Gain Control of SOA Preamplifier

Daisuke Umeda Sumitomo Electric
Dekun Liu Huawei

IEEE P802.3ca 100G-EPON Task Force meeting, Chicago
5-7 March 2018

Supporters

- John Johnson, Broadcom
- Rene Bonk, Nokia Bell Labs
- Hanhyub Lee, ETRI

Motivation

- SOA preamplifier at OLT is one of the candidates to overcome upstream loss budget, especially 50G/100G.
- Introduced SOA gain control method with system support at the meeting on January, 2018.

[1] "Gain Control of SOA Preamplifier"
http://www.ieee802.org/3/ca/public/meeting_archive/2018/01/umeda_3ca_1_0118.pdf

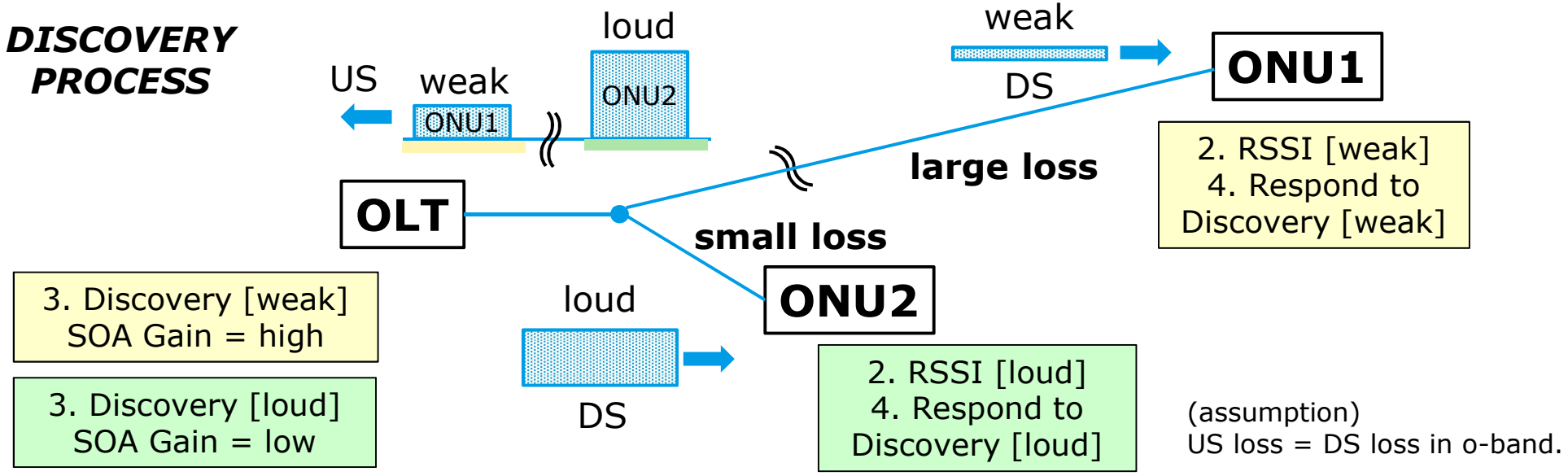
- In this contribution, I propose the procedure and parameters for gain control of SOA preamplifier at OLT with system support.

SOA Gain Control

1. OLT announces the parameters to determine OLT Rx power class to all ONUs.
2. ONU measures Rx power and estimates OLT Rx power and determines OLT Rx power class (loud or weak).

   OLT Rx power = ONU Tx power - Channel Insertion Loss

   = ONU Tx power – (OLT Tx power – ONU Rx power)
3. Dedicated discovery for OLT Rx power class is executed. SOA gain is controlled depending on OLT Rx power class.
4. ONUs corresponding to OLT Rx power class respond and are registered.



Reference information of power leveling control

1) If the ONU RSSI is greater than or equal to –7 dBm, then PL of 12 dB is applied.
2) If the ONU RSSI is less than –7 and greater than or equal to –10 dBm, then PL of 9 dB is applied.
3) If the ONU RSSI is less than –10 and greater than or equal to –13 dBm, then PL of 6 dB is applied.
4) If the ONU RSSI is less than –13 and greater than or equal to –16 dBm, then PL of 3 dB is applied.
5) If the ONU RSSI is less than –16 then PL of 0 dB is applied.

The PL procedure reduces the apparent differential optical path loss of the ODN and, hence, the optical dynamic range at the OLT, at least for ONUs with PL. If all ONUs implement PL then all of the four optical parameters (OOC, OOB, isolation, overload) could be relaxed. However if there is a mix of ONUs with and without PL, then only the PSD requirements (OOC and OOB) will be able to be relaxed for the ONUs employing PL.

- Similar mechanism can be used for NG-EPON OLT with preamplifier adjustment

Start Up

OLT announces the following parameters to all ONUs by a new MPCPDU Message.

Parameter	Description	Example
OLT_Tx	OLT Transmitter Power (from TSSI, Calibration value or Typical Spec.)	6.0 dBm
NUM_th	Number of Valid Thresholds	3
TH0	Threshold 0 (High)	-9 dBm
TH1	Threshold 1 (Middle)	-12 dBm
TH2	Threshold 2 (Low)	-15 dBm

(Note) OLT transceiver provides these parameters.

- Extend the current discovery gate message to support different kinds (loud or small) ONUs registered at different time slot

Table 77–3—GATE MPCPDU discovery information fields

Bit	Flag field	Values
0	OLT is 1G upstream capable	0 – OLT does not support 1 Gb/s reception 1 – OLT supports 1 Gb/s reception
1	OLT is 10G upstream capable	0 – OLT does not support 10 Gb/s reception 1 – OLT supports 10 Gb/s reception
2–3	Reserved	Ignored on reception
4	OLT is opening 1G discovery window	0 – OLT cannot receive 1 Gb/s data in this window 1 – OLT can receive 1 Gb/s data in this window
5	OLT is opening 10G discovery window	0 – OLT cannot receive 10 Gb/s data in this window 1 – OLT can receive 10 Gb/s data in this window
6–15	Reserved	Ignored on reception

New Gate discovery fields (1)

Considering there are general +/-2dB accuracy for TSSI, while the OLT Tx power spread range is generally 3dB, so we can evaluate OLT Rx power based on the average value of launch power in OLT and ONU

GATE MPCPDU discovery information fields		
Bit	Flag field	Values
0	OLT is 1G upstream capable	0 – OLT does not support 1 Gb/s reception 1 – OLT supports 1 Gb/s reception
1	OLT is 10G upstream capable	0 – OLT does not support 10 Gb/s reception 1 – OLT supports 10 Gb/s reception
2-3	Reserved	Ignored on reception
4	OLT is opening 1G discovery window	0 – OLT cannot receive 1 Gb/s data in this window 1 – OLT can receive 1 Gb/s data in this window
5	OLT is opening 10G discovery window	0 – OLT cannot receive 10 Gb/s data in this window 1 – OLT can receive 10 Gb/s data in this window
6-8	ONU Rx_RSSI indication	000 : registration for all ONUs 001 : registration for ONUs Rx_RSSI<th1 010 : registration for ONUs Rx_RSSI>=th1 100 : registration for ONUs Rx_RSSI<th0 101 : registration for ONUs Rx_RSSI>=th0 & Rx_RSSI<th1 110 : registration for Rx_RSSI>=th1 & Rx_RSSI<th2 111 : registration for ONUs Rx_RSSI>=th2
9-15	Reserved	Ignored on reception

$th0 = TH0 - (\overline{ONU\_Tx} - \overline{OLT\_Tx})$ $th1 = TH1 - (\overline{ONU\_Tx} - \overline{OLT\_Tx})$ $th2 = TH2 - (\overline{ONU\_Tx} - \overline{OLT\_Tx})$

OLT allocate different gate message for different kinds of ONUs for registration, OLT do the according configuration for pre-amplifier

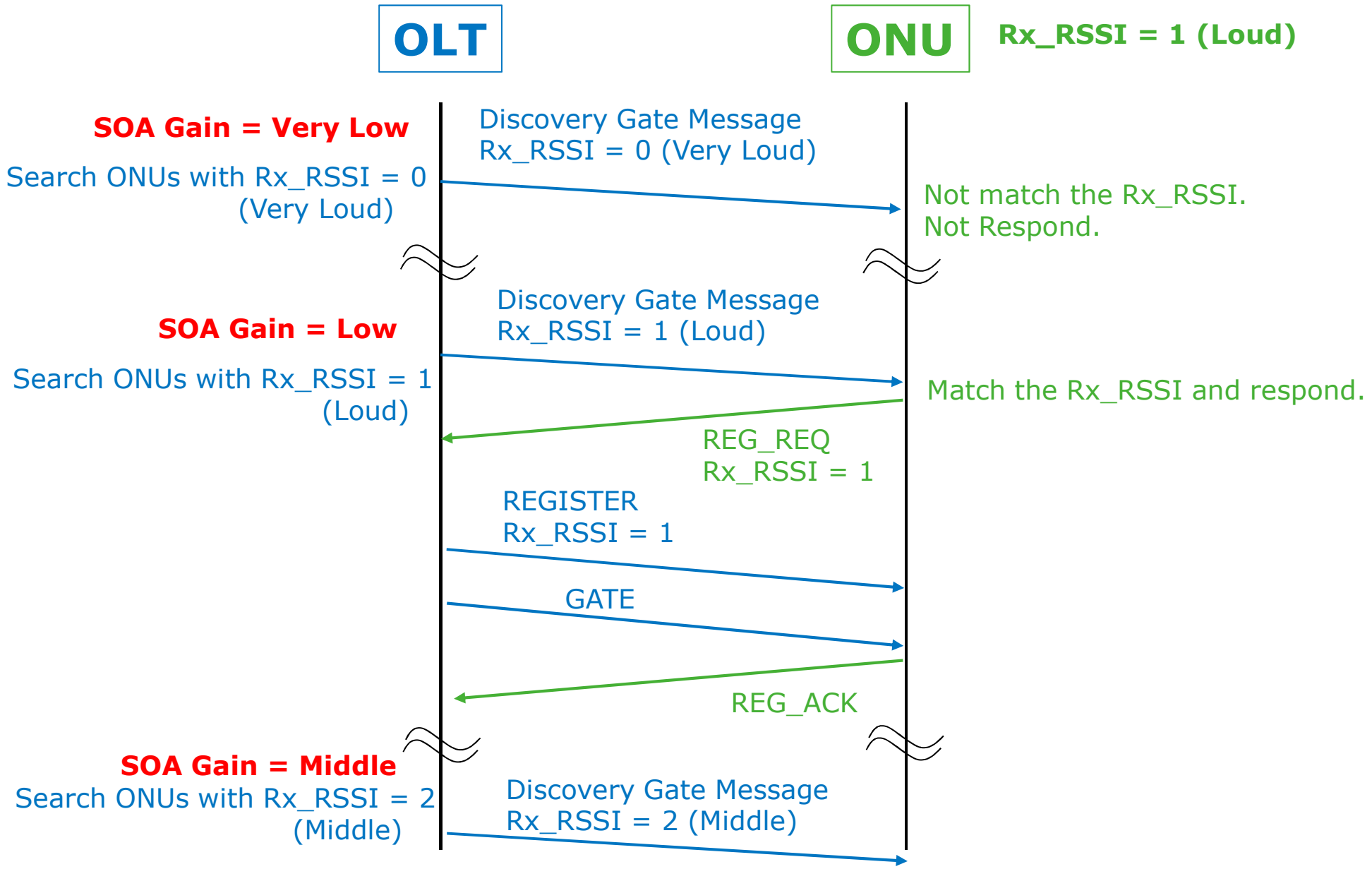
New Gate discovery fields (2)

If more accuracy is needed , we can use a little more complicated model:

GATE MPCPDU discovery information fields		
Bit	Flag field	Values
0	OLT is 1G upstream capable	0 – OLT does not support 1 Gb/s reception 1 – OLT supports 1 Gb/s reception
1	OLT is 10G upstream capable	0 – OLT does not support 10 Gb/s reception 1 – OLT supports 10 Gb/s reception
2-3	Reserved	Ignored on reception
4	OLT is opening 1G discovery window	0 – OLT cannot receive 1 Gb/s data in this window 1 – OLT can receive 1 Gb/s data in this window
5	OLT is opening 10G discovery window	0 – OLT cannot receive 10 Gb/s data in this window 1 – OLT can receive 10 Gb/s data in this window
6-8	ONU Rx_RSSI indication	000 : registration for all ONUs 001 : registration for ONUs Rx_RSSI<TH1-(ONU_Tx –OLT_Tx) 010 : registration for ONUs Rx_RSSI>=TH1-(ONU_Tx – OLT_Tx) 100 : registration for ONUs Rx_RSSI<TH0-(ONU_Tx –OLT_Tx) 101 : registration for ONUs Rx_RSSI>=(TH0-(ONU_Tx – OLT_Tx)) & Rx_RSSI< (TH1-(ONU_Tx –OLT_Tx)) 110 : registration for Rx_RSSI>=&TH1-(ONU_Tx –OLT_Tx)) & Rx_RSSI<(TH2-(ONU_Tx –OLT_Tx)) 111 : registration for ONUs Rx_RSSI>=TH2-(ONU_Tx – OLT_Tx)
9-15	Reserved	Ignored on reception

OLT allocate different gate message for different kinds of ONUs for registration, OLT do the according configuration for pre-amplifier

Discovery Process



Summary

- Proposed procedure and parameters for gain control of SOA preamplifier at OLT.
  - SOA pre/post amplifier would be necessary for 25G and 50G US (2x25G or 1x50G).
  - Gain control mechanism can be applied to APD receiver in case that higher receive power (overload) is required.
  - For dual rate operation of 25G and 10G, the same OLT Rx thresholds are available. OLT/ONU Tx powers are different.

- Consideration on accuracy and long term operation.
  - What we really need is to distinguish very loud ONUs. RSSI accuracy would be enough for this purpose.
  - If more accuracy is needed, Tx powers can be measured by TSSI, or calibrated values can be used.
  - Protection mechanism should be implemented to avoid damage or OLT Rx due to unexpected failure.
  - Further study is needed how to update Rx_RSSI for long term operation.