

# Upstream Burst Delimiter and Sync Pattern Assignment

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# Supporters

100G-EPON

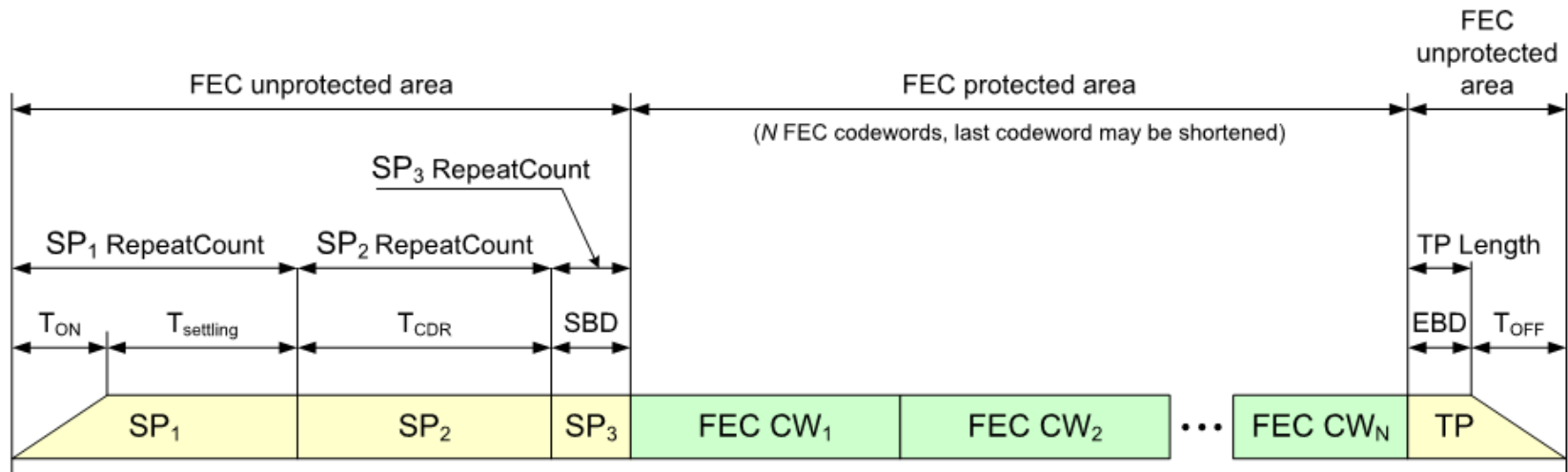
- ❑ Glen Kramer, Broadcom (co-author)
- ❑ Duane Remein, Huawei

- ❑ In January 2018, several contributions on upstream burst delimiter selection were reviewed
  - [kramer\\_3ca\\_2\\_0118.pdf](#)
  - [effenberger\\_3ca\\_1\\_0118.pdf](#)
  - [hajduczenia\\_3ca\\_1\\_0118.pdf](#)
- ❑ Further operating recommendations received during comment resolution in May 2018
- ❑ It was observed that different OLT Receiver implementations may favor different bit sequences for achieving the optimal receiver settling (AGC) and clock & data recovery (CDR) performance.
- ❑ There was an agreement to allow the OLT to announce the desired sync patterns to the registering ONUs and to require the ONUs to use the announced patterns in their upstream burst transmissions.
- ❑ This presentation provides the details of such operation

# Burst Synchronization Patterns

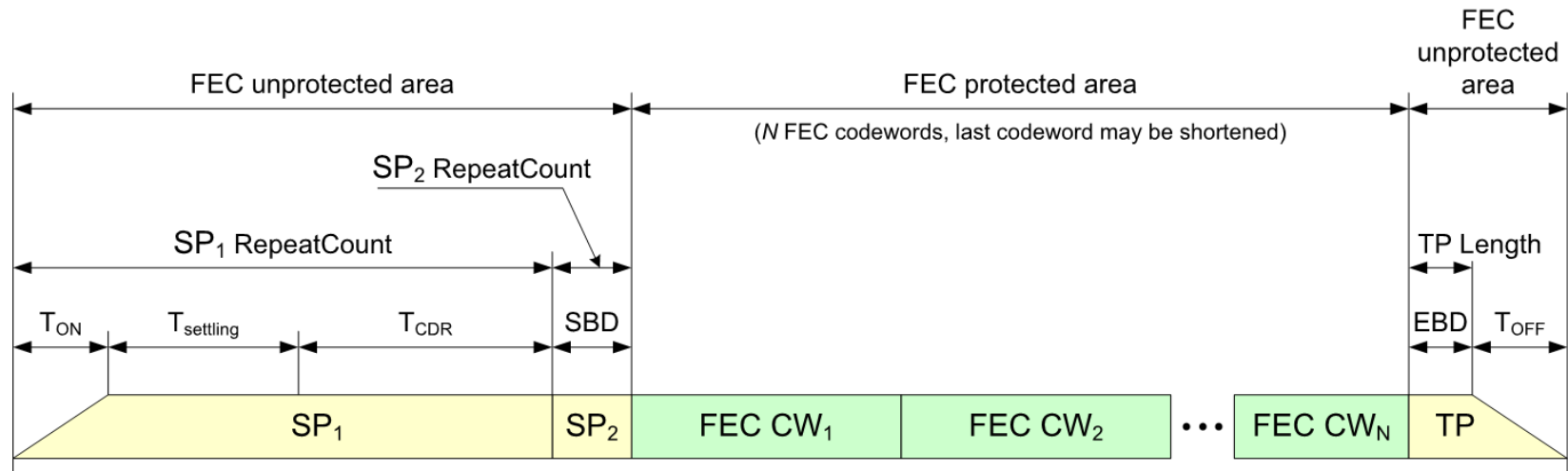
- ❑ Generally, to optimize the receiver performance, two patterns are needed to be selected: one for the AGC and another for CDR.
- ❑ In order to delineate the burst synchronization sequence from the scrambled and FEC-encoded data portion of a burst, an additional *Start-of-Burst Delimiter* (SBD) pattern is specified.
- ❑ While SBD does not directly affect the OLT receiver performance, its choice is dependent on the preceding CDR pattern, therefore SBD pattern should be announced by the OLT as well
  - To be reliably detected, the SBD should provide high Hamming distance against the CDR pattern and against any combination of CDR tail + SBD head.
- ❑ Thus, in general, three patterns need to be announced by the OLT:
  1. Sync pattern for AGC
  2. Sync pattern for CDR
  3. Sync pattern for SBD
- ❑ In some implementations, AGC and CDR patterns may be the same, so only effectively two patterns need to be announced.

# Burst structure, 3 zones



- ❑ Size of each shown region is in multiples of 257-bit blocks
- ❑ Four separate regions of FEC unprotected area are defined:
  - Sync Pattern  $SP_1$  (covers  $T_{on} + T_{settling}$ )
  - Sync Pattern  $SP_2$  (covers  $T_{CDR}$ )
  - Sync Pattern  $SP_3$  (covers Start-of-Burst Delimiter)
  - Terminating Pattern  $TP$  (covers End-of-Burst Delimiter +  $T_{off}$ )
- ❑  $SP_1$ ,  $SP_2$ , and  $SP_3$  values and their durations are announced by the OLT
- ❑ End-of-Burst Delimiter (EBD) is not configurable (fixed in spec). EBD uses one 257-bit block of all zeros (similar to 10G-EPON)

# Burst structure, 2 zones



- ❑ Size of each shown region is in multiples of 257-bit blocks
- ❑ Four separate regions of FEC unprotected area are defined:
  - Sync Pattern  $SP_1$  (covers  $T_{on} + T_{settling} + T_{CDR}$ )
  - Sync Pattern  $SP_3$  (covers Start-of-Burst Delimiter)
  - Terminating Pattern  $TP$  (covers End-of-Burst Delimiter +  $T_{off}$ )
- ❑  $SP_1$  and  $SP_2$  values and their durations are announced by the OLT.  $SP_3$  duration is set to zero.
- ❑ End-of-Burst Delimiter (EBD) is not configurable (fixed in spec). EBD uses one 257-bit block of all zeros (similar to 10G-EPON)

# High-Level Protocol Overview

- ❑ OLT broadcasts  $SP_1$ ,  $SP_2$ , and optionally  $SP_3$  patterns to registering ONUs during the initial MPCP Discovery using SYNC\_PATTERN MPCPDUs before issuing the DISCOVERY\_GATE.
  - Each SP pattern is announced using a separate SYNC\_PATTERN MPCPDUs
- ❑ The required durations for  $SP_1$ ,  $SP_2$ , and  $SP_3$  periods are announced in the DISCOVERY\_GATE MPCPDU.
  - $SP_1$  should allow for the maximum  $T_{on}$  time, since the actual  $T_{on}$  time for a given ONU is not known before the discovery.
  - Also, since the RTTs and, therefore, the exact burst arrival times, are not known, the OLT may decide to require longer  $SP_1$  and/or  $SP_2$  periods.
- ❑ ONU always uses SP values and durations announced by OLT.
- ❑ When the OLT receives the REGISTER\_REQ MPCPDU from an ONU, it learns some characteristics of that ONU, such as the actual  $T_{on}$  time, RTT, and receive power level (or ONU's power class)
- ❑ Based on learned ONU-specific information, the OLT may announce different patterns or the durations to individual ONUs.
  - New patterns are announced by sending SYNC\_PATTERN MPCPDUs on unicast PLID
  - New durations are provisioned as part of the REGISTER MPCPDU

# SYNC\_PATTERN MPCPDU / 1

- ❑ Used to announce the value of Synchronization Pattern (SP) to ONUs
- ❑ *SpInfo* carries information on SP pattern in this MPCPDU:
  - **Bit 0-1:** *SpIndex* (value 1, 2, 3), indicating which SP period is carried in this SYNC\_PATTERN message ( $SP_{1/2/3}$ )
  - **Bit 3-4:** *SpCount* (value 2 or 3), indicating how many SYNC\_PATTERN messages are expected in announcement sequence
  - **Bit 7:** *SpBalanced* (value 0 or 1). Balanced bit sequence may be more suitable for some OLT Rx implementations. But 257-bit pattern cannot be perfectly balanced. When the *SpBalanced* bit is set to 1, rather than repeating  $SP+SP\dots SP$  N times, the ONU shall alternate SP and its inverted value  $\overline{SP}$  N times ( $SP+\overline{SP}+SP+\overline{SP}\dots$ ).
  - **Bit 15:** SP bit 0 (first bit of the SP value)
  - Other bits reserved / set to 0 on transmit

## SYNC\_PATTERN MPCPDU

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x0018	2
Timestamp	4
SpInfo	2
SpValue	32
Padding	6
FCS	4



# SYNC\_PATTERN MPCPDU /2

## □ *SpValue* structure

- Bits 1 through 256 of Sync Pattern saved into 32-octets wide data field *SpValue*, right adjusted. Bit 0 of Sync Pattern saved into *SpInfo* field (see previous slide for details).
- The same encoding is used for  $SP_1$ ,  $SP_2$ , and  $SP_3$  fields

Octet	Value (binary)
0	SP<8:1>
...	...
30	SP<248:241>
31	SP<256:249>

# DISCOVERY\_GATE

- ❑ Changes to DISCOVERY\_GATE MPCPDU to carry Discovery Repeat values for individual SP zones.
- ❑ *Repeat Count* indicates how many times the given 257-bit SP value field is transmitted during Discovery Window transmission.
- ❑ Separate repeat count value for SP<sub>1</sub>, SP<sub>2</sub>, and SP<sub>3</sub> sync pattern zones. When only two zones are present, SP<sub>3</sub> repeat count is set to 0.

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x0017	2
Timestamp	4
Channel Assignment	1
Start Time	4
Discovery Grant Length	3
Reserved	2
Discovery Information	2
Repeat Count SP <sub>1</sub>	2
Repeat Count SP <sub>2</sub>	2
Repeat Count SP <sub>3</sub>	2
Pad	22
FCS	4

# REGISTER MPCPDU

- ❑ Changes to REGISTER MPCPDU to carry Granting Repeat values for individual sync pattern zones.
- ❑ *Repeat Count* indicates how many times the given 257-bit SP value field is transmitted during regular granting operation.
- ❑ Separate repeat count value for  $SP_1$ ,  $SP_2$ , and  $SP_3$  sync pattern zones. When only two zones are present,  $SP_3$  repeat count is set to 0.
- ❑ **Laser On/Off Time fields are removed (in .3ca, the ONUs do not need to subtract optical overhead from the received grant length).**

Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x0015	2
Timestamp	4
Assigned Port (PLID)	2
Assigned Port (MLID)	2
Flags	1
Reserved	2
Echo Pending Grants	1
Repeat Count $SP_1$	2
Repeat Count $SP_2$	2
Repeat Count $SP_3$	2
Pad	26
FCS	4

- ❑ OLT announces SP values using SYNC\_PATTERN MPCPDU before issuing DISCOVERY\_GATE MPCPDU
- ❑ SYNC\_PATTERN MPCPDUs are sent on broadcast PLID during the discovery process. OLT may change SP values for individual ONU after the discovery sending SYNC\_PATTERN MPCPDUs on unicast PLID.
- ❑ Each SP value is announced using a separate SYNC\_PATTERN MPCPDU.
- ❑ The OLT may announce 2 or 3 SP values (as indicated by SP Count field):
  - $SP_1$  for laser\_on and AGC,  $SP_2$  for CDR, and  $SP_3$  for SBD
  - $SP_1$  for laser\_on+AGC+CDR,  $SP_2$  for SBD,  $SP_3$  is ignored if announced.
- ❑ OLT may announce different SP values (or even different counts of SP values) for different discovery attempts.
- ❑ OLT announces Repeat Count SP values in DISCOVERY\_GATE MPCPDU for Discovery Window, and in REGISTER MPCPDU for granting operation.

- ❑ Unregistered ONUs always process and store the last-announced SP values (SP values may change from one discovery attempt to another).
- ❑ ONUs do not validate the SP values or acknowledge the SYNC\_PATTERN MPCPDUs received from the OLT.
- ❑ An unregistered ONU shall not respond to a DISCOVERY\_GATE MPCPDU until a full set the SP values is received from the OLT.
- ❑ Once registered, ONU stops listening and acting on SYNC\_PATTERN MPCPDUs sent on broadcast PLID, but may still receive SYNC\_PATTERN MPCPDU(s) on unicast PLID.

# Proposed default SP settings

□ By default, OLT uses two SP zones:

– **SP<sub>1</sub>**

- Covers laser\_on period, AGC, and CDR
- Duration:  $T_{\text{on}} + T_{\text{receiver\_settling}} + T_{\text{CDR}}$ , in units of 257-bit blocks
- SpValue: 0x1-55-...-55
- SpBalanced = True (1)

– **SP<sub>2</sub>**

- Covers SBD
- Duration: 1
- SpValue: 0x1-BF-40-18-E5-C5-49-BB-59  
-6B-F8-D8-12-D8-58-E4-AB  
-40-BF-E7-1A-3A-B6-44-A6  
-94-07-27-ED-27-A7-1B-54
- SpBalanced = False (0)

see [kramer\\_3ca\\_2\\_0118.pdf](#)

□ Vendors may overwrite any and all of the above parameters. Care should be taken to ensure that there is sufficient Hamming distance between the CDR and SBD patterns