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초고속 광가입자 망 기술 및 표준

2002.11.28

삼성종합기술원 i-networking lab 김 아 정

삼성전자 표준연구팀 송 재 연

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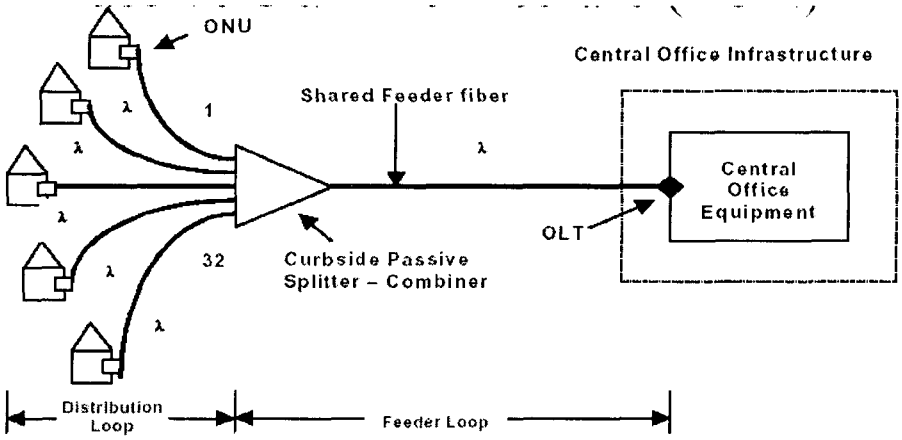
Passive Optical Network



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Passive Optical Network

❖ Shared feeder fiber

- Same bit rate on feeder and distribution, but each home must share using multiple-access protocol
- Increase capacity by reducing sharing

❖ Electronics at CO and home

❖ Technology evolution requires upgrading all homes served by splitter simultaneously

❖ Distance limited by power loss due to splitting

- unless use optical amplifiers

❖ Services on common data link layer (unless multiple lambdas per home used)

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Contents

1	IEEE 802.3ah EFM STFs
2	EPON MAC Protocol : MPCP
3	MPCP issues
4	PMD Issues

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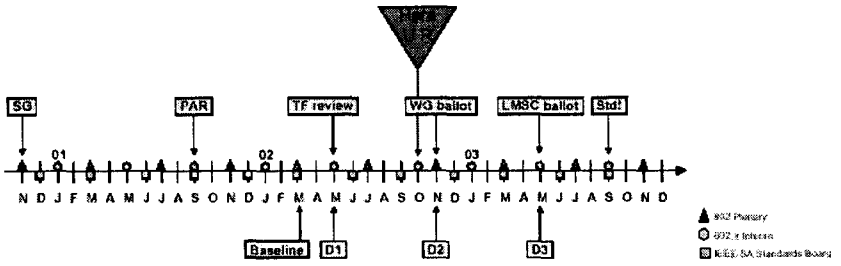
EFM 현황

표준화 일정

- IEEE LAN/MAN Standard Committee(LMSC) 산하 802.3 WG은 2000.11 Plenary meeting에서 EPON 표준을 위한 EFM SG 결성을 승인
- Sub-track별 활동 시작(2001.07)
- NesCom과 STB의 정식 PAR로 승인 받아 TF 구성(2001. 10)
- EPON STF, Optical PMD STF baseline Pass(2002.03), OAM STF baseline Pass(2002.05)
- Draft v1.1(~2002.10) (일정지연 가능)
- Over 200 individuals from 80+ companies worldwide participated in.



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EFM Objectives

- ❖ Speed
  - P2P optical fiber : 100Mbps, 1000Mbps using 100BASE-X, 1000BASE-X
  - P2P copper : support a variety of bit rates, depending on the span and the SNR
  - P2MP optical fiber : support 1000Mbps
- ❖ Support the only FDX
- ❖ MPCP(Multi-Point MAC Control Protocol
  - The MAC protocol for P2MP topology consist of OLT and ONUs
- ❖ P2P Emulation sublayer
  - Makes an underlying P2MP network appear as a collection of P2P links to the higher protocol layer(above MAC Client)
  - It achieves this by prepending a LLID to the beginning of each packet, replacing 2 octets of the preamble
- ❖ Support far-end OAM for subscriber access networks:
  - Remote Failure Indication
  - Remote Loopback
  - Link Monitoring

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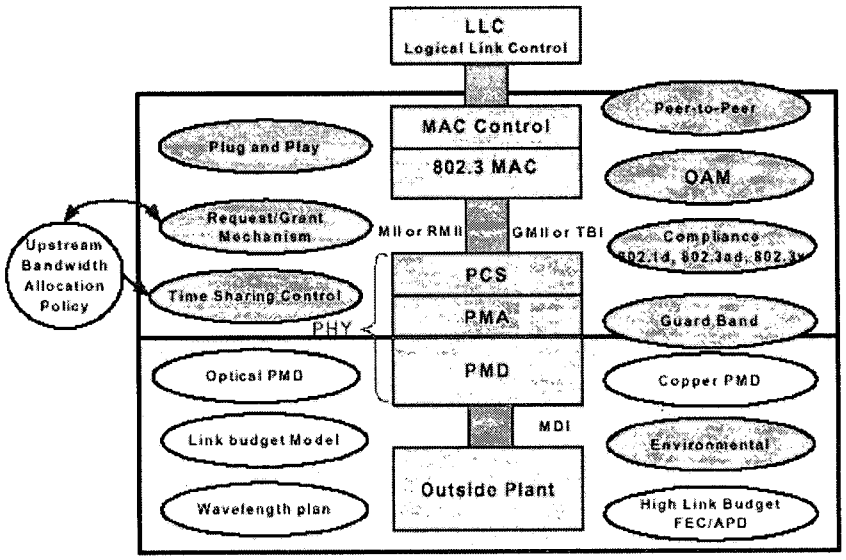
EFM issues



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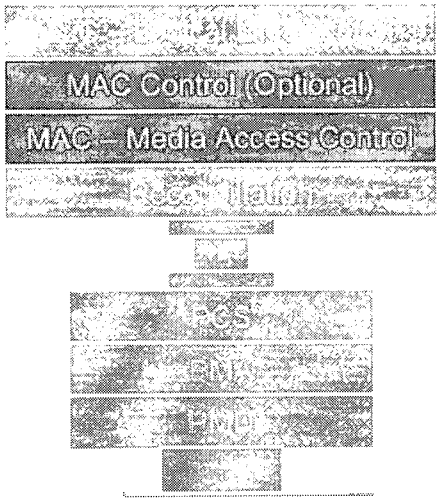
Architectural layers(IEEE view)



"Minimal changes" are allowed here if necessary

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EFM STFs(I)

Sub tracks	담당부분	목표	주요활동인물
EPON	P2MP(Point-to-Multi Point) MAC control 프로토콜	상향 트래픽의 대역폭 보장	Gerry Pasavento(teknovous) Dolors Sala(Broadcom) Ariel Maislos(Passave) Glen Kramer(Alloptic)
	➢ MPCP(Multi-Protocol Control Protocol) : MAC Control protocol ➢ MPCP의 구체화 & convergence 단계 ➢ timing control : OLT absolute timestamp(Jan. 2002) ➢ P2P emulation : LLID(Logical Link ID)(Mar. 2002) ➢ single LLID vs. multiple LLID per ONU(July 2002) ➢ 802.1D Compliance : ULSLE(Sept. 2002) ➢ multiple vMAC definition(Sept. 2002) ➢ multipoint MAC Control(Sept. 2002)		

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EFM STFs(II)

Sub-tracks	담당부분	목표	주요활동인물
Optics	optical PMD의 프로토콜에 미치는 영향 부분을 담당	optical PMD(Physical Medium Dependent)	Vipul Bhatt(Finisar)
	➢ BM(Burst Mode) transceiver관련 연구		
OAM	EFM에서의 OAM의 규정과 범위	Ethernet의 효율적인 OAM제정	Matt Squire(Hatteras Networks) Ben Brown(AMCC)
	➢ OAM의 범위 - remote loopback - link monitoring - remote failure indication ➢ Slow protocol을 사용하는 OAM 방안 baseline proposal 통과(2002.5) ➢ OAM sublayer 정의(draft v1.0) ➢ OAM control client 정의(Nov. 2002)		

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EFM STFs(III)

Sub-tracks	담당부분	목표	주요활동인물
Copper	전송매체를 copper로 하였을 경우의 거리와 전송 속도 등의 규정	광케이블 인프라가 성숙되기 전의 과도기 시장을 선점	Hugh Barrass(Cisco)
	➢ encapsulation technique 사용제안		

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1	IEEE 802.3ah EFM STFs
2	EPON MAC Protocol : MPCP – Message format – Auto discovery – Ranging – Report – Transmission
3	MPCP issues
4	PMD Issues

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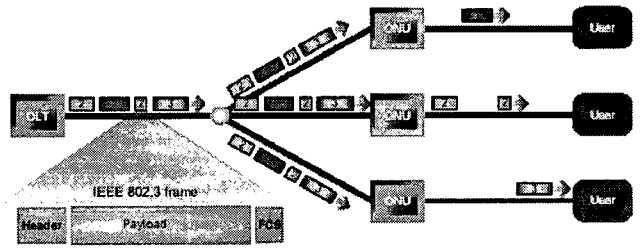
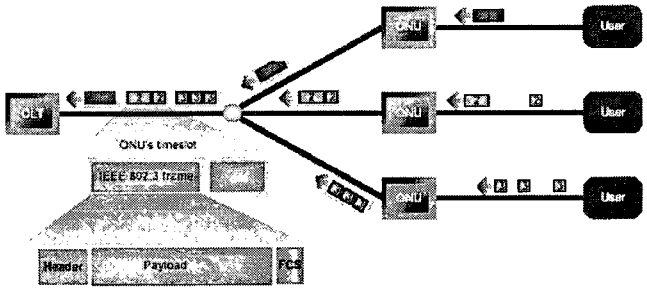
Basic operation of EPON

- downstream
  - Broadcasting



- Upstream
  - Time division
  - No collision
  - No fragmentation



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General description of MPCP

- The Multi-Point Control Protocol (MPCP)
  - specifies a control mechanism between a Master unit and Slaves units connected to a Point-to-Multi-Point (P2MP) segment to allow efficient transmission of data
  - operates by allowing only a single ONU to transmit in the upstream at a time

- Functions performed are:
  - Support P2PE
  - Support multiple MACs and MAC Clients
  - Support dynamic binding of MACs to ports by allocation/deallocation of such LLID
  - Support a mechanism for SCB(Single Copy Broadcast)
  - Flexible architecture allowing dynamic allocation of bandwidth
  - Use of 32 bit timestamp for timing distribution
  - MAC Control based architecture
  - Registration process
  - Ranging process

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ONU operations

1. waits for discovery GATE from OLT
   - **performs discovery process which includes**
   - **ONU synchronizes to OLT timing through timestamps on**
   - **Ranging**
   - **Assignment of LLID**
3. waits for Normal GATE for its transmission grant
   - **ONU transmits frames in these grants**
   - **Request for additional bandwidth can be sent in REPORT frames**

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OLT operations

1. Controls ONU registration process
   - **broadcasts discovery GATE**
   - **Performs ranging operation**
   - **Generates time stamped messages to be used as global time reference**
2. Assigns bandwidth (MPCP allocation)
   - **Assigns individual grant windows to registered ONUs**
   - **Generates discovery windows for new ONUs**

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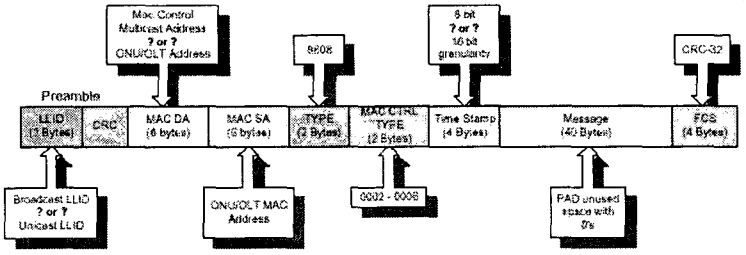
Message format

- MAC Control Frame
- GATE, REPORT, REGISTER_REQUEST, REGISTER, REGISTER_ACK



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Auto Discovery(I)

- Knowing it's there
- Knowing who it is
- Negotiating System parameters such as:
  - **Determining RTT**
  - **Laser turn-on/off times**
  - **Number of Logical MAC' s per ONU**
- Various Logical MAC Types (P2PE, SE, SCB) are being defined
- During Discovery, At Least One vMAC is registered
- Assigning PON Tags (LLID's) for vMACs
- Registration failure mode
  - **Random start time**
  - **Random GATE skip**

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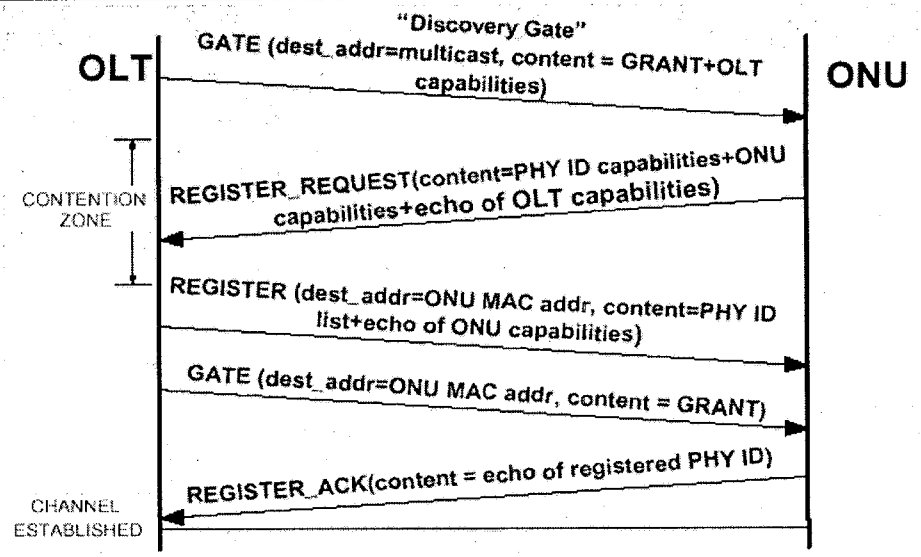
Auto Discovery(II)



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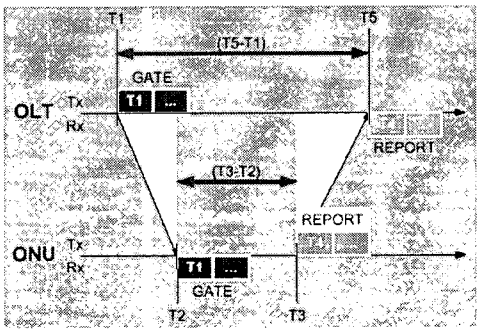
Ranging : RTT measurement

- OLT sends GATE at absolute T1
- ONU receives GATE at T2 and resets local counter to show T1
- ONU sends REPORT at time T3, showing timestamp T4
- OLT receives REPORT at absolute T5

$$RTT = T2 - T1 + T5 - T3$$
$$= T5 - T4$$
$$(T3 - T2 = T4 - T1)$$



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REPORT

- REPORT frames pass queue status from ONU to OLT
- A reported element contains the number of bytes requested per 802.1Q priority queue
- REPORT must be sent periodically for ranging.
- Requests include IPG. OLT will compute compensation for Laser turn-on/off times.
- More efficient reporting method is considered : queue threshold, vendor general space,..

REPORT BIT MASK [1BYTE] Bit #n is 0: No report for queue #n Bit #n is 1: Queue #n report exists
REPORT #0[4BYTE] Number of bytes reported for queue #n
.....
REPORT #X[4BYTE] Number of bytes reported for queue #n

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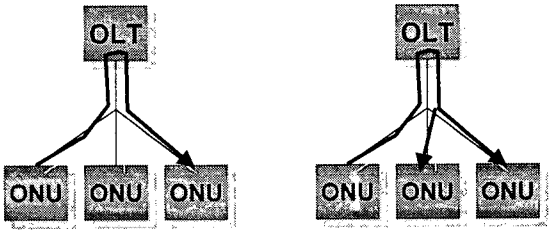
Transmissions

- Emulation issues
  - P2P-LAN : service for data only applications
  - SCB(Single Copy Broadcasting) : support of digital video broadcast
  - Shared-LAN : for campus environments



P2P emulation SCB

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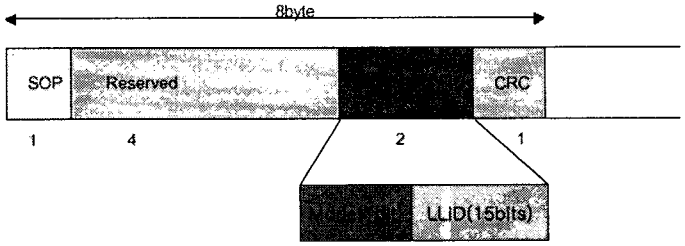
LLID

- What they are:
  - **Introduced for 802.1D Bridge compliance**
  - **Identification of an ONU from a Bridging perspective (P2PE)**
  - **1:1 association between single ONU and OLT vMAC**
  - **Allow for filtering of ONU-ONU bridged traffic**
  - **Carried in the preamble in either direction on the PON**
  - **Stripped off before frame enters MAC**



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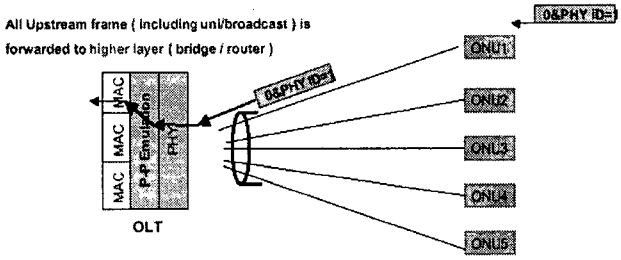
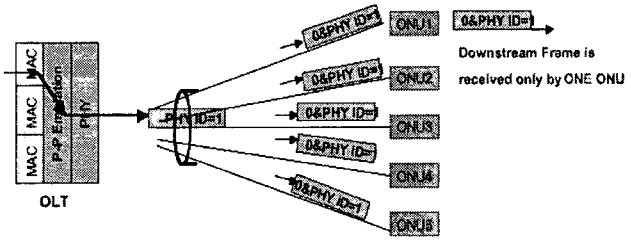
Ex) P2P Emulation using LLID

upstream



downstream



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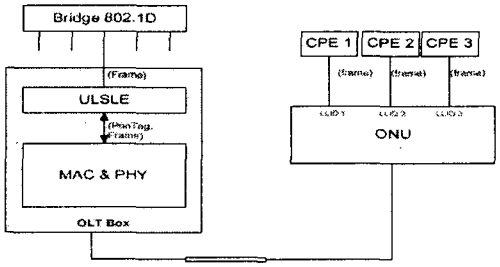
Compliance layering : ULSLE

- **A new optional functionality is proposed : ULSLE(Upper Layer Shared LAN Emulation)**
- **A simple way to describe the ULSLE functionality is as a modified Bridge**
- **A LLID information is passed between MAC-control and ULSLE.**
- **P2P emulation is defined with a LLID between a single logical port ONU and OLT**
- **In Sept, 2002, IEEE802.3ah asked the functionality requirement to 802.1D group**



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1	IEEE 802.3ah EFM STFs
2	EPON MAC Protocol : MPCP
3	MPCP issues • layering issue • # of LLID per ONU?
4	PMD Issues

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Layering issue : OLT layer diagram(1)

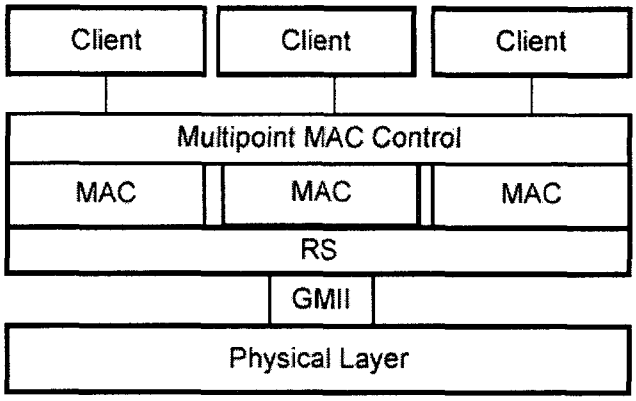

Figure 56–2—OLT Layered system diagram

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OLT layer diagram(2):Multipoint MAC Control

- Multipoint MAC Control
  - **Can support new functions like MPCP, management protocol**
  - **1. OMP**
    - Located in MAC control sublayer
    - Manage the real-time control
    - Transparent to CSMA/CD MAC
  - **2. MAC Control**
    - Has extensive functionality to manipulate multiple underlying MACs simultaneously
    - Mandatory for P2MP
  - **3. Multiplexing Control**
    - Multiplexing Control function) ensures that at any time only one frame exists

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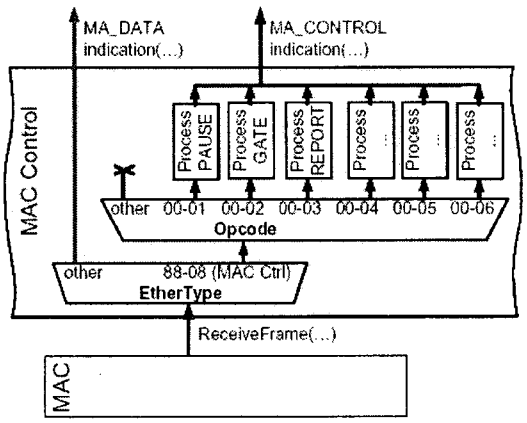
OLT layer diagram(3):Multipoint MAC Control

- Frame reception



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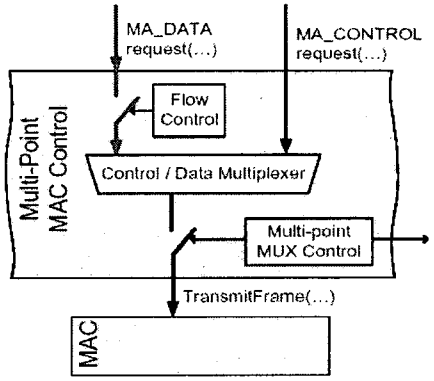
OLT layer diagram(4):Multipoint MAC Control

- Frame transmission



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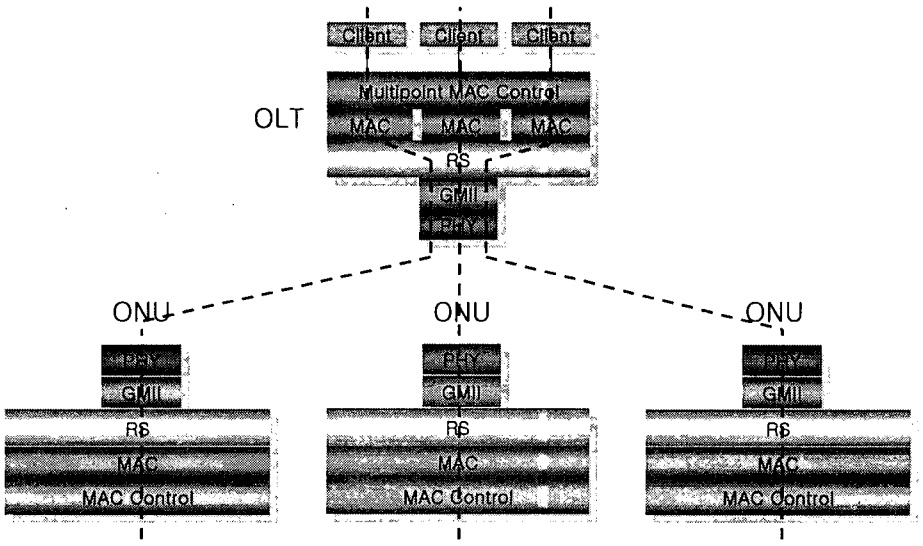
OLT layer diagram(5):virtual MAC



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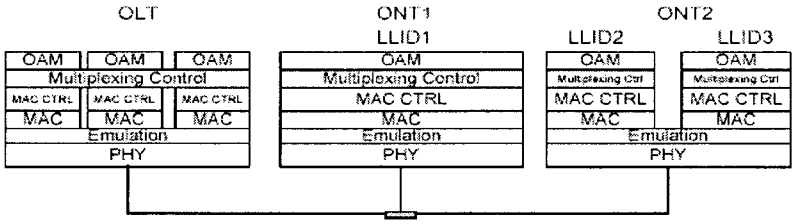
LLID issue : Single or multiple per ONU?

- Single LLID
  - Single MAC stack at the ONU PON port
  - Bridge/L2 switch at the ONU
    - ONU follows the typical Ethernet switch model
    - Supports intra-ONU bridging
  - Accept in principle in Sept. meeting
- Multiple LLID
  - The goal of having multiple LLIDs per ONU is to make multi-subscriber ONU behave as multiple single-subscriber ONUs



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PMD issues

- EPON PMD는 ITU-T Q2/15의 결정논의 사항에 맞게 interoperability를 영두로 수정되고 있음
- Burst mode timing parameters and its system implications, link budget, evaluation of FEC-related test reports.
- Critical review of Tx parameters like OMA and spectral width.
- Harmonization with TTC specs, MDC/MDIO compatibility, test patterns.
  - EPON의 competitor인 100M P2P 에 대한 정의 작업이 TTC와의 liaison을 통해 활발하게 이루어지고 있음
- TDP refinement and preparation to collect data, completion of power budget tables, examining the need for RIN and stressed sensitivity specs .
- FEC의 adopt 여부는 CDR locking 과 data integrity의 문제로 인하여 다음 회의로 연기

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