Gain Control of SOA Preamplifier

Daisuke Umeda   Sumitomo Electric

Dekun Liu   Huawei

Supporters

Motivation

- At the last meeting in Chicago, Motion #9 on the extension of the discovery message was passed.

> **Motion #9**
>
> In order to extend OLT burst receiver dynamic range, move to extend the discovery message shown in umeda_3ca_1b_0318.pdf pages 7 and 8 to support ONUs with different RX_RSSI to be registered in different time slots. Align the table with new bit positions in draft as amended in this meeting.
>
> Moved: Daisuke Umeda   Second: Dekun Liu
>
> For: 19   Against: 0   Abstain: 3
>
> Technical (≥ 75%)   Motion Passed

- In order to use RX_RSSI indicator, we propose to announce OLT Rx thresholds and OLT/ONU transmitter powers from OLT to all ONUs in this contribution.

Table 144-6 Discovery Information Fields

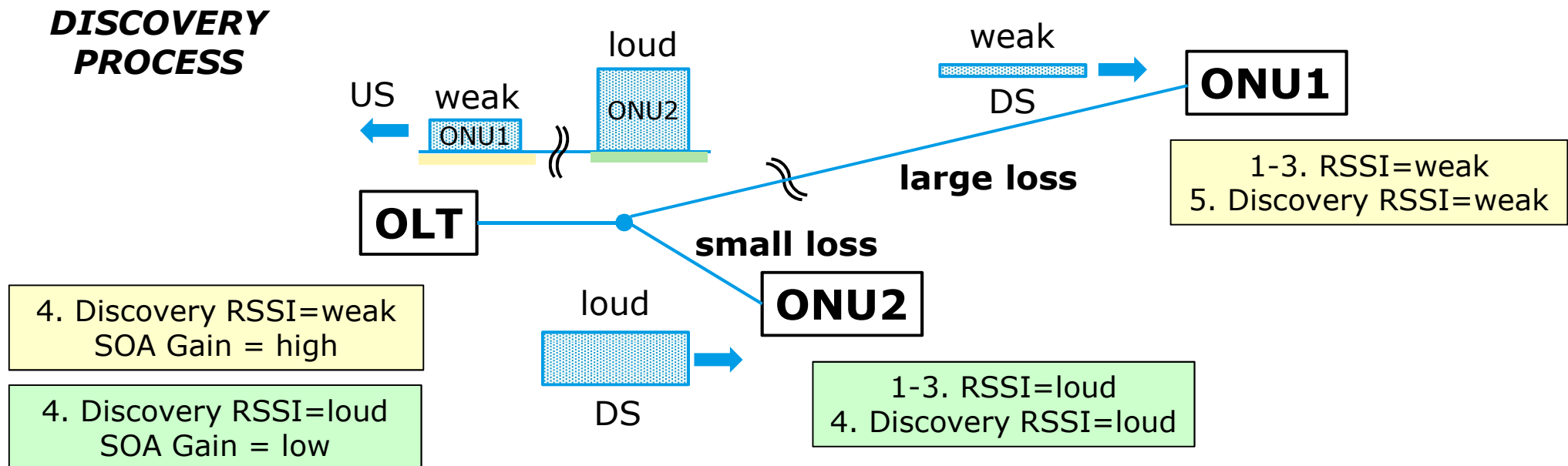|	GATE MPCPDU discovery information fields	
Bit	Flag field	Values
0	Reserved	Ignored on Reception
1	OLT is 10G upstream capable	0 – OLT does not support 10 Gb/s reception 1 – OLT supports 10 Gb/s reception
2	OLT is 25G upstream capable	0 – OLT does not support 25 Gb/s reception 1 – OLT supports 25 GB/s reception
3-4	Reserved	Ignored on reception
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	OLT is opening 25G discovery window	0 – OLT cannot receive 25 Gb/s data in this window 1 – OLT can receive 25 Gb/s data in this window
➔ 7-8	Reserved	Ignore on Reception
7-9 ➔ 9-11	ONU R̶x̶ RSSI indication	000 : registration for all ONUs 001 : registration for ONUs RSSI < th1 010 : registration for ONUs RSSI $\geq$ th1 100 : registration for ONUs RSSI < th0 101 : registration for ONUs RSSI $\geq$ th0 & RSSI < th1 110 : registration for RSSI $\geq$ th1 & RSSI < th2 111 : registration for ONUs RSSI $\geq$ th2
10-15 ➔ 12-15	Reserved	Ignored on reception

- Recommend to leave reserved bits at Bits7-8 for future updates and shift "ONU RSSI indication" to Bits9-11.

- In order to use ONU RSSI indication, ONUs need RSSI thresholds th0-2 information.

    $$th_x = TH_x + OLT\_Tx - ONU\_Tx \qquad (dBm)$$

    TH_x: OLT Rx threshold (dBm), OLT_Tx: OLT Tx power (dBm), ONU_Tx: ONU Tx power (dBm)

Discovery with ONU RSSI Indication

1. OLT announces parameters to calculate ONU RSSI thresholds by **DISCOVERY GATE message or a new MPCPDU.**

2. ONU receives the parameters and calculates ONU RSSI thresholds.

3. ONU monitors RSSI, compares the RSSI value with ONU Rx thresholds and determines the RSSI class.

4. OLT executes dedicated discovery by DISCOVERY GATE message with ONU RSSI Indication.

5. ONU responds to the DISCOVERY GATE with matched RSSI Indication.

DISCOVERY PROCESS

loud

weak

US   weak

ONU2

weak

DS

ONU1

ONU1

large loss

1-3. RSSI=weak
5. Discovery RSSI=weak

OLT

small loss

4. Discovery RSSI=weak
SOA Gain = high

loud

ONU2

4. Discovery RSSI=loud
SOA Gain = low

DS

1-3. RSSI=loud
4. Discovery RSSI=loud

Announcement of TH$_X$ and OLT/ONU_Tx Parameters

OLT announces the following parameters to all ONUs.

Parameter	Description	Example
TH0 [1]	OLT Rx threshold 0 (Low)	-15 dBm
TH1 [1]	OLT Rx threshold 1 (Middle)	-12 dBm
TH2 [1]	OLT Rx threshold 2 (High)	-9 dBm
OLT_Tx [2]	OLT transmitter power	6 dBm
ONU_Tx10G [3]	ONU 10G transmitter power	6 dBm
ONU_Tx25G [3]	ONU 25G transmitter power	6 dBm
(ONU_Tx50G) [3]	Reserved (ONU 50G transmitter power)	

(Note)

(1) OLT announces "OLT Rx thresholds" TH$_X$ and ONUs calculate "ONU RSSI tresholds" th$_X$.

th$_X$ for 10G US ONU: th$_{X}$_10G = TH$_X$ + OLT_Tx – ONU_Tx10G   (dBm)   X=0,1,2

th$_X$ for 25G US ONU: th$_{X}$_25G = TH$_X$ + OLT_Tx – ONU_Tx25G   (dBm)   X=0,1,2

th$_X$ for 50G US ONU: th$_{X}$_50G = TH$_X$ + OLT_Tx – ONU_Tx50G   (dBm)   X=0,1,2

(2) A typical, calibrated or TSSI value can be announced as OLT transmitter power.

(3) Typical values are announced as ONU transmitter powers. ONU Tx power range is about 3dB and typical value is accurate enough.
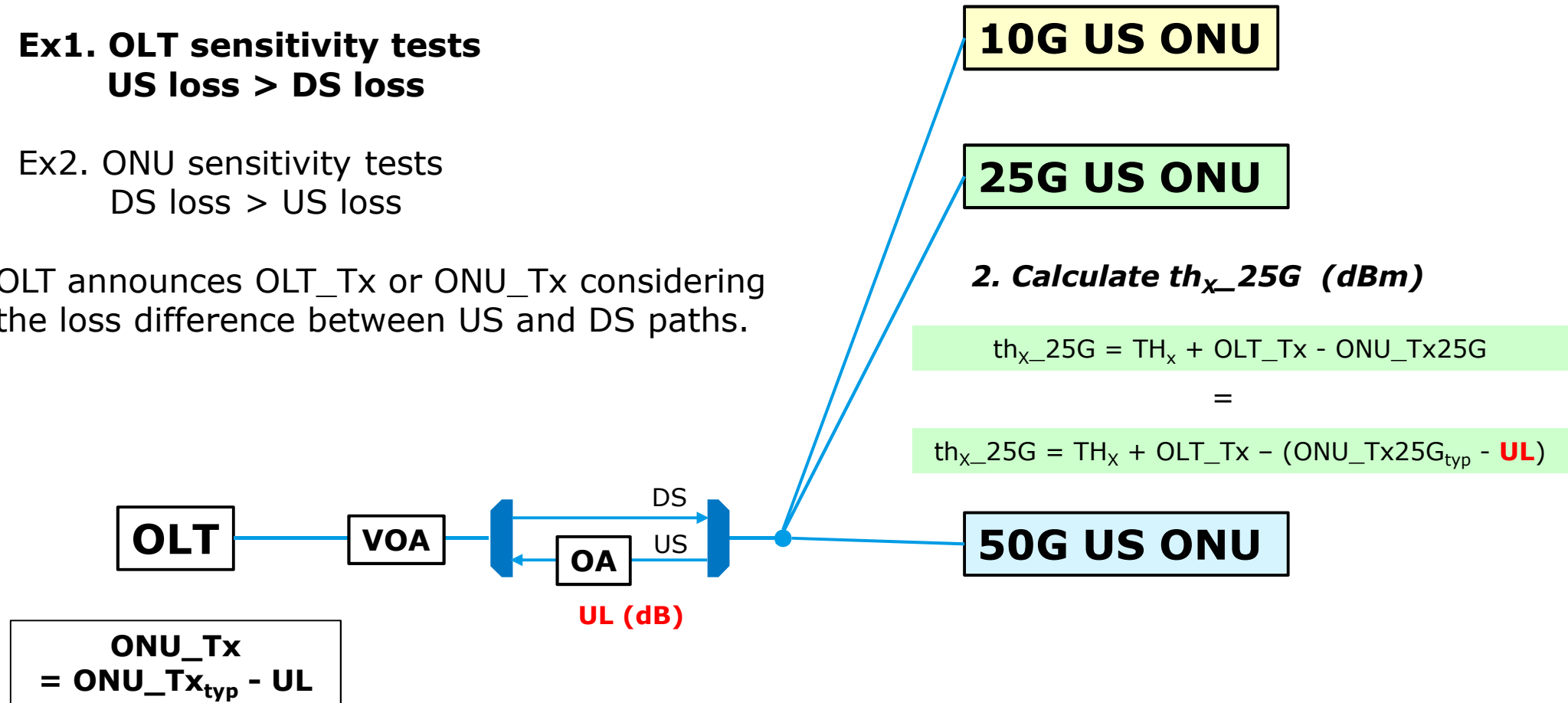
Calculation of ONU RSSI thresholds
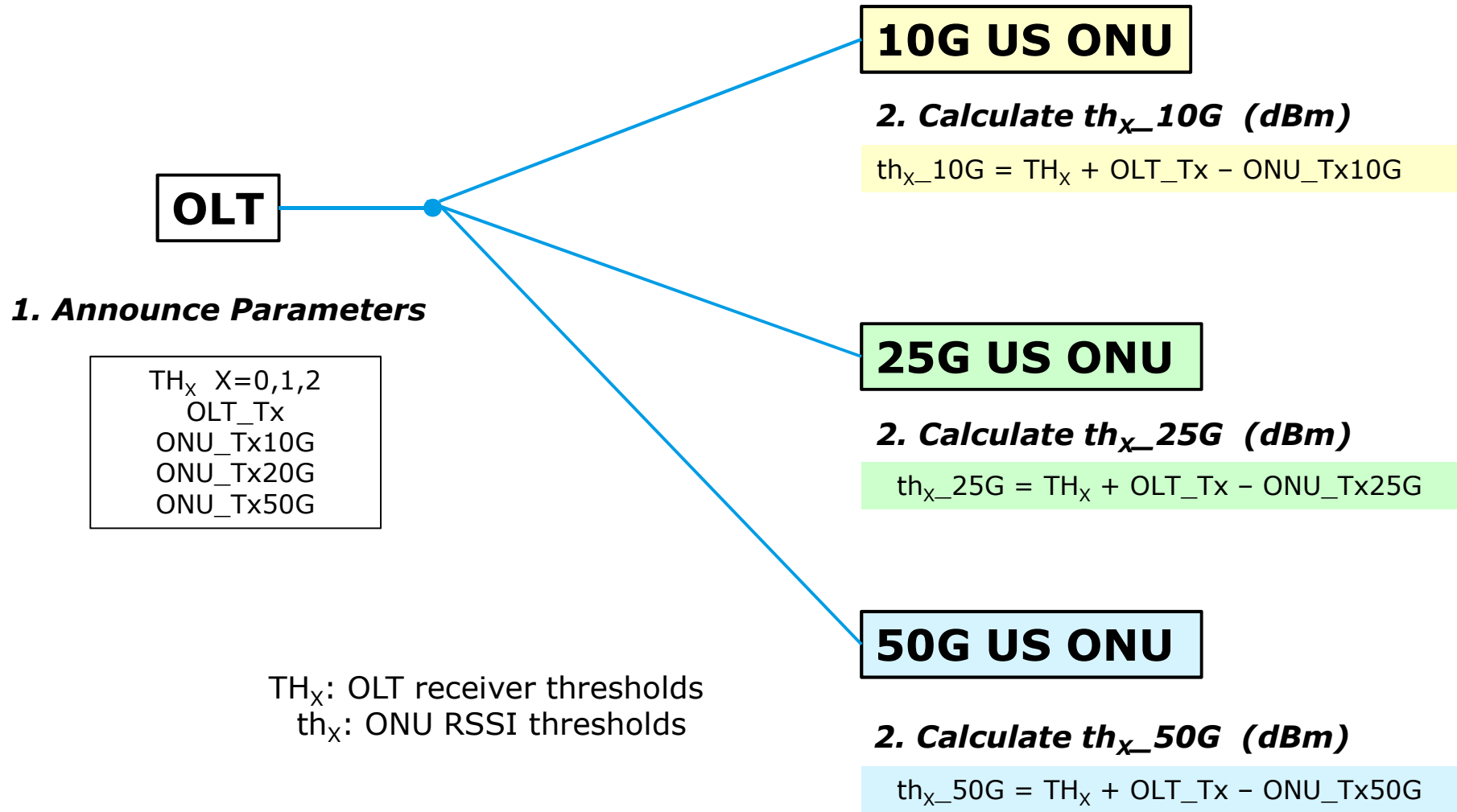
OLT

1. Announce Parameters

TH_X X=0,1,2
OLT_Tx
ONU_Tx10G
ONU_Tx20G
ONU_Tx50G

TH_X: OLT receiver thresholds
th_X: ONU RSSI thresholds

10G US ONU

2. Calculate th_X_10G (dBm)

$th_X\_10G = TH_X + OLT\_Tx - ONU\_Tx10G$

25G US ONU

2. Calculate th_X_25G (dBm)

$th_X\_25G = TH_X + OLT\_Tx - ONU\_Tx25G$

50G US ONU

2. Calculate th_X_50G (dBm)

$th_X\_50G = TH_X + OLT\_Tx - ONU\_Tx50G$

Consideration on Asymmetric Channel Insertion Loss

In some system tests, asymmetric C.I.L. configurations are needed.

Ex1. OLT sensitivity tests
   US loss > DS loss

Ex2. ONU sensitivity tests
   DS loss > US loss

OLT announces OLT_Tx or ONU_Tx considering the loss difference between US and DS paths.

10G US ONU

25G US ONU

2. Calculate th_x_25G (dBm)

$$th_x\_25G = TH_x + OLT\_Tx - ONU\_Tx25G$$

$$=$$

$$th_x\_25G = TH_x + OLT\_Tx - (ONU\_Tx25G_{typ} - \textbf{UL})$$

50G US ONU

DS

OLT — VOA — | OA | US

UL (dB)

ONU_Tx
= ONU_Tx$_{typ}$ - UL
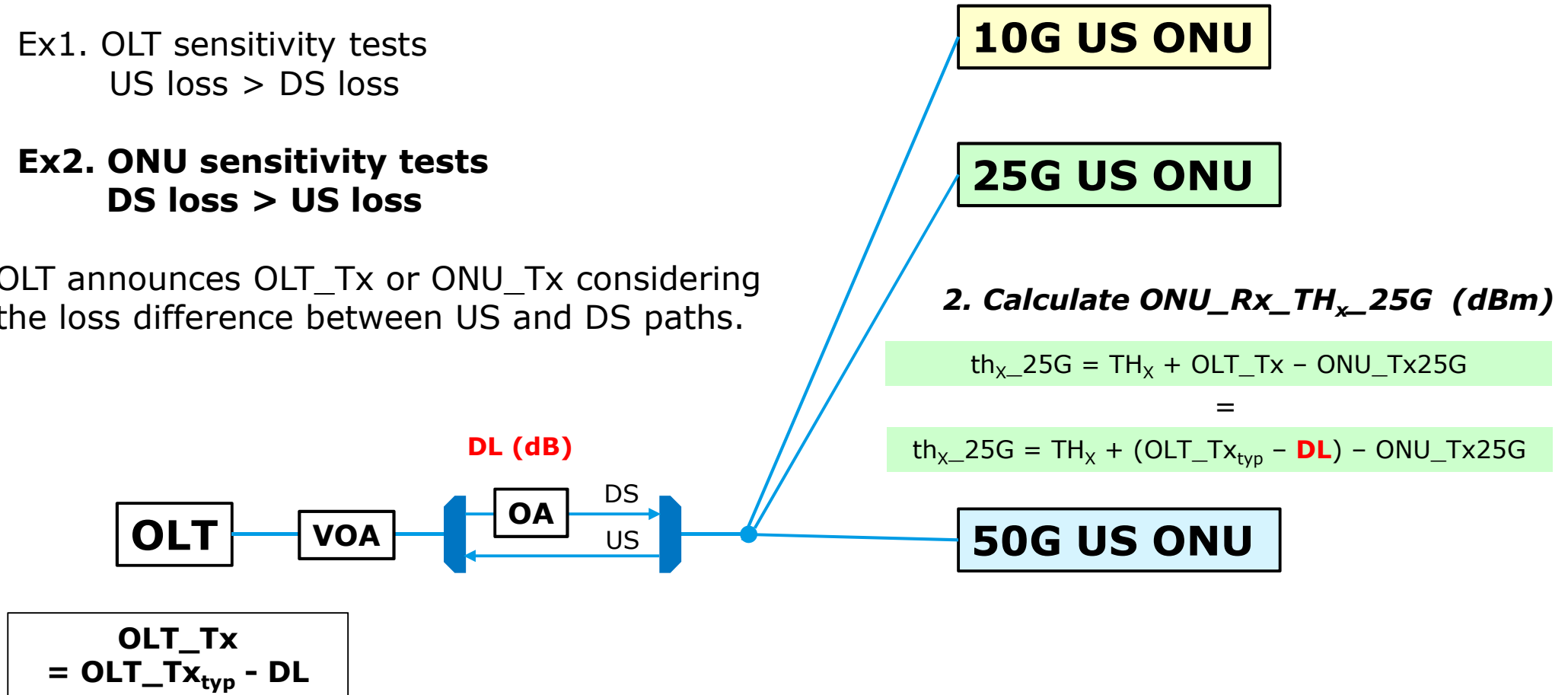
Ex.1 OLT sensitivity test

Consideration on Asymmetric Channel Insertion Loss

In some system tests, asymmetric C.I.L. configurations are needed.

Ex1. OLT sensitivity tests
US loss > DS loss

**Ex2. ONU sensitivity tests
DS loss > US loss**

OLT announces OLT_Tx or ONU_Tx considering the loss difference between US and DS paths.

10G US ONU

25G US ONU

2. Calculate $ONU\_Rx\_TH_x\_25G$ (dBm)

$$th_X\_25G = TH_X + OLT\_Tx - ONU\_Tx25G$$

$$=$$

$$th_X\_25G = TH_X + (OLT\_Tx_{typ} - DL) - ONU\_Tx25G$$

DL (dB)

OLT — VOA — OA — DS / US — **50G US ONU**

**OLT_Tx
= OLT_Tx_{typ} - DL**

Ex.2 ONU sensitivity test

Announcement TH_x and OLT/ONU_Tx Parameters by DISCOVERY GATE message

Use 16 Octets on DISCOVERY GATE MPCPDU to announce OLT Rx threshold and OLT/ONU transmitter power information.

- TH_X : OLT Rx thresholds are 16-bit signed two's-complement value, with the LSB equal to 0.1 uW, covering the range of 0 to 6.5535 mW ($\sim$ -40 to +8.2 dBm)

- OLT_Tx and ONU_Tx: OLT/ONU Tx powers are 16-bit signed two's-complement values, with the LSB equal to 0.8 uW, covering the range of 0 to 52.428 mW ($\sim$ -31 to +17.2 dBm)

OLT Rx threshold and OLT/ONU Tx power Information fields			
Octet	Field	Value	Unit
0-1	TH0	0 to 6.5535 mW ($\sim$ -40 to 8.2 dBm)	0.1 uW
2-3	TH1		
4-5	TH2		
6-7	OLT_Tx	0 to 52.4 mW ($\sim$ -31 to +17.2 dBm)	0.8 uW
8-9	ONU_Tx10G		
10-11	ONU_Tx25G		
12-15	Reserved	Ignored on reception	

10G US ONU: $th_{X}\_10G = TH_X * OLT\_Tx / ONU\_Tx10G$ (mW)

25G US ONU: $th_{X}\_25G = TH_X * OLT\_Tx / ONU\_Tx25G$ (mW)

	Octets
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
Sync Time	2
Discovery Information	2
OLT Rx TH and OLT/ONU Tx power Information	16
Pad	12
FCS	4

OCTETS WITHIN FRAME TRANSMITTED TOP–TO–BOTTOM

Figure 144-23 – DISCOVERY GATE MPCPDU

Announcement TH_x and OLT/ONU_Tx Parameters by a new MPCPDU message

- Opcode : 0x001a (next available)
- TH_x : OLT Rx thresholds are 16-bit signed two's-complement value, with the LSB equal to 0.1 uW, covering the range of 0 to 6.5535 mW (~ -40 to +8.2 dBm)
- OLT_Tx and ONU_Tx: OLT/ONU Tx powers are 16-bit signed two's-complement values, with the LSB equal to 0.8 uW, covering the range of 0 to 52.428 mW (~ -31 to +17.2 dBm)

Octet	Field	Value	Unit
0-1	TH0	0 to 6.5535 mW (~ -40 to 8.2 dBm)	0.1 uW
2-3	TH1		
4-5	TH2		
6-7	OLT_Tx	0 to 52.4 mW (~ -31 to +17.2 dBm)	0.8 uW
8-9	ONU_Tx10G		
10-11	ONU_Tx25G		
12-15	Reserved	Ignored on reception	

	Octets
Destination Address	6
Source Address	6
Length/Type = 0x8808	2
Opcode = 0x01a	2
Timestamp	4
TH0	2
TH1	2
TH2	2
OLT_Tx	2
ONU_Tx10G	2
ONU_Tx25G	2
Reserved/Pad	28
FCS	4

OCTETS WITHIN FRAME TRANSMITTED TOP-TO-BOTTOM

10G US ONU: $th_x\_10G = TH_x * OLT\_Tx / ONU\_Tx10G$ (mW)
25G US ONU: $th_x\_25G = TH_x * OLT\_Tx / ONU\_Tx25G$ (mW)

Reference Information of IEEE1904.1 SIPON

Monitor functions

9.1.5.6 Optical transmitter output power

The ONU and OLT should support the measurement of the output power of the optical transmitter. The measured value is represented in the format of a 16-bit unsigned integer (with the value range of 0 to 65535), with the LSB equal to 0.1 µW, covering the range of 0 to +6.5535 mW (~ −40 to +8.2 dBm). The measurement accuracy is better than ±3 dB across the total measurement range.

9.1.5.7 Optical receiver input power

The ONU should support the measurement of the input power of the optical receiver. The measured value is represented in the format of a 16-bit unsigned integer (with the value range of 0 to 65535), with the LSB equal to 0.1 µW, covering the range of 0 to +6.5535 mW (~ −40 to +8.2 dBm). The measurement accuracy is better than ±3 dB across the total measurement range.

Summary

- Proposed to leave reserved bits of Bits7-8 for future updates and shift "ONU RSSI Indication" to Bits9-11.

- Proposed the announcement of OLT Rx thresholds and OLT/ONU transmitter powers by DISCOVERY GATE message, and by a new MPCPDU message.

- Recommend the announcement by DISCOVERY GATE message for simple implementation.

Motion

Move to adopt slide 10 in umeda_3ca_1_0518 to announce of OLT/ONU transmitter powers and thresholds of receiver power class.

Moved:

Second:

For:

Against:

Abstain: