may grant more than seven LLIDs by issuing multiple GATE MPCPDUs with the same *StartTime* value.

– A GATE MPCPDU may be transmitted on any downstream channel and it may allocate upstream transmission windows on any or all upstream channels. An ONU ignores all the transmission allocations for the upstream channels that are not enabled in that ONU.

– The ONU processes the GATE MPCPDUs in the order they are received and generates the upstream envelopes following the order of *EnvAlloc[i]* fields in each GATE MPCPDU. Therefore, it is possible for an LLID to be allocated multiple disjoint envelopes within the same grant.

– The value of the Timestamp field in MPCPDUs references the transmission (and reception) time of the ESH preceding these MPCPDUs. For that reason, the OLT shall never allocate overlapping envelopes to the PLID, except the fully-overlapping envelopes.

– In the case that the ONU is given partially overlapping PLID envelope allocations, it shall choose only one of these envelopes for MPCPDU transmission, and only if the envelope length is enough for at least one complete MPCPDU. The ONU ignores the rest of the overlapping PLID envelope allocations.

802.3ca, 144.3.6.1

– The ONU shall not fragment MPCPDU frames, regardless of the value of the Fragmentation flag in the *EnvAlloc* structure that allocates a PLID envelope.

Reporting PLID queue

Behavior adopted by Motion #3 from 07/17 (see remein_3ca_1_0717.pdf)

❑ "LLID Report" is a tuple consisting of two values: **$LLID_{16}$** and **$QueueLength_{24}$**

- LLID can be either MLID, ULID, or a GLID

- PLIDs are never reported, because PLID queue is always zero and REPORT MPCPDUs are generated just-in-time for transmission

802.3ca approved spec

❑ No restrictions on FR for PLID in GATEs:

- **ForceReport:** When this flag is set to 1, the ONU shall report the total length of the frames queued for transmission on this specific LLID.

❑ No restrictions on PLID *LlidStatus* in REPORTs:

- **LLID:** This 16-bit unsigned integer value represents the logical link that is being reported.

❑ By definition, an LLID is a collective term that refers to a *Physical Layer ID (PLID)*, *management link ID (MLID)*, *user link ID (ULID)*, and a *group link ID (GLID)*.

Proposed GATE/REPORT behavior to be specified in 1904.4

Goal

❑ Three critical goals:

– Allow
… (1) deterministic reporting of LLID queue state
… (2) for a large number of LLIDs
… (3) while minimizing bandwidth consumed by the REPORT MPCPDUs.

Definitions

- ❑ **"Mandatory LLID Report"** – a report that was explicitly requested by the OLT via setting of the FR flag to 1 in a previous *EnvAlloc* to this LLID.

- ❑ **"Gratuitous LLID Report"** – a report sent by the ONU without an explicit request by the OLT.
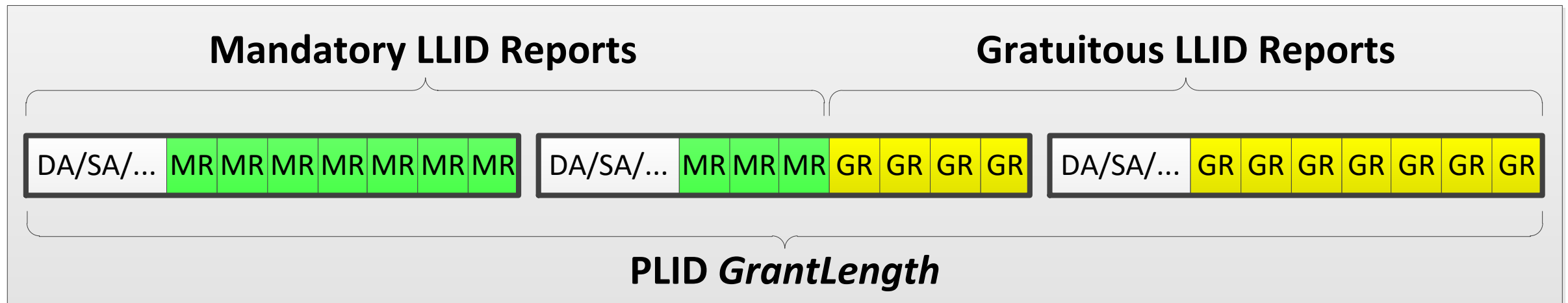
PLID Envelope Allocation by OLT

- **The OLT <u>shall</u> allocate PLID envelope size sufficient to send at least one MPCPDU**
  - Minimum PLID *EnvLength* = 11EQs (88 bytes)
  - FR and F flags shall be set to 0

- **The OLT <u>should</u> allocate sufficiently large PLID envelopes for the number of FR flags that are set to 1.**

- **OLT <u>may</u> allocate longer PLID envelopes in order to receive additional gratuitous reports.**

- Example:
  - OLT set FR = true in *EnvAllocs* assigned to 10 LLIDs
  - ONU is required to send at least 10 *LlidStatus* reports
  - One REPORT MPCPDU may include at most 7 *LlidStatus* reports.
  - 2 REPORT MPCPDUs are required
  - The OLT should allocate PLID *EnvLength* of at least 21 EQs
    - (ESH+ECH+72B+ECH+72B) / 8
  - ONU shall send 10 mandatory *LlidStatus* reports and it may send up to 4 gratuitous reports

PLID Envelope Transmission by ONU

- ☐ ONU shall send at least one REPORT MPCPDU per PLID envelope, even if there is nothing to report

- ☐ PLID *EnvLength* in a GATE message indicates to the ONU the maximum number of REPORT MPCPDUs to send.
  - – Under some conditions, ONU may generate fewer REPORT MPCPDUs than what would fit in PLID envelope. This is explained later.

- ☐ ONU does not need to generate REPORTs if they cannot be transmitted.

- ☐ Example:
  - – OLT set FR = 1 in *EnvAllocs* assigned to 10 LLIDs

  - – ONU is required to send at least 10 *LlidStatus* reports

  - – One REPORT MPCPDU may include at most 7 *LlidStatus* reports.

  - – 2 REPORT MPCPDUs are required

  - – The OLT should allocate PLID *EnvLength* of at least 21 EQs
    - • (ESH+ECH+72B+ECH+72B) / 8

  - – ONU shall send 10 mandatory *LlidStatus* reports and it may send up to 4 gratuitous reports

REPORT Generation

- ❑ The ONU may be allocated more space for *LlidStatus* reports than the number of FR=1 flags set for the current grant.
  - – REPORT MPCPDU carries 7 LLID Reports, so after the last mandatory LLID Report, there may be 1 to 6 extra slots in the last REPORT MPCPDU
  - – The OLT may even grant extra envelope space for additional full REPORT MPCPDUs

- ❑ After generating the **mandatory** *LlidStatus* reports, the ONU shall use the remaining slots in REPORT MPCPDUs for **gratuitous** *LlidStatus* reports, according to the LLID reporting priority

Mandatory LLID Reports　　　　**Gratuitous LLID Reports**

DA/SA/... MR MR MR MR MR MR MR　　DA/SA/... MR MR MR GR GR GR GR　　DA/SA/... GR GR GR GR GR GR GR

PLID *GrantLength*

LLID Reporting Priority

☐ The ONU shall fill the available *LlidStatus* slots in the following priority order:

Priority	*FR* flag	Last reported *QueueLength*	New arrivals	Current queue length
1 – Requested by OLT	1	n/a	n/a	n/a
2 – An idle LLID became active	0	= 0	Yes	> 0
3 – LLID was active and had new arrivals	0	> 0	Yes	> 0
4 – An active LLID became idle	0	> 0	No	= 0
5 – LLID has residual data, but no new arrivals	0	> 0	No	> 0
6 – LLID was idle and remains idle*	0	= 0	No	= 0

*Optional to report, even if there are available *LlidStatus* slots in REPORT MPCPDU

Polling of an ONU

- ❑ Idle ONUs need to be polled periodically, even though they may remain idle for long times.

- ❑ **Goal:** reduce polling overhead to a minimum

- ❑ **OLT behavior:**
  Polling GATE shall contain at least an *EnvAlloc* for PLID and may contain additional *EnvAlloc*s for ULIDs or GLIDs
  - – Minimum PLID *EnvLength* = 11EQs (88 bytes) for one REPORT MPCPDU

- ❑ **ONU behavior:**
  - – An idle ONU (ONU without any user traffic) shall generate <u>at least </u>one REPORT MPCPDU, regardless of how many LLIDs are provisioned or how large the allocated PLID envelope is

  - – According to gratuitous reporting rules, the polling REPORT will be filled with gratuitous *LlidStatus* reports (or may contain no reports if all LLIDs are at priority 6, i.e., remain idle)

  - – It is <u>extremely rare </u>for more than 7 LLIDs to become non-idle in the same polling interval (2-4 ms?).

  - – But if that happens, the ***NonEmptyQueues*** field in REPORT MPCPDU will show the total number of LLIDs that became non-idle since the last REPORT

Thank You