
# China Telecom
# Technical Requirement of GPON Device
# （V0.2）

(Request for advice)

China Telecom Corporation

April 2008

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# Preface

The standard is based on ITU-T G.984 and our domestic standard for communication industry “Technical Requirement for Access Network – Gigabit-capable Passive Optical Network (GPON)” so as to enhance the interoperability, operation and management ability of the GPON system, suggesting specific requirement for GPON protocol (PMD, TC and OMCI etc), device specification, device functionality and element management system etc.

This standard has been made by the Department of Technology China Telecom.

## 1 Coverage

The standard specifies reference model, device type and specification, GPON protocol, system functions, service load capability and performance, system protection, operation maintenance, deployment environment and electric safety, etc of Gigabit-capable Passive Optical Network (GPON), and gives detailed specification for PMD sublayer, TC sub-layer and TC adaptation sublayer, OMCI and protocol interoperability of service layer.

The standard is used for OLT and ONU equipments of GPON system in the network environment of China Telecom.

## 2 Reference Documents for Standardizing

The items in the files as below will be the standards referred by this standard. All following revision records (not including corrigendum) or revisions of all reference files with date noted are not applicable in the standard, but it is encouraged to confirm whether to use the latest version of these files according to the protocols achieved by the standard and research of all parties. The latest version of the reference files without date noted is applicable to this standard.

| | |
|---|---|
| YD/T 1128-2001 | The whole specification for telephone switching equipments (Amendment 1) |
| YD/T 1292-2003 | The control protocol of media network gateway based on H.248 |
| YDN 065-1997 | The whole technical specification for telephone switching equipments of the post and telecommunication department |
| ITU-T G.983 | Broadband Passive Optical Network(BPON) |
| ITU-T G.984 | Gigabit-capable Passive Optical Networks（GPON） |
| ITU-T Y.1291（2004） | The architecture supporting QoS of packet network |
| ITU-T Y.1730（2004） | The function requirements of Ethernet OAM |
| IEEE 802-2001 | IEEE standard for LAN and Metropolitan Area Network (MAN): Overview and Architecture |
| IEEE 802.1D-2004 | IEEE standard for LAN and MAN－Media Access Control Network Bridge |
| IEEE 802.1Q-2005 | IEEE standard for LAN and MAN－Virtual LAN protocol |
| IEEE 802.1ad | IEEE standard for LAN and MAN－Virtual LAN protocol－Amendment File 4: Provider Network Bridge |
| IEEE 802.3-2005 | Information Technology－Communication and data exchange among systems－Specific requirements for LAN and MAN－3rd part: Access method of CSMA/CD and physical layer specification － Amendment files: For media access control parameters of user access network, physical layer and management |
| IETF RFC 1112 | Host Extensions for IP Multicasting |
| IETF RFC 2236 | Internet Group Management Protocol, Version 2 |
| IETF RFC 3376 | Internet Group Management Protocol, Version 3 |
| IETF RFC3985（2005） | PWE3 Architecture |
| IETF RFC4197（2005） | Requirements for Edge-to-Edge Emulation of Time Division Multiplexed (TDM) Circuits over Packet Switching Networks |
| IETF RFC4553（2006） | Structure-Agnostic Time Division Multiplexing (TDM) over Packet (SAToP) |
| DSL Forum TR-069 | CPE WAN Management Protocol |
| DSL Forum WT-142 | Framework for TR-069 enabled PON devices（Revision 3） |

## 3 Abbreviations

The abbreviations as below are applicable to this standard.

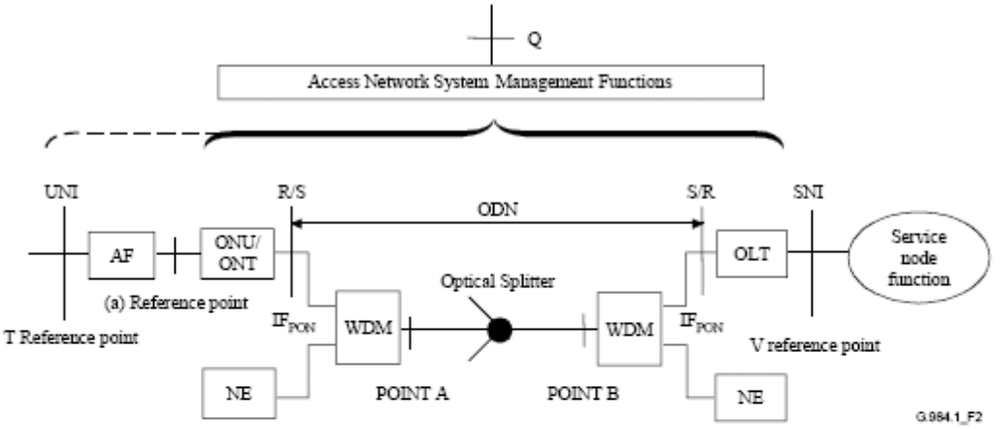
| | | |
|---|---|---|
| ACS | Auto-Configuration Server | 自动配置服务器 |
| BITS | Building Integrated Timing System | 楼宇综合定时供给系统 |
| CATV | Community Antenna Television | 有线电视系统 |
| CBR | Constant Bit Rate | 固定码率 |
| CDR | Call Detail Record | 呼叫信息记录 |
| CVLAN | Customer VLAN | 用户（内层）虚拟局域网 |
| DA | Destination Address | 目的地址 |
| DBA | Dynamic Bandwidth Allocation | 动态带宽分配 |
| DLF | Destination Lookup Failure | 目的地址查找失败 |
| DSCP | Differentiated Services Code Point | 差分服务代码点 |
| EMS | Element Management System | 网元管理系统 |
| FCS | Frame Check Sequence | 帧校验序列 |
| FE | Fast Ethernet | 快速以太网 |
| FEC | Forward Error Correction | 前向纠错 |
| FTTB | Fiber to the Building | 光纤到楼宇 |
| FTTBiz | Fiber to the Business | 光纤到企业 |
| FTTC | Fiber to the Curb | 光纤到路边 |
| FTTCab | Fiber to the Cabinet | 光纤到交接箱 |
| FTTH | Fiber to the Home | 光纤到家庭用户 |
| FTTO | Fiber to the Office | 光纤到公司/办公室 |
| GE | Gigabit Etherent | 千兆以太网 |
| GMII | Gigabit Media Independent Interface | 千兆比媒质无关接口 |
| GEM | GPON Encapsulation Method | GPON 封装模式 |
| GPON | Gigabit-Capable Passive Optical Network | 吉比特无源光网络 |
| GTC | GPON Transmission Convergence | GPON 传输汇聚（层） |
| HGU | Home Gateway Unit | 家庭网关单元 |
| IGMP | Internet Group Management Protocol | 互联网组管理协议 |
| IPG | Inter-packet Gap | 帧间隔 |
| LSB | Least Significant Bit | 最低位 |
| MAC | Medium Access Control | 媒质访问控制 |
| MDI | Medium Dependent Interface | 媒质相关接口 |
| MDU | Multi-Dwelling Unit | 多住户单元 |
| MPCP | Multi-point control protocol | 多点控制协议 |
| MPCPDU | MPCP Protocol Data Unit | MPCP 协议数据单元 |

| | | |
|---|---|---|
| MSB | Most Significant Bit | 最高位 |
| MSTP | Multiple Spanning Tree Protocol | 多生成树协议 |
| MTU | Multi-Tenant Unit | 多商户单元 |
| NMS | Network Management System | 网络管理系统 |
| NT | Network Terminator | 网络终端 |
| OAM | Operation, Administration & Maintenance | 操作、管理和维护 |
| ODN | Optical Distribution Network | 光分配网络 |
| OLT | Optical Line Terminal | 光线路终端 |
| OMCC | ONU Management and Control Channel | ONU 管理控制信道 |
| OMCI | ONU Management and Control Interface | ONU 管理控制接口 |
| ONU | Optical Network Unit | 光网络单元 |
| OSI | Open System Interconnection | 开放系统互联 |
| P2MP | Point to Multipoint | 点到多点 |
| P2PE | Point to Point Emulation | 点到点仿真 |
| PCS | Physical Code Sublayer | 物理编码子层 |
| PDU | Protocol Data Unit | 协议数据单元 |
| PLOAM | Physical Layer OAM | 物理层操作管理维护 |
| PMA | Physical Medium Attachment | 物理媒质附加（子层） |
| PMD | Physical Medium Dependent | 物理媒质相关（子层） |
| PON | Passive Optical Network | 无源光网络 |
| PPPoE | Point-to-Point Protocol over Ethernet | 以太网上的 PPP 协议 |
| PWE3 | Pseudo Wire Emulation Edge-to-Edge | 边缘到边缘的伪线仿真 |
| QoS | Quality of Service | 服务质量 |
| RED | Random Early Detection | 随机先期检测 |
| RF | Radio Frequency | 射频 |
| RS | Reconciliation Sublayer | 协调子层 |
| (R)STP | (Rapid) Spanning Tree Protocol | （快速）生成树协议 |
| SA | Source Address | 源地址 |
| SBU | Single Bussiness Unit | 单商户单元 |
| SCB | Single Copy Broadcast | 单拷贝广播 |
| SFU | Single Family Unit | 单住户单元 |
| SIP | Session Initiation Protocol | 会话起始协议 |
| SLA | Service Level Agreement | 服务等级协议 |

| | | |
|---|---|---|
| SNI | Service Node Interface | 业务节点接口 |
| SP | Strict Priority | 严格优先级 |
| SR-DBA | Status Reporting DBA | 基于状态报告的动态带宽分配 |
| STM | Synchronous Transfer Mode | 同步转移模式 |
| SVLAN | Service VLAN | 业务（外层）虚拟局域网 |
| TC | Transmission Convergence | 传输汇聚 |
| TDM | Time Division Multiplex | 时分复用 |
| TOS | Type of Service | 服务类型 |
| T-CONT | Transmission Container | 传输容器 |
| RTT | Round Trip Time | 往返时间 |
| UNI | User Network Interface | 用户网络接口 |
| VDSL2 | Very High Speed Digital Subscriber Line 2 | 第二代甚高比特率数字用户环路技术 |
| VLAN | Virtual Local Area Network | 虚拟局域网 |
| VoIP | Voice over IP | IP 语音 |
| WRED | Weighted Random Early Detection | 加权随机先期检测 |
| WRR | Weighted Round Robin | 加权轮询 |

## 4 Reference Model of GPON System

GPON system usually consists of OLT on central office side, ONU on user side and ODN, and adopts point-to-multipoint network topology. An ODN consists of single mode fiber and passive optic components like optic splitter and connector. It provides physical connection media of optic transfer between OLT and ONU. Please see the figure 1 for GPON system reference configuration.




| | |
|---|---|
| ONU | Optical Network Unit |
| ONT | Optical Network Terminal |
| ODN | Optical Distribution Network |
| OLT | Optical Line Termination |
| WDM | Wavelength Division Multiplex Module (If WDM is not used, this function is not necessary.) |
| NE | Network Element which uses the different wavelength from the OLT and the ONU |
| AF | Adaptation Function (Sometimes, it may be included in the ONU.) |
| SNI | Service Node Interface |
| UNI | User Network Interface |
| S | Point on the optical fibre just after the OLT (Downstream)/ONU (Upstream) optical connection point (i.e., optical connector or optical splice) |
| R | Point on the optical fibre just before the ONU (Downstream)/OLT (Upstream) optical connection point (i.e., optical connector or optical splice) |
| (a) Reference point | If AF is included in the ONU, this point is not necessary. |
| POINT A/B | If WDM is not used, these points are not necessary. |

NOTE – Whether or not the AF is an operating object of the Q interface depends on the service.

$IF_{pon}$: interface of R/S and S/R reference point, only defined in GPON system. This interface support transmission protocol between OLT and ONU.

Q: SNMP implementation. GPON system connects telecom management network(TMN) through SNMP interface and manages network element through SNMP protocol.

Figure1 GPON System Reference Configuration

Depending on the deployment location of ONU in the access network, there are several network applications in GPON system: Fiber To The Cabinet (FTTCab), Fiber To The Building/Curb(FTTB/C), Fiber To The Home(FTTH), Fiber To The Office(FTTO). Generally an ONT is an ONU which provides user network interface. In this specification, they are not distinguished explicitly. ONU is used generally.

# 5 Service Type and Device Type

## 5.1 Service Type

The service types carried by GPON system include Ethernet/IP service, Voice service, TDM service and CATV service. GPON system shall support Ethernet/IP service. TDM service is recommended. Voice service and CATV service are optional.

## 5.2 Device Type

### 5.2.1 ONU

There may be several types of ONU devices. This standard has regulated 5 major types according to the current application situation of GPON equipments.

- SFU (Single Family Unit) Type of ONU

It is mainly used for Single Family users, only supporting the terminal function of broadband access with 1 or 4 Ethernet ports, providing Ethernet/IP Service, supporting VoIP (integrated with IAD) or CATV service, and it is mainly for FTTH environment (Used with the family network gateway for offering stronger service capabilities).

The 3 kinds of specific status of SFU type of ONU are as Table 1 below according to the service types and port numbers of ONU.

Table 1 Instances of SFU type of ONU

| Number | Number of Ethernet Port | Number of POTS Port | CATV RF Port |
|---|---|---|---|
| SFU-1 | 1 | 0 | Optional |

| | | | |
|---|---|---|---|
| SFU-2 | 4 | 0 | Optional |
| SFU-3 | 4 | 2 | Optional |

（Note: When business clients do not need TDM service, SFU can also be used for business clients.）

- HGU (Home Gateway Unit) type of ONU

It is mainly used for Single Family users with the function of family network gateway, which is equal to a family network gateway with GPON uplink port, having 4 Ethernet, 1 WLAN and at least 1 USB ports, providing Ethernet/IP service, supporting VoIP (integrated with IAD), CATV service, TR-069 remote management and it is mainly for FTTH environment.

The 2 kinds of specific status of HGU type of ONU are as Table 2 below according to the service types and port numbers of ONU.

Table 2 Instance of HGU type of ONU

| Number | Number of Ethernet Port | Number of POTS Port | Number of WLAN Port | Number of USB Port | CATV RF Port |
|---|---|---|---|---|---|
| HGU-1 | 4 | 0 | 1 | 1 | Optional |
| HGU-2 | 4 | 2 | 1 | 1 | Optional |

（Note: This standard only regulates relative requirements of HGU type of ONU and GPON port. Please refer to relative standards for China Telecom Family Network Gateway for other requirements.）

- MDU (Multi-Dwelling Unit) type of ONU

It is mainly used for Multi-Dwelling users with the function of broadband access terminal, having several (at least 8) user end ports (including Ethernet, ADSL2+ or VDSL2 ports), providing Ethernet/IP service, supporting VoIP (integrated with IAD) or CATV service, and it is mainly for FTTB/FTTC/FTTCab environment.

The 5 kinds of specific status of MDU type of ONU are as Table 3 below according to the service types and port numbers of ONU.

Table 3 Instance of MDU type of ONU

| Number | Number of Ethernet Port | Number of ADSL2+ Port | Number of VDSL2 Port | Number of POTS Port | CATV RF Port |
|---|---|---|---|---|---|
| MDU-1 | 8/16/24/32 | 0 | 0 | 0 | Optional |
| MDU-2 | 8/16/24/32 | 0 | 0 | 16/24/32 | Optional |
| MDU-3 | 0 | 16/24/32/48/64/72/96 | 0 | 0 | 0 |
| MDU-4 | 0 | 16/24/32/48/64/72/96 | 0 | 16/24/32/48/64/72/96 | 0 |
| MDU-5 | 0 | 0 | 8/12/16/24/32/48/64 | | 0 |
| MDU-6 | 0 | 0 | 8/12/16/24/32/48/64 | 16/24/32/48/64 | 0 |

ADSL2+ port of MDU-3 shall include divider.

It’s recommended user port is designed with module (in unit of 8/12 ports) and can support mix of different module types(Ethernet, DSL, POTS).

（Note: When business clients do not need TDM service, MDU can also be used for business clients.）

- SBU (Single Bussiness Unit) type of ONU

It is mainly used for Single Business users and Single Office in an enterprise, supporting terminal functions of broadband access, having 4 Ethernet and 4 E1 ports and providing Ethernet/IP and TDM service, and it is mainly for FTTO environment.

The 1 kind of specific status of SBU type of ONU is as Table 4 below according to the service types and port numbers of ONU.

Table 4 Instance of SBU type of ONU

| Number | Number of | Number of E1 Port | Number of POTS |
|---|---|---|---|

| | Ethernet Port | | Port |
|---|---|---|---|
| SBU-1 | 4 | 2/4 | Optional |

■ MTU (Multi-Tenant Unit) type of ONU

It is mainly used for multiple enterprise customers and multiple offices of an enterprise, supporting terminal functions of broadband access. It is configured with multiple Ethernet ports (8 or above) and E1 port, providing Ethernet/IP service and TDM services, supporting VoIP service (integrated with IAD), and it is mainly for FTTB/FTTBiz locations.

The 2 kinds of specific status of MTU type of ONU are shown in Table 5 according to the service types and port numbers of ONU.

Table 5 Instance of MTU type of ONU

| Number | Number of Ethernet Port | Number of E1 Port | Number of POTS Port |
|---|---|---|---|
| MTU-1 | 16 | 4/8 | 0 |
| MTU-2 | 8/16 | 4/8 | 8/16 |

For MTU-2, the number of POTS ports shall be equal to the one of Ethernet ports.

For each type of ONU mentioned above, its Ethernet port can be 100Base-T or 1000Base-T.

### 5.2.2 OLT

The OLT equipment contains one or more PON ports. It shall support Ethernet/IP service, provide Ethernet uplink port. Support of TDM service and corresponding STM-1 or multiple E1 uplink ports is recommended. Support of CATV service is optional.

## 6 Requirement of GPON Protocol

### 6.1 Reference Model of GPON System Protocol

According to G.984, the protocol stack of GPON system is as figure 2. It consists of Physical Media Dependent (PMD) layer and GPON Transmission Convergence (GTC) layer. GTC layer includes two sub-layers: GTC framing sub-layer and TC adaptation sub-layer. There are two encapsulation modes in GTC layer: ATM mode and GEM mode. This technical requirement only regulates GEM mode. GEM mode of GTC layer provides two kinds of interface for client layer: GEM client interface and ONT management and control interface (OMCI).

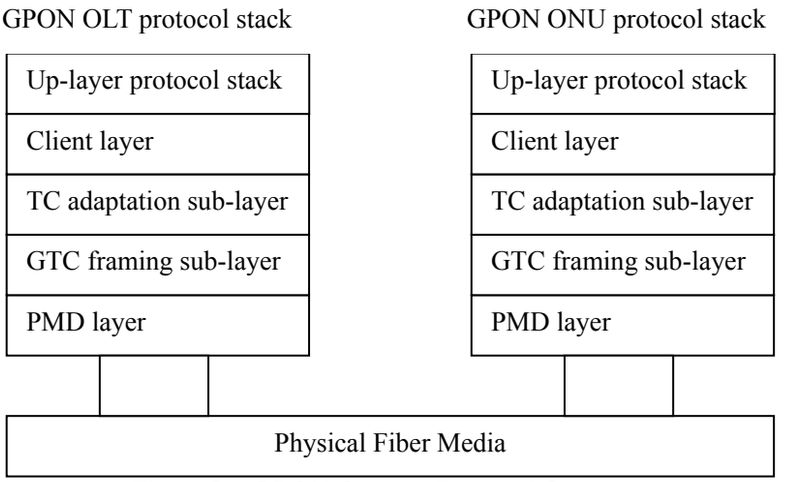



Figure2 GPON System Protocol Stack

## 6.2 PMD Sublayer

Single mode fiber confirming to ITU-T G.652 shall be used in GPON system.

GPON system is a bi-directional system with single fiber. Different wave lengths are used in upstream and downstream. 1260nm~1360nm is used for upstream direction while 1480nm~1500nm is used for downstream direction. If there is the third wave length carring CATV service, 1540nm~1560nm shall be used. The specification of CATV service carred by GPON system is not regulated in this technical requirement.

GPON system shall support bit rate of 2488.32Mbit/s for downstream and 1244.16Mbit/s for upstream.

The optical port at PON end shall support ClassB+. Class C is recommended. The chacteristics shall conform to G.984.2.

## 6.3 GTC and TC Sublayer

The GTC sub-layer and TC sub-layer in GPON system shall conform to G.984.3. It's needed to be emphasized that: the TC layer shall adopt GEM encapsulation mode, support FEC for downstream and optionally support FEC for upstream.

### 6.3.1 ONU Authentication by OLT

OLT shall accept registration request from any ONU(the request is not authenticated and is accepted by default). OLT shall support authentication based on ONU "SN" and "SN+Password". Unauthorized request shall be rejected. The format of SN shall conform to ANS T1.220-2000(The Vendor ID is 4 octects and shall not include the "_" character); the format of password is 10 octents of ASCII code. The ONU authentication method adopted by OLT shall be configurable.

In addition, when the ONU is authenticated with "SN" or "SN+Password", the registration event of invalid ONU shall be reported to the EMS system. The authentication procedure shall conform to ITU-T G.984.

The system shall support ONU deregistration. Once the ONU received Disable_serial_number message, it transits from operation state into emergency-stop state (O7); if the ONU is manually reset, it still enters emergency-stop state (O7) after registration.

The system can support password authentication (or is known as Key authentication). The specification is to be determined.

## 6.4 OMCI Sublayer

The OLT controls an ONU through OMCI. OMCI protocol shall allow the OLT to establish and release the channel with an ONU, manage UNI port on ONU, request configuration information and performance statistics, report event (e.g. link failure) to system administrator. OMCI request ONU administration in configuration management, fault management, performance management and security management.

GPON system shall establish a GEM connection for ONU management and control interface. The OLT assigns the PortID of management and control interface for each ONU through PLOAM message. The OLT MAC layer shall allocate a granted flow for OMCC upstream bandwidth of each ONU. OMCC packet in upstream shall be put in high priority queue all the time or handled with CBR service type. OMCC paclet in downstream is controlled by the OLT completely. The response time for high priority protocol message shall be within 1 second and 3 seconds for low priority protocol message.

The requirement of OMCI shall conform to G.984.4

## 6.5 Clock Requirement

### 6.5.1 Clock Requirement of OLT

The OLT supports Native TDM service shall select clock source in the following precedence and use as the transmission clock of OLT circuit:

1. External timer interface, e.g. 2MHz/2Mbit/s clock from BITS output；
2. STM-N service interface；
3. E1 service interface；
4. Internal timer。

OLT timer shall support trace and free-oscillating working mode. If there is no available external timer source, the OLT shall select free-oscillating mode automatically. While the OLT works under free-oscillating mode, the accuracy of internal clock shall not be below the third level clock($\pm 4.6\times10^{-6}$ppm).

The OLT shall not disturb any service while switching the timer clock source.

6.5.2 Clock Requirement of ONU

The ONU shall retrive clock source from downstream signal of PON port and use as local transmission clock for upstream.

ONU shall also support local clock source and the accuracy shall not be below $\pm 5.0\times10^{-5}$ ppm.

The ONU shall support recovery clock from self-adaptation, differential or PON port circuit for E1 signal.

# 7 Port Requirement of Network End and User End

## 7.1 Port Requirement of OLT Network End

The network end of OLT must support GE port. 10GBASE-X port is optional.

The OLT shall provide at least 4 GE uplink ports.

For multi-service OLT equipments providing leased line service of TDM data, the network end shall support E1 or STM-1 port.

OLT shall support plug/unplug of uplink optic module.

### 7.1.1 GE Port

GE port can be one or more kinds of 1000BASE-LX, 1000BASE-SX, 1000BASE-CX and 1000BASE-T ports. The port types shall meet the regulations of IEEE 802.3-2005.

### 7.1.2 10GBASE-X Port

10GBASE-X Port shall conform to IEEE 802.3-2005.

### 7.1.3 E1 Port

E1 Port shall conform to ITU-T G.703 or GB7611-2001.

### 7.1.4 STM-1 Port

STM-1 Port shall conform to ITU-T G.707.

## 7.2 Port Requirement of ONU User End

### 7.2.1 Port Type of ONU User End

The port types of ONU User End include ports such as 10/100BASE-T, 10/100/1000BASE-T, E1, Z/Za, DSL and CATV RF, etc.

#### 7.2.1.1 10/100BASE-T Port

10/100BASE-T Port of User End shall conform to IEEE 802.3-2005.

#### 7.2.1.2 10/100/1000BASE-T Port

10/100/1000BASE-T Port of User End shall conform to IEEE 802.3-2005.

#### 7.2.1.3 E1 Port

E1 Port shall conform to ITU-T G.703 or GB7611-2001.

#### 7.2.1.4 Z/Za Port

Z Port shall conform to para. YD/T 1054-2000 10.1.1.

Za Port shall conform to para. YD/T 1054-2000 10.1.2.

#### 7.2.1.5 DSL Port

DSL Port includes ADSL2+ and VDSL2 ports.

ADSL2+ Port shall conform to ITU-T G.992.5.

VDSL2 Port shall conform to ITU-T G.993.2.

#### 7.2.1.6 CATV RF Port

The specific standard of CATV RF port is undetermined.

#### 7.2.1.7 Other Ports

Other port requirements relative to HGU ONU (such as WLAN, USB ports) are in the reative standards of China Telecom Home Network Gateway.

### 7.2.2 Port Requirement of ONU User End

All types and port number of ONU User End ports are in 5.2.1.

# 8 Ethernet Function Requirement

## 8.1 Ethernet Basic Function

### 8.1.1 MAC Switching

#### 8.1.1.1 OLT MAC Address Switching

OLT shall support MAC address switching and dynamic learning. The learning capability of MAC address shall not be less than 1000/s.

The MAC address cache of each PON port of OLT shall not be less than 2K. MAC address cache in aggregation switching plane shall not be less than 16K.

OLT MAC address aging time shall be configurable.

#### 8.1.1.2 SFU/HGU/SBU type of ONU MAC Address Switching

SFU/HGU/SBU Type of ONU with more than one Ethernet ports shall support switching by MAC address and dynamic learning. Unicast MAC address cache capability shall not be less than 32.

#### 8.1.1.3 MTU/MDU type of ONU MAC Address Switching

Unicast MAC Address Cache capability of MDU/MTU type of ONU shall not be less than 32x User ports (including Ethernet port, ADSL2+ Port or VDSL2 Port)

The MAC address aging time of ONU shall be configurable.

### 8.1.2 Layer 2 Switching

#### 8.1.2.1 OLT Layer 2 Swithing

OLT shall support layer 2 switching of Ethernet service, layer 2 switching capability shall assure the line rate forwarding in upstream and downstream service.

#### 8.1.2.2 ONU Layer 2 Switching

For ONU with more than one Ethernet port shall support layer 2 switching of Ethernet service, layer 2 switching capability shall assure the line rate forwarding in upstream and downstream service.

### 8.1.3 Frame Filtering

#### 8.1.3.1 OLT Frame Filtering

OLT shall support frame filtering of Ethernet frame based on source and destination MAC addresses.

#### 8.1.3.2 ONU Frame Filtering

HGU, MDU and MTU types of ONU shall support frame filtering based on physical port, source and destination MAC address, physical port and source and destination MAC address, and support enabling/disabling of frame filtering of Ethernet frame based on each physical port and MAC address.

SFU and SBU types of ONU optionally support frame filtering as mentioned above.

### 8.1.4 Layer 2 Isolation

#### 8.1.4.1 OLT Layer 2 Isolation

OLT shall implement layer 2 isolation among ONUs.

#### 8.1.4.2 ONU Layer 2 Isolation

MDU and MTU types of ONU shall support layer 2 isolation among Ethernet ports.

### 8.1.5 Spanning Tree

#### 8.1.5.1 OLT Spanning Tree

When the network end of OLT has multiple GE or 10/100Base-T ports, it shall support Rapid Spanning Tree Protocol (RSTP) and optionally the Multiple Spanning Tree Protocol (MSTP) as defined in IEEE 802.1D.

#### 8.1.5.2 ONU Spanning Tree

10/100Base-T and GE ports on MDU and MTU types of ONU user end shall support Spanning Tree Protocol (STP) or Rapid Spanning Tree Protocol (RSTP) as defined in IEEE 802.1D.

### 8.1.6 Flow Control

#### 8.1.6.1 OLT Flow Control

The network end port of OLT shall support full duplex IEEE 802.3x flow control protocol, whose relative functions are configurable.

#### 8.1.6.2 ONU Flow Control

The network end port of ONU shall support full duplex IEEE 802.3x flow control protocol, whose relative functions are configurable.

### 8.1.7 Local Aggregation of Network End

When OLT has multiple PON ports, it shall support Layer 2 aggregation of Ethernet service of all service boards.

### 8.1.8 Link Aggregation

If the OLT has multiple uplink ports at network end, it shall support link aggregation for uplink port as defined in IEEE 802.3ad. If the OLT has multiple uplink modules, it shall support link aggregation among uplink modules.

## 8.2 VLAN

### 8.2.1 OLT VLAN

OLT shall support IEEE 802.1Q protocol and VLAN is partitioned by ONU GEM port. OLT shall support VLAN tagging/untagged, VLAN transparent, VLAN translation, VLAN priority tagging, VLAN filtering etc.

OLT shall support VLAN management according to VLAN tagging filter data、VLAN tagging operation configuration data and Extended VLAN tagging operation configuration data.

OLT shall support 4K VLAN simultanously. VLAN ID can be 1 through 5094.

OLT shall support adequate VLAN Translation Entries (it is recommended that VLAN Translation shall be supported on both Main Switching Board and PON port board (implemented by PON MAC chip). The number of VLAN Translation entries supportted by Main Switching Board shall be 4094. Each PON port of the PON link board shall suppot at least [8×the max number of ONU] VLAN Translation entries, that is 512 at least.

The network end port of OLT shall support VLAN Trunk.

It's recommended OLT supports VLAN Aggregation to convert NxVLAN from ONU to a single VLAN before forwarding. And the NxVLAN can be reverse-converted to a single VLAN according to MAC or IP address.

### 8.2.2 ONU VLAN

ONU shall support IEEE 802.1Q protocol and VLAN is partitioned by physical port at user side. ONU shall support Access, Trunk, Hybrid, VLAN transparency, VLAN translation, VLAN priority tagging, VLAN filtering etc.

ONU shall support VLAN management according to VLAN tagging filter data、VLAN tagging operation configuration data and Extended VLAN tagging operation configuration data.

ONU behavior under Access, Trunk and Hybrid mode shall conform to IEEE 802.1Q; ONU behavior under VLAN transparency, VLAN tagging and VLAN translation shall conform to <China Telecom Technical Requirement of EPON device V2.0>. The ME for each mode is to be determined.

#### 8.2.2.1 Definition of VLAN Mode

The bahaviors of all VLAN modes for Ethernet port are defined as below:

（1）Access Mode：In this mode, the process mode for the received upstream Ethernet frames by ONU is adding PVID; ONU strips VLAN tag for downstream packet. The specific process method is in Table 6.

Table 6 ONU Processing in Access Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | tagged | The packet is forwarded if VLAN Tag is equal to PVID, otherwise discarded |
| | untagged | Add the default PVID（the primary parameter is VID）, forward |

| | | |
|---|---|---|
| Downstream | tagged | Forward to the corresponding UNI port according to the VID and strip the tag; if the VLAN ID is not equal to the configured PVID, discard the packet. |
| | untagged | Discard |

（2）Trunk Mode：In this mode, the process mode for the received upstream Ethernet frames by ONU is that: if the packet is untagged, PVID is added; If the packet is tagged, it's forwarded or discarded according to the ingress rule and membership of the port. The process mode for the received downstream Ethernet frames by ONU is that: if the VLAN ID is equal to the PVID, the tag is striped and the packet is forwarded; otherwise, the packet is forwarded without any change. The specific process method is in Table 7.

Table 7 ONU Processing in Trunk Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | tagged | Ethernet packet is not changed（preserve the original VLAN TAG），forward |
| | untagged | Add the default PVID（the primary parameter is VID），forward |
| Downstream | tagged | Forward to the corresponding UNI port according to the VID and strip the tag; if the VLAN ID is not equal to the configured PVID, the packet is forwarded without any change. |
| | untagged | Discard |

（3）Hybrid Mode：In this mode, the process mode for the received upstream Ethernet frames by ONU is that: if the packet has no VID, the PVID is added; if the packet is tagged, it's forwarded or discarded according to the ingress rule and membership of the port. The process mode for the received downstream Ethernet frames by ONU is that: the egress rule of the VLAN is checked, if it's tag-out, strips the VLAN ID and forward; if it's untag-out, the packet is forwared without any change. The specific process method is in Table 8.

Table 8 ONU Processing in Hybrid Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | tagged | Ethernet packet is not changed（preserve the original VLAN TAG），forward |
| | untagged | Add the default PVID（the primary parameter is VID），forward |
| Downstream | tagged | Check the egress attribute of the port, if it's untag-out, strips the VLAN ID and forward; if it's tag-out, the packet is forwarded without any change |
| | untagged | Discard |

（4）VLAN Transparent Mode：In this mode, the process mode for the received upstream Ethernet frames by ONU is no action (no matter the Ethernet frame is with VLAN TAG) but transparent forwarding it to OLT. Transparent forward is also used for downstream Ethernet frames. The specific process method is in Table 9.

Table 9 ONU Processing in Transparent Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | tagged | Ethernet packet is not changed（preserve the original VLAN TAG），forward |
| | untagged | Ethernet packet is not changed，forward |
| Downstream | tagged | Ethernet packet is not changed（perserve the original VLAN TAG），forward |

| | | |
|---|---|---|
| | untagged | Ethernet packet is not changed，forward |

（5）VLAN Tag Mode：In this mode, the process mode for the received upstream Ethernet frames by ONU is adding a network layer VLAN tag to it; for downstream Ethernet frames, ONU strips their VLAN Tags. The specific process method is in Table 10

Table 10 ONU Processing in TAG Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | Tagged | Discard |
| | untagged | Add new VLAN Tag（the primary parameter is VID），forward。 |
| Downstream | tagged | Forward to the corresponding UNI port according to the VID and strip the tag; if the VLAN ID is not equal to the configured PVID, discard the packet. |
| | untagged | Discard |

（6）VLAN Translation Mode：In this mode, ONU will transform VLAN TAG users in upstream Ethernet frames mark by themselves (the VID cannot be dedicated, and there may be other users using the same VID in the same system) into unique VLAN Tag of network end, while ONU will do the opposite operation for downstream frames. When ONU supports VLAN Translation, its VLAN Translation shall support that EtherType is 0×8100, and other EtherType values are supported optionally. The processing method for messages by ONU in VLAN Translation mode is as shown in Table 11:

Table 11 ONU Processing in Translation Mode

| Direction | Ethernet Frame is tagged? | Processing |
|---|---|---|
| Upstream | tagged | If VID of the original TAG has the corresponding entry in VLAN Translation list of ports (equal to the input VID), VID will be converted into corresponding VID by the list (output VID) and be forwarded; if VID of the original TAG has not the corresponding entry in VLAN Translation list of ports, it will be discarded. |
| | untagged | Add default VLAN ID and forward |
| Downstream | tagged | If VID of the original TAG has the corresponding entry in VLAN Translation list of ports (equal to the input VID), VID will be converted into corresponding VID by the list (output VID) and be forwarded; if VID of the original TAG is the default VID, Tag will be cleared and forwarded; if VID of the original TAG has not the corresponding entry in VLAN Translation list of ports, it will be discarded;<br>In the current circumstance, it is only required to make ONU able to convert VID values, and the conversion of other fields (such as TPID, CFI and Pri) is not required temporarily. In the downstream conversion procedure, ONU reserves the original TPID and Pri values of the message. |
| | untagged | Discard |

#### 8.2.2.2 VLAN of SFU/HGU/SBU type of ONU

ONU shall support at least 8 VLAN ID and the range is 1 through 4094.

SFU and SBU type of ONU shall support at least 8 VLAN translation entries and each Ethernet UNI port shall support at least 8 VLAN translation entries.

#### 8.2.2.3 VLAN of MDU/MTU type of ONU

ONU shall support at least 8 x UNI port number(includes Ethernet port, ADSL2+ port or VDSL2 port) VLAN ID and the range is 1 through 4094.

The each Ethernet UNI port shall support at least 8 VLAN translation entries and the ONU shall support at least (8 x Ethernet port number) VLAN translation entries.

MDU type of ONU with DSL port shall support VLAN partitioning according to PVC: One VLAN for each PVC(1:1 mapping of PVC and VLAN) and one VLAN for multiple PVCs(N:1 mapping of PVC and VLAN, aggregation of the same service from multiple users to one VLAN).

ONU shall support modification of priority tag of data packet compulsorily and addition of priority tag for untagged packet.

## 8.3 VLAN Stacking（IEEE 802.1ad）

### 8.3.1 OLT VLAN Stacking

OLT shall support VLAN Stacking meeting IEEE 802.1ad, and the outer TPID parameters of VLAN Stacking Ethernet frames shall be configurable.

It's required that CVLAN priority tag can be mapped to SVLAN. In normal conditon, SVLAN is mapped from service type while CVLAN is mapped from user port.

OLT shall support SVLAN ID mapping from CVLAN ID and priority tag.

OLT shall support CVLAN and SVLAN ID range of 1 through 4094.

OLT port at network end shall support SVLAN TRUNK.

### 8.3.2 ONU VLAN Stacking

MDU and MTU types of ONU shall support VLAN Stacking meeting IEEE 802.1ad, and the outer TPID parameters of VLAN Stacking Ethernet frames shall be configurable.

# 9 Dynamic Bandwidth Allocation（DBA）

## 9.1 General Requirement of DBA

GPON system adopts status report(SR) based dynamic bandwidth allocation to improve bandwidth utilization for upstream and assure fairness of service and QoS.

Assigned bandwidth consists of 4 types, listed in precendence: Fixed bandwidth, Assured bandwidth, Non-assured bandwidth and Best-effort bandwidth. The service types designated by different T-CONT types are listed as Table 12.

Table 12 T-CONT Types

| | **Delay sensitive** | **Applicable T-CONT types** | | | | |
|---|---|---|---|---|---|---|
| | | **Type 1** | **Type 2** | **Type 3** | **Type 4** | **Type 5** |
| Fixed | Yes | X | | | | X |
| Assured | No | | X | X | | X |
| Non-assured | No | | | X | | X |
| Best-effort | No | | | | X | X |
| NOTE – In Types 3, 4 and 5, assignable bandwidth has the upper bound specified by Maximum bandwidth that should be provisioned for these types. | | | | | | |

GPON system shall support all 5 T-CONT types. Regarding bandwidth control parameters, GPON system shall support at least fixed bandwidth, assured bandwidth and maximum bandwidth.

## 9.2 DBA function requirement of OLT

OLT shall adopt dynamic bandwidth allocation to improve system bandwidth utilization and assure fairness of service and QoS. SR-DBA and piggy-back DBA mode 0 shall be supported. Mode 1 and 2 are optional. OLT shall allocate bandwidth assignment based on T-CONT and assure upstream bandwidth from an ONU shall not exceed the maximum bandwidth of SLA. The specification shall conform to G.984.3.

The minmum allocatable bandwidth shall not be greated than 512kbit/s, the granularity shall not be greater than 256kbit/s, the accuracy shall be within ±5%(the requirement of accuracy can be more genrous for 64 bytes packet).

OLT shall support at least 512 T-CONTs and 4096 GEM ports for each PON port.

### 9.3 DBA Function Requirement of ONU

SFU, HGU and SBU types of ONU shall support at least 8 T-CONTs and 8 GEM port. It's recommdended that MDU and MTU types of ONU support more T-CONT and GEM port. The upstream bandwidth of T-CONT shall be configurable through DBA by OLT.

ONU shall support DBRu mode 0 status report. Mode 1 and 2 are optional. The specification shall conform to G.984.3

## 10 QoS Mechanism of Multi-service

### 10.1 QoS General Requirement of Multi-service

GPON system shall provide necessary QoS mechanism, so as to guarantee to provide QoS of all kinds of priority service according to SLA protocol in both the upstream and downstream direction.

GPON system shall support the QoS mechanisms based on ITU-T Y.1291 including Traffic classification, Marking, Queuing and scheduling, Traffic shaping and policing, Congestion avoidance and Buffer management.

### 10.2 Service Level Agreement (SLA)

GPON system shall support setting SLA parameters specified for each user and service. For instance, the system can regulate SLA parameters such as different delay and dithering, Assuring Bandwidth and Max bandwidth, etc. specified for different users and service and shall support respective settings of upstrea and downstream service.

### 10.3 Classification of Service Flow

#### 10.3.1 Upstream Service Flow Classification of OLT

OLT shall support classification of upstream service flow through relative parameters in Ethernet frames, and mark priority according to the requirement of para. 10.4. In the default status, OLT trusts the priority tag ONU provides, and the function is not enabled.

The parameters that can be used for service classification include: GEM-Port,MAC DA, MAC SA, VLAN ID, User Priority (IEEE802.1D), Ethernet type (i.g. PPPoE, PWE3, MAC Control etc), destination IP address, source IP address, IP protocol type (TCP, UDP, ICMP, IGMP etc), IP TOS/DSCP, L4 protocol port etc. The deep checking flow classication (the first 80 octets) is recommended to be supported.

OLT shall support remote management of ONU service flow classification based on OMCI. The specification is to be determined.

#### 10.3.2 Upstream Service Flow Classification of SFU/SBU types of ONU

ONU shall support classification of upstream service flow based on physical port and relative parameters in Ethernet frames. And different service flows can be mapped to different GEM ports, GEM port is then mapped to T-CONT.

ONU shall support remote configuration of service flow classification function by OLT through OMCI.

The parameters that can be used for service flow classification include: MAC DA, MAC SA, VLAN ID, User Priority (IEEE802.1D), Ethernet type (i.g. PPPoE, PWE3, MAC Control etc), and the optional parameters include: destination IP address, source IP address, IP protocol type (TCP, UDP, ICMP, IGMP and etc), IP TOS/DSCP, destination L4 protocol port, source L4 protocol port, and etc.

#### 10.3.3 Upstream Service Flow Classification of MDU/MTU types of ONU

ONU shall support classification of upstream service flow based on physical port and relative parameters in Ethernet frames. And different service flows can be mapped to different GEM ports and T-CONTs.

ONU shall support remote configuration of service flow classification function by OLT through OMCI.

The parameters that can be used for service flow classification include: MAC DA, MAC SA, VLAN ID, User Priority (IEEE802.1D), Ethernet type (i.g. PPPoE, PWE3, MAC Control etc), and the optional parameters include: destination IP address, source IP address, IP protocol type (TCP, UDP, ICMP, IGMP and etc), IP TOS/DSCP, destination L4 protocol port, source L4 protocol port, and etc. It's recommended flow classication based on deep checking (the first 80 octets) of packet and IP packet with option can be supported.

#### 10.3.4 Upstream Service Flow Classification of HGU type of ONU

The Upstream Service Flow Classification of HGU type of ONU shall meet the relative regulations of China Telecom Home Network Gateway.

10.4 Priority Tagging

OLT and ONU equipments shall support priority marking of upstream service by flow classification , and have capability to forcibly modify priority marks. The mark shall adopt IEEE 802.1D User Priority, and IP TOS and DSCP priority marks are supported optionally.

OLT shall support remote management of ONU upstream service priority tag through OMCI.

ONU shall support local configuration of the service priority tag for all user ports, while ONU shall support remote configuration of its priority tag by OLT through OMCI.

缺省情况下，IEEE 802.1D的优先级（User Priority）排序及其与各种业务映射关系如表13所示（IEEE802.1Q-2005 Annex G.4）：

By default, User Priority of IEEE 802.1D and its mapping relations with all service are as shown in Table 13 (IEEE802.1Q-2005 Annex G.4):

Table 13 User Priority of IEEE 802.1D and its Mapping Relations with Service Type

| User Priority | Abbreviation | Service Type | Note |
|---|---|---|---|
| 7 | NC | Network Control | Includes TDM |
| 6 | IC | Internetwork Control | |
| 5 | VO | Voice（< 10 ms latency and jitter） | VoIP |
| 4 | VI | Video(< 100 ms latency and jitter） | IPTV、Video |
| 3 | CA | Critical Applications | |
| 2 | EE | Excellent Effort | |
| 0（Default） | BE | Best Effort | data service |
| 1 | BK | Background | |

10.5 Priority Queue

10.5.1 OLT Priority Queue

The upstream and downstream service of OLT shall be mapped to different priority queues according to IEEE 802.1D User Priority Tag and be scheduled.

OLT port at network end shall support 8 priority queues.

10.5.2 ONU Priority Queue

The upstream and downstream service of ONU shall be mapped to different priority queues according to IEEE 802.1D User Priority Tag and be scheduled.

SFU, HGU and SBU types of ONU shall support at least 4 priority queues.

For MDU and MTU types of ONU, ports of each user end shall support at least 4 priority queues.

10.6 Rate Limiting

10.6.1 Upstream Rate Limiting

10.6.2 ONU Upstream Rate Limiting

Ethernet ports on user end of MDU and MTU types of ONU shall support port rate limiting of upstream service.

Ethernet ports on user end of SFU, SBU and HGU types of ONU optionally support port rate limiting of upstream service.

Meanwhile, ONU schedules the upstream service flow according to DBA authorization of OLT in order to implement rate limiting of Upstream Service Flow.

10.6.2.1 OLT Upstream Rate Limiting

OLT shall support DBA mechanism in order to implement the Speed Restriction of Upstream Service Flow and upstream bandwidth allocation of each LLID.

When there are OLT equipments with L2 aggregation function, its upstream port (SNI) optionally supports the function of L2 Traffic Shaping.

10.6.3 Downstream Upstream Rate Limiting

10.6.3.1 ONU Downstream Upstream Rate Limiting

Ethernet ports on user end of MDU and MTU types of ONU shall support port Speed Restriction of downstream service and optionally supports speed restriction based on service flow.

Ethernet ports on user end of SFU, SBU and HGU types of ONU optionally support port Speed Restriction of downstream service.

10.6.3.2 OLT Downstream Upstream Rate Limiting

For downstream service, OLT shall support the rate control specified for user VLAN, GEM port or different classification flows, and shall support L2 Traffic Shaping or Policing Mechanism.

10.7 Priority Scheduling

10.7.1 OLT Priority Scheduling

OLT shall support the schedule function of downstream service according to SLA. The downstream service by OLT shall support strict priority policing (SP) queue schedule, Weighted Round Robin (WRR), and SP+WRR algorithm can be configured. SP+WRR is used by default.

The priority schedule of upstream service is completed by DBA of OLT and the local schedule function of ONU together.

10.7.2 ONU Priority Scheduling

ONU shall have the function of local schedule of upstream service according to OLT bandwidth authorization, whose schedule algorithm shall support SP algorithm as well as WRR or SP+WRR algorithm, and SP+WRR algorithm can be configured. SFU, HGU and SBU types of ONU use SP algorithm by default, while MDU and MTU types of ONU suggests that SP+WRR algorithm be used.

HGU, MDU and MTU types of ONU optionally supports the local schedule of downstream service; SP, WRR or SP+WRR shall be supported, and SP+WRR is suggested to be supported.

For the system uses SP+WRR algorithm, OLT (upstream) and ONU (downstream) shall use SP schedule for the service flow whose priority value is “7” and “6” (such as network control protocol message and TDM service). WRR schedule mechanism is used for other priorities of service.

10.8 Buffer Management

10.8.1 ONU Buffer Management

ONU shall support buffer management; whose specific mechanism is not specified.

At any moment, the upstream and downstream buffer shall not be less than 256KB for each ONU.

The maximum available buffer in upstream and downstream shall not be less than 128KB.

ONU shall support congestion prevention mechanisms, whose algorithms are Tail-Drop, RED, WRED. Tail-Drop shall at least be supported.

10.8.2 OLT Buffer Management

For assuring QoS, OLT shall provide sufficient cache, whose capacity is not regulated.

ONU shall support congestion prevention mechanisms, whose algorithms are Tail-Drop, RED, WRED. Tail-Drop shall at least be supported by equipments.

11 Security

11.1 Data Security of PON Port

GPON system shall support AES-128 as defined in ITU-T G.984, the implementation of key renewal and synchronization shall conform to G.984.

GPON system shall support enable and disable of encryption for GEM port while ONU is registered and service flow shall not be disturbed during enabling and disabling.

11.2 Limit of MAC Address Learning

OLT shall support the limit of MAC Address learning based on ONU, and the restricted MAC address number can be flexibly configured.

MDU and MTU types of ONU shall support the limit of user MAC address learning based on ports, and the restricted MAC address number can be flexibly configured. When the number of MAC addresses is beyond the number restriction of OLT or ONU, OLT or ONU shall ignore the new MAC addresses until there is MAC address

aged out.

### 11.3 Filter and Inhibition

OLT , MDU and MTU types of ONU shall support frame filter and inhibition for broadcast ethernet frames of specific physical ports, Multicast ethernet frame, unicast Ethernet frame according to MAC addresses (Source or Destination), VLAN ID. It optionally supports Access Control List based on Source/Destination IP Address, Source/Destination TCP or UDP ports and Protocol Number based Access Lists（ACL）.

OLT, MDU and MTU types of ONU shall support filter for illegal frames and illegal Multicast source filter (such as user end Multicast data flow).

MDU and MTU types of ONU shall support the inhibition function of protocol messages such as IGMP, DHCP based on user ports.

ONU shall support terminating and transparent transmission for BPDU (802.1D) messages received by user end ports, which is configurable.

OLT, MDU and MTU types of ONU shall support dumping the Ethernet frames with unknown source MAC address, and prevent MAC address deceiving.

### 11.4 User Authentication and User Access Line(Port) Tagging

GPON system shall support PPPoE and DHCP user authentication and support the corresponding user access line (port) identifier functions (i.e. PPPoE+ and DHCP Option 60, Option82). The specific approach shall meet the requirements of “Code format requirements for user access line (port) in E/GPON system of CTC (Request For Proposal)”

### 11.5 Other Security Functions

OLT is recommended to provide the following security functions:

1、IP/MAC cheating proof

2、Protection of DOS attack

3、IP/MAC addresses association

OLT can support DHCP Snooping optionally.

## 12 Multicast

### 12.1 Implementation of Multicast

GPON system adopts SCB+IGMP to implement dispatch of multicast service and group member management. i.e. OLT dispatches multicast content through broadcast GEM port in PON port interface. GPON system shall support multicast group member management through IGMP.

i.e. OLT uses IGMP Proxy and ONU uses IGMP Snooping to control the members of Multicast through standard IGMP Snooping protocol. IGMP Report/Leave and Query messages are generally used for management of the dynamic in/out and maintenance. The Multicast Service Permission Control is realized by IPTV service platform (IPTV platform obtains user’s permission information for Multicast service by using set-top box and delivers different EPG to users according to the various kinds of access permission. The user only has access to the channels listed on EPG, as such, Multicast access permission control is realized.).

In this mode:

- ONU establishes an association relationship between the group member and the exchange port (i.e. the Multicast Transmission List, the transmission item in Multicast Transmission List takes Group Address/Multicast MAC Address as the index instead of MVLAN+Group Address/Multicast Address) by monitoring the the mode in which Multicast Clients (e.g the set-top box) sends Reports to IGMP members of Multicast router. ONU transmits the received downstream data packet to ports that have group members according to the Multicast Transmission List.
- As the IGMP Proxy, OLT intercepts all IGMP Requests sent from Multicast Client and processes the same, then transmit the IGMO Requests to the upper Multicast router, and establishes the accociation relationship between the group member and the PON port (i.e. a Multicast Transmission List). Meanwhile, OLT transmits the data packet to PON ports according to the Multicast Transmission List. OLT simulates a Multicast Host on the uplink port and a Multicast router on the downlink port.

In the forwarding procedure of Multicast service flow, Multicast, OLTand Multicast terminal (such as set-top box) operate normal IGMP protocol message interaction like IGMP Query and Report, etc. The OLT enabled with IGMP Proxy shall send downstream IGMP Query message to ONU under PON ports (including general query message and specific group query message.) The IGMP General//Group-Specific Query messages sent by OLT carries Multicast VLAN Tag. ONU broadcasts IGMP General Query and Group-Specific Query messages to all member ports. ONU shall ignore the following two kinds of IGMP General/ Group-Specific Query on receiption:

- IGMP General/ Group-Specific Query without VLAN Tag；
- IGMP General/ Group-Specific Query with VLAN Tag, but the VLAN ID does not belong to the VLAN ID group configured for the ONU (e.g. if the ONU is configured with VLAN 1000, 1001 and 1002, i.e. if one or more ports of such ONU belong to these Multicast VLANs; if the IGMP General/ Group-Specific Query carries a VLAN Tag with VID=1004, the ONU shall ignore this IGMP General/ Group-Specific Query whether 1004 is the unicast VID or Multicast VID in the GPON);

(Another simplified implementation method is: ONU transmits all IGMP General Querys of each Multicats VLAN to all Ethernet ports, without considering the Ethernet port belongs to such Multicast VLAN or not. In this condition, the UNI port that does not belong to the Multicast VLAN will also receive the IGMP General Querys of such Multicast VLAN. This implementation method will not affect the function of Multicast Client.)

IGMP Group-Specific Query messages in downstream shall be marked with Multicast VLAN Tag by the Multicast VLAN the chanel belongs to (held in broadcast LLID.) IGMP General Query shall be delivered in all Multicast VLANs in the GPON system, which means that OLT will copy every IGMP General Query message marked with different VLAN Tag and deliver them to all ONUs in broadcast LLID. For example, in an GPON system, there are 4 Multicast VLANs of 1000, 1001, 1002 and 1003 holding different IPTV channel group. Each time the Query Interval timer (according the definition of RFC2236) is timed out, OLT will generate an IGMP General Query message and make 4 copies of it deliverd in 4 Multicast VLANs. (Explanation: with generating multiple copies of IGMP General Query messages on the Ethernet UNI ports of ONU and on PON ports in the way, as there are less Multicast VLANS that are generally 1 or more in GPON system and the default value of IGMP Query Interval is generally 125s, the whole cost can be ignored. Multiple messages will not bring about negative effects on Multicast clients and OLT state machine.)

When a user wants to leave the specific channel applied for, the Multicast client (set-top box) will send upstream IGMP Leave message to ONU.

MDU and MTU types ONUs shall support Fast Leave function (each ONU port is set for one client, the rate needs to be limited, as such, the Fast Leave function shall be supported) and Non Fast Leave function (multiple Multicast clients are possibly connected to each port, so Non Fast Leave shall be supported)under IGMP Snooping and Controlable Multicast Protocol modes. SFU/SBU/HGU types of ONU shall support Non Fast Leave function, Fast Leave function under IGMP Snooping and Controlable Multicast Protocol modes shall be optional (if the rate of ONU port and client downstream bandwide are adequate, the delay of leaving the current Multicast group will not negatively affect the new added Multicast service flow).

ONU shall support multicast cross VLAN. i.e. ONU can translate the VLAN of multicast data packet carried by broadcast GEM port in downstream to arbitrary VLAN. Remote management of multicast cross VLAN is to be determined.

### 12.2 Multicast Protocol

Multicast protocol support IGMP V2 (RFC 2236). IGMP V3 (RFC 3376) and multicast management protocol MIB (RFC 2933) are optional.

OLT shall support IGMP Proxy.

ONU shall support IGMP Snooping, IGMP Snooping with Proxy reporting/Query or IGMP Proxy.

## 13 System Protection

### 13.1 Device Protection

The OLT device in GPON system shall support redundancy protection for key components like main control module, power and up-link module。

The ONU device can support redundant power protection(backup battery) optionally。

### 13.2 Fiber Protection and Switch-over (optional)

#### 13.2.1 Function Requirement of Fiber Protection and Switch-over

For improving the network reliability and viability, the fiber protection and switch-over mechanism can be used in the GPON system. Fiber protection and switch-over can be done by 2 methods as below:

- Automatic Switch-over: Triggered by failure detection, such as signal loss, frame loss or poor signal(BER is below predefined threshold), etc;
- Compulsory Switch-over: Triggered by management event like fiber re-routing, fiber change etc; After the switch-over, the GPON system shall support protected service recovery either automatically or compulsorily。

### 13. 2. 2 Types of fiber protection and Switch-over

There are mainly two types of fiber protection and switch-over configuration：Main fiber protection switching and full fiber protection switching. The full fiber protection switching can be categorized into two types. They are depicted as figure 3, 4 and 5 respectively。

1） Type a：OLT PON port、main fiber redundancy protection：

- OLT: The spare OLT PN ports are in the cold standby status, OLT checks the line status (checking method is undetermined;), OLT PON port status, the switch-ober shall be completed by OLT.
- Splitter: 2:N splitter is used;
- ONU: No specific requirement.

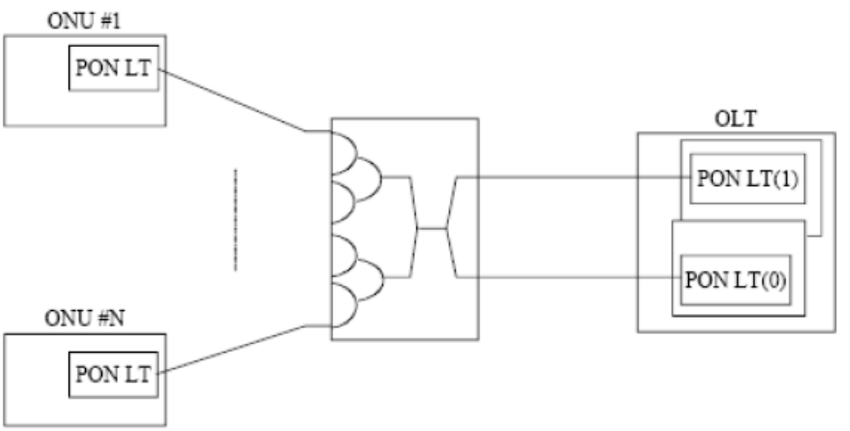



Figure 3 Main fiber protection switching

2） Type b：Full fiber protection switching supprots backup for OLT, ONU, splitter and all fiber。

- OLT: The main and spare OLT PON ports are both in working status;
- Splitter: 2 1:N splitters are used;
- ONU: Interally install an optical switch device in the front of PON port. Check line status by ONU (checking method is undetermined), and comfirm the main line. Switching should be completed by ONU.
- Failure can be recovered in any point by switching to the backup device hence it's highly reliable。
- One exception of the full fiber protection switching is some ONUs and the fiber between ONU and splitter are not fully redundent. In Configuration 1, the ONU without backup fiber is not protected. In configuration 2, the protection switching of ONU without backup fiber is same as main fiber protection switching。

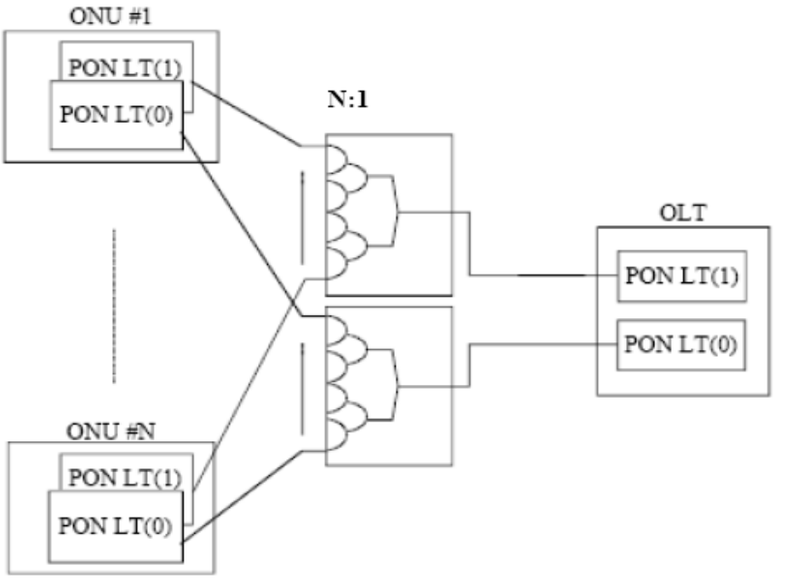



Figure 4 Full Fiber Protection Switching（Configuration 1）

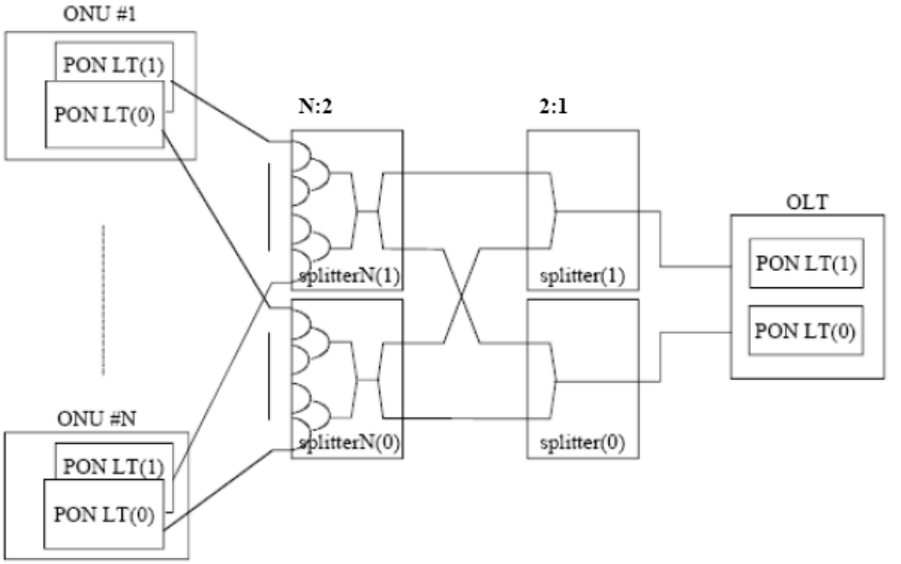



Figure 5 Full Fiber Protection Switching（Configuration 2）

13. 2. 3 Fiber Protection and Switch-over Rule

In GPON system, when fiber protection type a and b meets one of the conditions as below, fiber protection and switch-over must be done:

1) Lost of Signal (LOS);
2) Poor Signal Path:
   - The input signal power is too high or too low;
   - Error code rate is beyond the limit;
   - Other conditions are undetermined.

13. 2. 4 Performance requirement of fiber protection switching

In the configuration of main fiber protection switching, OLT redundant circuit is in cold standby status. The OLT shall re-range each ONU after the switch-over. Therefore, signal loss or frame loss is unavoidable in normal condition. The requirement of switch-over time is to be determined.

In the configuration 1 of full fiber protection switching, OLT and ONU redundant circuit is in hot

standby status. Re-ranging is not necessary. Seamless switch-over can be done (no frame loss). The switch-over time and recovery time in both upstream and downstream fiber shall be within 50ms.

In the configuration 2 of full fiber protection switching is same as main fiber protection switching.

### 13.2.5 Recovery Mechanism of Protection Switch-over

All protection switch-over mechanism of GPON system can support automatic and manual recovery function for the protected service. For the automatic recovery method, after the failure that causes switch-over is cleared and a certain period of waiting time (WTR), the protected service shall automatically recover to the original work routing, while WTR shall be configurable. The service interuption caused by recovery action is to be determined.

### 13.2.6 Requirement of PLOAM frame

The protection switching in GPON is usually implemented by PLOAM PST message. Please refer to ITU-T G.983.5 for detailed specification.

## 14 Requirement of Voice Service（Optional）

If GPON system provides voice service, VoIP must be supported. SFU, HGU and SBU types of ONU shall adopt SIP protocol, while MDU and MTU types of ONU shall adopts H. 248.

The internal IAD of MTU-type ONU is suggested to support VoIP Centrex function.

Voice grouping is implemented by ONU for VoIP service in GPON system.

The ONU supporting VoIP loading that is to implement H.248 protocol shall conform to YD/T 1292-2003 and H.248 Protocol Regulation of China Telecom.

The ONU supporting VoIP loading that is to implement SIP protocol shall conform to IETF RFC 3435 and SIP Protocol Specification of China Telecom.

The voice service shall be marked as high priority service, so as to assure the transmission quality of VoIP. Strict priority schedule is used for voice service.

## 15 Requirement of TDM Service（Optional）

The OLT in GPON system is recommended to support TDM service. As for SBU and MTU types of ONU used for busniess clients, TDM shall be supported. It's not necessary for other types of ONU.

When GPON system carries TDM leased line service (E1 or n×64kbit/s data service), IETF PWE3 or Native TDM (TDM over GEM, G.984) shall be adopted.

The implementation of PWE3 shall conform to IETF RFC3985 (2005) and RFC4197 (2005). The encapsulation method shall adopt RFC4553 (SATOP) or Draft-ietf-pwe3-cesopn-02.txt (CESOPSN), whose specific implementation shall be configured by OLT and the local network administrator of ONU. The TDM service carried by GPON system shall adopt self-adapting clock restoration, that is, restore the clock from the clock poke from data packet. PWE3 data packet of GPON system contains RTP header of certain length. The format of RTP and definition of byte field shall conform to RFC3550. The byte length of clock pokes used by 2 ends of IWF of TDM circuit uses 4 bytes, while the synchronization data unit of clock poke is bit.

For guaranteeing the inerconnection requirement based on TDM, OLT and ONU equipments shall be respectivel set with adopted standard, E1 number of encapsuation, corresponding IP address of CESoP, MAC Address, VLAN.

The TDM service implemented by Native TDM shall conform to ITU-T G.984.

As for OLT equipments providing TDM service, the interconnection function of TDM (E1 and n×64Kbps) service is optionally supported. STM-1 in uplink port is recommended.

## 16 Performance Index Requirement of Service Load

### 16.1 Performance Index Requirement of Ethernet/IP Service

Etherent/IP data service is defined by IEEE 802.3 and conforms to IEEE 802.1D. The Layer 2 switching of OLT and ONU shall assure line rate forwarding. The performance indexes of Ethernet/IP service include transmission latency, throughput, Packet Loss Rate and long-term packet loss rate.

#### 16.1.1 Throughout

When GPON system is only loaded with Ethernet/IP service, the upstream capacity of PON port shall not be less than 1Gbit/s (any packet length from 64Byte to 1518Byte), while the downstream capacity of PON Port shall not be less than 2.2Gbit/s (any packet length.)

### 16.1.2 Transmission Latency

When GPON system is only loaded with Ethernet/IP service, in the case that the flow volumn is not beyonf 90% of the system capacity, the upstream transmission (UNI to SNI) delay shall be less than 1.5ms (any Ethernet packet length from 64Byte to 1518Byte), while the downstream transmission (SNI to UNI) delay shall be less than 1ms (any Ethernet packet length)

### 16.1.3 Packet loss rate

When the GPON system only loads Ethernet/IP service, in the case that the upstream and downstream flow volumn are both 1Gbit/s the packet loss rate of upstream of PON Port shall be less than 10% (any Ethernet packet length), while the packet loss rate of downstream of PON Port shall be less than 5% (any Ethernet packet length).

### 16.1.4 Long-term packet loss rate

When the GPON system only loads Ethernet/IP service, the long-term (24 hours) packet loss rate shall be 0 under certain flow volumn (90% of the capacity).

## 16.2 Performance Index Requirement of Voice Service

When the GPON system loads voice service by VoIP, the performance index requirement as below shall be met.

a) Dynamic switch time of voice code <60ms.
b) Supposed to have the storing capacity of 80ms cache, for guaranteeing voice interruption and dithering not to occur.
c) Objective Evaluation of Voice
   - When the network environment is pretty good, the average of PSQM < 1.5;
   - When the network environment is poor (packet loss rate=1%, dithering=20ms, delay= 100ms), the average of PSQM < 1.8;
   - When the network environment is pretty bad (packet loss rate=5%, dithering=60ms, delay=400ms), the average of PSQM < 2.0.
d) Subjective Evaluation of Voice
   - When the network environment is pretty good, MOS>4.0;
   - When the network environment is poor (packet loss rate=1%, dithering=20ms, delay=100ms), MOS>3.5;
   - When the network environment is pretty bad (packet loss rate=5%, dithering=60ms, delay=400ms), MOS>3.0.
e) Coding Rate
   - G.711, Coding Rate = 64kbit/s;
   - It is required that the coding rate <18kbit/s for G.729a.
   - It is required that the coding rate of G.723.1 (5.3)<18kbit/s, G.723.1 (6.3)<15kbit/s for G.723.1.
f) Delay Index (Loopback Delay)

The delay of VoIP involves coding/decoding delay, input cache delay of receiving end and internal queue delay, etc.

   - When G.729a is adopted, the Loopback delay < 150ms;
   - When G.723.1 is adopted, the Loopback delay < 200ms.

## 16.3 n×64Kbit/s digital connection and performance index of E1 channel by Circuit Simulation

### 16.3.1 Bit Error Rate

In the normal working condition, the bit error rate of n×64Kbit/s digital connection and performance index of E1 channel of the GPON system is 0 for 24 hours.

### 16.3.2 Transmission Latency

In the normal working condition, the transmission latency of n×64Kbit/s digital connection and 2048kbit/s path < 1.5ms from the user end port to the network end one.

16.3.3 Dithering Transmission Characteristics

The Dithering Transmission Characteristics of E1 Port shall meet the regulation in figure 6 and Table 14.

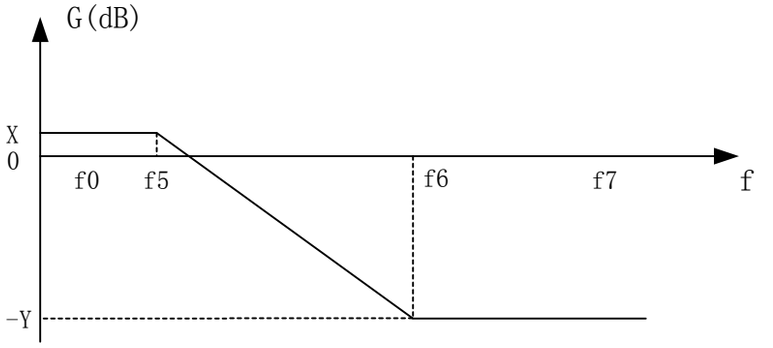



Figure 6 Dithering Transmission Characteristics of E1 Port

Table 14 Dithering Transmission Parameters of E1 Port

| Port Rate | Frequency f（Hz） | | | | Gain G（dB） | |
|---|---|---|---|---|---|---|
| (kb/s) | f0 | f5 | f6 | f7 | X | -Y |
| 2048 | * | 40 | 400 | / | 0.5 | -19.5 |

Note：“*” value is provided by equipment manufacturer, but f0 shall not be higher than 20Hz.

17 Remote Management of ONU

17.1 Port Loopback

OLT shall support remote enabling and disabling loopback of ONU Ethernet port through OMCI. ONU shall support loopback of Ethernet port. The loopback of ONU ethernet port shall be configured by attribute “Ethernet loopback configuration” of ME “Physical path termination point Ethernet UNI”.

17.2 Performance Statistics of Ethernet Port

OLT shall support performance statistics of ONU ethernet port through OMCI. The performance statistics shall be inquired by “Get current data” operation of ME instance “Ethernet performance monitoring history data”，”Ethernet performance monitoring history data2” and ”Ethernet performance monitoring history data3”. The implementation shall conform to ITU-T G.984.4.

17.3 ONU Software Upgrade

GPON system support ONU remote software upgrade through OMCI. The flow of software upgrade is as following:

OLT sends message “Start download” to ONU notifying the beginning of software download. Once ONU has acknowledged correctly, OLT sends message “Download section” and starts download of software section. Once all software sections are downloaded to ONU, OLT sends message “End download” with CRC and software version information that are used to verify downloaded software. Once OLT has received acknowledgement of “End download” from ONU, OLT sends message “Commit image” and “Activate image” sequentially, and assigns the just downloaded software as the active boot image. If OLT has received acknowledgement of “End download” with CRC error, the download is restarted.

During the message flow mentioned above, when ONU has received message “End download” from OLT, ONU sends acknowledgement. It’s needed to be considered that ONU is only able to respond with a certain delay after the image is written into flash and verified. To assure ONU can respond message “End download” correctly, the implementation is specified as below:

The definition of parameter and variable:

End_download_tx：global variable, It specifies the number of “End download” sent by OLT at a moment for a particular ONU in OLT state machine. The initial value is 1.

End_download_Num：global variable. It specifies the maximum number of “End download” sent by OLT during software upgrade. The initial value is to be determined.

End_download_Time：global variable. It specifies the interval(in second) of adjacent “End download” messages for a parcitular ONU in OLT state machine. The initial value is to be determined.

Implementation：

During ONU is writing the flash, it doesn’t respond the “End download” from OLT. Once the OLT has sent “End download”, if a valid acknowledgement from ONU doesn’t arrive in the time specified by “End_download_Time”, and End_download_tx＜End_download_Num, OLT resends “End download” and increases End_download_tx. If a valid acknowledgement from ONU doesn’t arrive in the time specified by “End_download_Time”, and End_download_tx≥End_download_Num, the download is aborted.

The flow chart of ONU remote software upgrade is as figure 7. And state transition diagram is as figure 8.

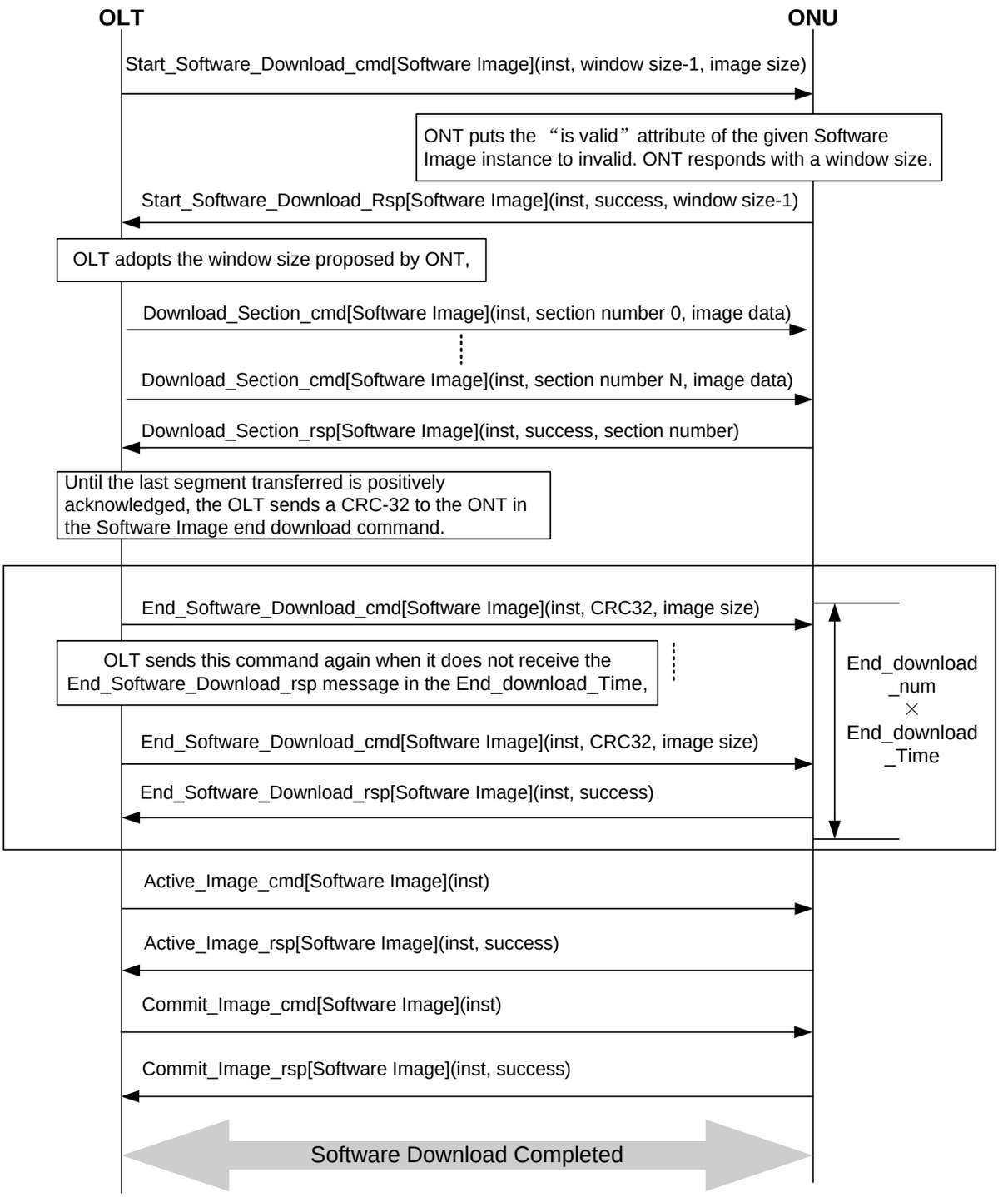



Figure7 Message Flow of ONU Remote Software Upgrade

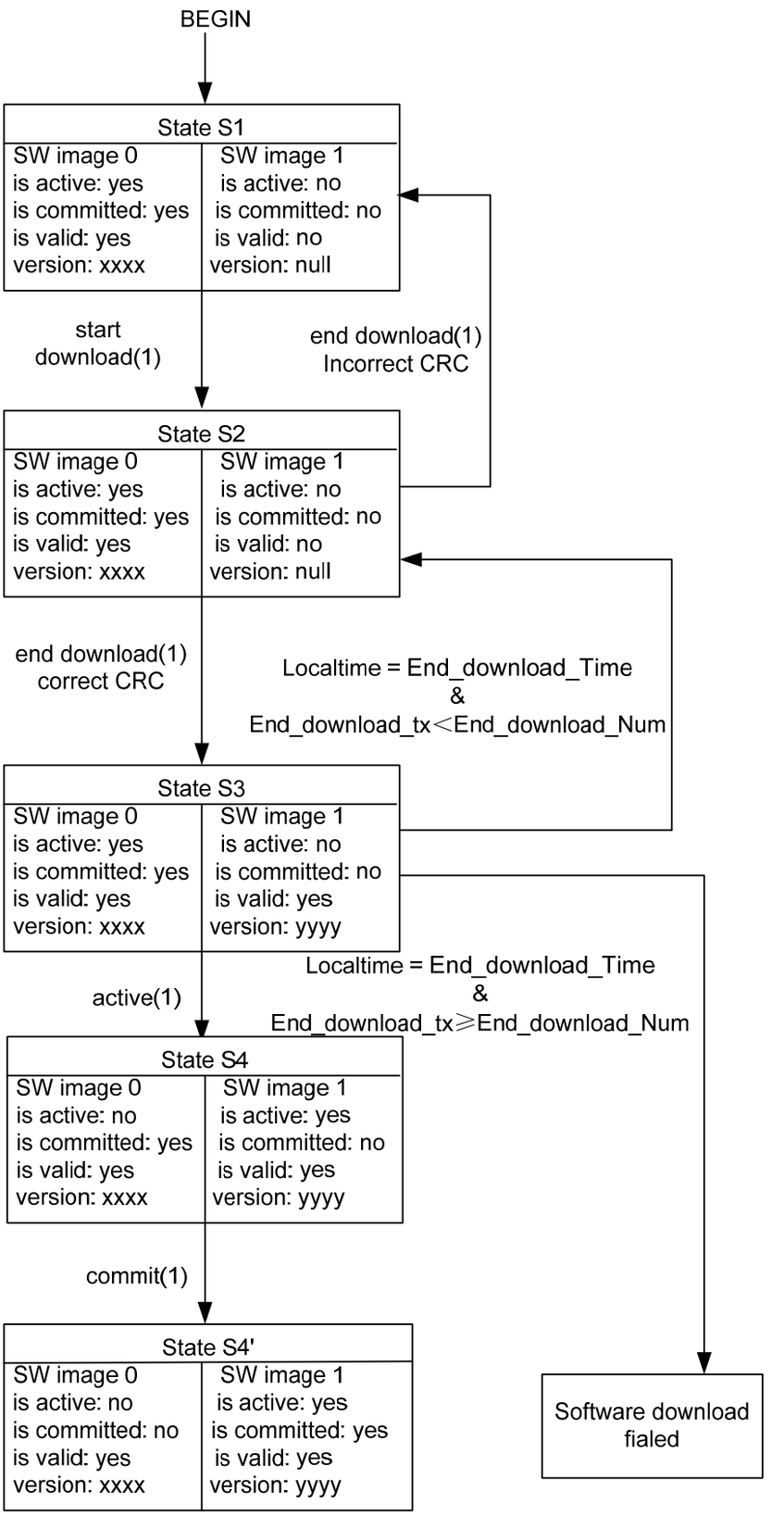



Figure8 State Transition Diagram of ONU Remote Software Upgrade

## 18.1 OLT Requirement of Operational Management and Maintenance

The operational maintenance and management of GPON system shall support configuration, failure, performance and safety management of OLT and ONU. The operational management and maintenance of OLT is mainly implemented through GPON Element Management System (EMS, also Equipment Network System). There are two modes for achieving ONU's operational management and maintenance, namely, local management and remote management. Local management generally refers to that maintenance personnel execute local configuration, failure, performance, and safety management for ONU via PCs(dedicate console port, UNI FE port, serial port etc). Remote management means that system administrator implements remote management (involving configuration, failure, performance, safety, etc.) for ONU via EMS. There are also many ways for enabling ONU's remote management:

- As the proxy of network administration system, OLT implements ONU's remote management through OMCI as specified in ITU-T G.984;
- Implement remote management for ONU by Automatic Configuration Server (ACS) in the TR-069 mode specified by DSL Forum;

For various types of ONU, the modes for implementation of remote management are different. See Section 17.4 for details of Requirement.

## 18.2 Requirement of Element Management System(EMS)

### 18.2.1 General EMS Requirement

1) Management Protocol and Equipment Management Port

a) EMS shall operate, manage and maintain GPON system through SNMP V2c network management protocol with V3 release as optional; network administration options in TELNET or WEB mode are supported;

b) EMS shall support access to OLT equipment in both outband and inband modes. The outband mode offers all functions available to the inband mode. In addition, the outband mode shall have access control enabled to protect against authorized access;

c) One DCN access mode of Ethernet, DDN (N×64kbit/s 1≤N≤30, V.35 port) and 2Mbit/s (G.703 codirectional port) shall be adopted between EMS and OLT; it is advised that Ethernet access mode be supported;

d) EMS management system shall keep available configuration management, failure management, performance management and safety management for equipment;

e) OLT shall support users to implement outband operational maintenance via CONSOLE port attached.

2) Access modes and capability for operational users (hereinafter referred to as "Users", EMS operators)

a) EMS shall support users' local and remote accessing;

b) EMS shall support concurrent operations of many users (16 users at least).

3) Requirement for software and hardware platforms

a) OS and database for EMS system

Operating system (OS) for the EMS platform of GPON adopts one of UNIX, Linux, Windows 2000/XP/2003/Server, Mac OS, Solaris, etc.; EMP shall support database management, capable of controlling all database systems within network administration system; also support one of such databases as MS SQL Server 2000/2005, MySQL and Oracle and its compatible version.

b) Software

EMS system software shall meet Requirement for forward compatibility; in other words, it can manage all network elements currently running on the network, and all data in systems of a lower version can migrate automatically to systems of a higher version, when software version is upgraded.

Either specialized client-side software mode or the Web mode may be adopted for the user side.

Network administration system shall offer self-management services such as system startup, initialization, closing and backup.

If OLT equipments support mixed plug-in of DSL port cards, EMS shall support unified management of DSLAM and OLT equipment.

c) Management capacity

The typical configuration for EMS platform shall enable the capacity for managing OLTs no less than 1000 and ONUs no less than 100000. It is suggested that the capacity in support of 1000000 threads be supported. To increase number of network elements managed imposes no remarkable impact upon system performance within maximum equipment capacity range.

d) Processing capability

EMS keeps available strong data processing capabilities of warning, performance, order, etc., meeting the following Requirement at least:

- Average alarm response time: No longer than 10s from network element warning to EMS alarm display;
- Alarm record capacity: No less than 5,000,000 entries or no shorter than 6 months;
- Performance record capacity: No less than 10,000,000 entries or no shorter than 6 months;
- Order log record capacity: No less than 150,000 entries or no shorter than 6 months;
- Other processing capability parameters: To be determined.

4） Reliability

EMS shall meet Requirement for reliability below:

a) EMS shall support database backup, recovery and copy. Backup data designated to the peripheral memory designated manually or automatically. The peripheral memory may include magnetic disc, magnetic tape, database, etc., and provides convenient data recovery operational port (when necessary) to recover storage information of the peripheral memory designated to system (from various storage media or geographical locations).

b) Support (1+1) hot-standby and warm-standby configurations. The primary standby switching duration for hot backup is no longer than 10 minutes. Two options are available to support floating IP settings.

c) Provide the services for monitoring the links between EMS server and network elements. Once any failure of EMS itself or the links with network elements arises, EMS shall remind users promptly. When the links are recovered, EMS shall provide related safety and recovery functions.

d) Network administration system shall implement continuous or intermittent testing, observation and monitoring for each part of the system to discover failure or performance weakening. EMS makes available monitoring services for the CPU, memory and database adopted for EMS system.

e) Investment and exit of EMS imposes no impact upon traffic flows of network elements.

f) Regular operations of network elements and normal services of network can’t be affected when system abnormalities are over.

g) The normal run of server-side and other user interfaces will not be affected when the process of user interface abnormally stops.

5） Software Management

a) Provide management functions for self-contained software. Included are:

- Software and patch installation management (GUI): Provide detailed and user-friendly software and patch installation wizard and generate relevant log files;
- Provide information of self-contained software version;
- Backup original programs in patch installation process;
- Effect automatic upgrade of local terminal and remote client side after server-side upgrade.

b) Implement remote maintenance for software on the network elements governed. Included are:

- Inquire about software version information of network elements;
- Online software upgrade;
- Hot software patch upgrade;
- Batch backup/recovery/upgrade for software;
- Batch upgrade and management for patches;
- Batch process of ONU software update;

6） Data Management

a) Copy and export the databases of configuration, warning, performance, etc. manually and automatically.

b) Provide print setup and print function for printout of the data of configuration, warning, performance, etc.

7） User interface

a) EMS chooses the interface in Chinese in priority with the interface in English as optional;

b) The man-machine port adopts the modes of window, icon, menu and cursor, being concise and user-friendly and rendering rich and accurate online help;

c) All elements of the network governed have a common management software platform. Areas authorized for management can be monitored in one operating window.

d) Screen protection: manual and automatic lockout of the screen at the client side is available. When an operator stops operating the system or has no operations in a specific period, the screen can be locked to

protect other users from access. In addition, the function for screen activation and reentry is available (with password required) with the screen to be enabled through touching upon mouse/keystroke. When an operator stops operations for a period, the system can make the user log out automatically.

8） Time Synchronization

a) The system shall ensure EMS system time and network element time synchronous and set time synchronization in an automatic way via NTP protocol and in a manual way;

- Execute time synchronization between network element and network management server manually (required);
- Synchronize network element time with the system time of EMS server with the time synchronization mechanism of SNMP protocol (required);
- Network element also supports NTP protocol and executes time synchronization with uniform time server through NTP protocol so as to automatically synchronize with system time of network management server (optional).

b) Time stamp is measured with second (s) as the unit.

9） Northward Port

EMS chooses and provides northward port in priority with port protocol as CORBA, XML or SOAP. Northward port shall provide the features of log-in, topology, service distribution, warning, stock statistics, performance statistics, etc., to assure extensibility, consistency and easy to operate of NMS access service, diversity of EMS services and easy to configure of various equipment and various service types.

In addition, EMS shall provide electronic bill interface with the telecommunication service system (system 97) to automate the process of service delivery. The specific electronic bill interface is to be determined.

### 18.2.2 Failure Management Requirement

1) Failure inspection function: network administrator shall be able to implement continuous or intermittent test, observation and monitoring for each part of the system, to discover failure or performance weakening. For example, the system shall produce an alarm when the physical layer performance (such as optional channel BER) of PON port is weakened greatly. When ONU suddenly powers down, the alarm Dying Gasp shall be made. EMS shall support detection of the alarm Dying Gasp.
2) Failure synchronization function: Manual and automatic failure synchronization shall be supported between EMS and network elements. Manual synchronization means that network administrator functions to synchronize the alarms generated on network elements manually. Automatic synchronization: network administrator functions to synchronize the alarms generated on network elements automatically, once the system is restored after EMS fails or the links between EMS and network elements fail.
3) Failure locating and analysis function: EMS shall function to determine the occurrence time and position of failure and pinpoint causes to the failure to the extent possible.
4) Alarm display.
   a) EMS shall display an alarm in many ways after the alarm arises, displaying alarms in different sounds and colors according to types and levels of them.
      - Provide a sound setup switch. Volumes and duration of alarms on various levels are tunable.
      - Provide Requirement for colors. Alarms on various levels are marked in different colors.

   b) Alarm display filtration: display current or historical alarm events selectively in accordance with filtration conditions set. Filtration conditions may be alarm source, alarm level, alarm type, alarm time, management area (*), alarm status lamp and any combination thereof.
5) Alarm sorting function: EMS shall function to indicate equipment failures through indicating lamps and alarm signal indication devices. Different failure causes correspond to different alarm information.
   Alarms are classified into the five types below, as recommended:
   a) Equipment alarm
   b) Service quality alarm
   c) Communications alarm
   d) Environmental alarm
   e) Processing failure alarm

   The system shall function to assign (or re-assign) levels of seriousness for alarms in the light of warning causes. The levels of seriousness are classified into the five types below:
   a) Critical alarm

b) Major alarm
c) Minor alarm
d) Warning
e) Cleared

According to alarm clean status, alarms can be classified:

a) Current alarm
b) Historical alarm

According to alarm confirm status, alarms can be classified:

a) Alarm confirmed
b) Alarm unconfirmed

6) Alarm processing

EMS shall support the alarm log function. In case any failure occurs, the operations concerned shall be recorded into logs. Statistical list of system alarm logs processes alarms in a staged way on the basis of failure severity, failure cause and time segment.

EMS supports processing rules for customized alarms, e.g., alarm forward shifting rule (notice made in E-mail or SMS) , alarm latency reporting rule, alarm enumeration (new alarms are generated automatically when alarms are accumulated to a certain number), automatic alarm identification rule, automatic alarm clearing rule, and alarm suppression rule.

Relevant alarm information of system administration system shall be removed automatically after failure events are recovered. In addition, manual removal is supported. For manual removal, the operation shall be recorded into logs.

7) Alarm polling and statistics

a) EMS shall support polling and statistics for current or historical alarms. The conditions for polling or statistics are the information below or any and/or combination thereof:

- Alarm source;
- Alarm occurrence time;
- Alarm severity level;
- Alarm causes;
- Alarm status;
- Alarm clearing time;
- Alarm confirming time;
- User identification;
- Alarm duration (optional);

b) EMS shall support output of polling or statistics of alarms. Alarm output conditions, alarm output destination and alarm output mode can be set. The modes for output of alarm polling/statistics reports include “Printout” and “Save as a file”. Alarm output conditions include the information below and any and/or combination thereof:

- Alarm type;
- Severity level;
- Alarm source.

### 18.2.3 EMS Configuration Management Function

EMS system of GPON shall make available configuration management function for OLT and ONU with specific Requirement as below:

1） Topology management

a) Display in icons all network elements, element groups (a network element may be divided into uncrossed element groups due to display demands) or subnets governed; if possible, display the rack/sub-rack components of network elements with sub-rack sequence, exact slot, unit disk, etc. included and marked with relevant names. Adopt different icons to mark nodes of various types (network elements, subnets or others). An operator, through clicking on network element icons, obtains detailed configuration information of network elements, or implements network element configuration and other management functions.

b) Network topologies can display running status and conditions of the network elements governed in a dynamic and real-time way.

- Reflect in a real-time way the changes to network topology structure and network element configuration. Variations of network topology structure (such as ONU upper line/lower line) and those of network element configuration information can be advised of users in topological graphs in certain conspicuous modes.

- When any failure arises from the communications between EMS and network elements, the failure can be reflected in topological graphs.

c) EMS can provide flexible and convenient topologic editing functions such as array, addition, deletion, modification and movement:

- Add and delete network elements on topologies manually;
- Add, modify and delete the connecting lines among network elements on topologies manually;
- Define, modify, move and delete positions and names of network elements manually;
- Provide automatic array of network elements;

d) Topology view function:

- Customize background maps;
- Zoom in and out topological graphs;
- Select if certain network elements are displayed or hidden according to Requirement.

2） Network element management

a) Create, modify, delete and inquire about configuration of network elements; nickname management (self-defined name of network element, nickname lookup and etc)

b) Inquire about and/or information of network elements including whether unit disks are installed in OLT slots (e.g., type, model and status of a unit disk in slot, with protection or not, and guard mode);

c) Implement inquiry and configuration operations of boards. Inquire, add and delete a single board; inquire about CPU utilization conditions of boards; conduct reset operations of boards.

d) Inquire and configure ONU authentication method. (Physical Identification based, Logical Identification based or Mixed mode)

e) Inquire about and modify ONU configuration information including ONU online status, addition mode (manual/automatic), remote reset of ONU, etc.;

f) EMS shall be able to configure parameters of OLT's port at the network side, e.g.,

- Port implementation;
- Full duplex/half duplex of port;
- Port flow control;
- VLAN function;
- MAC binding and ACL filtration;
- Rate limiting function;
- RSTP feature;
- Link aggregation;
- Port mirror image.

g) EMS can manage attributes of the UNI port of ONU in remote OAM mode. Included are:

- Port status management, e.g., Enabled/Disabled, operating rate, flow control, duplex and self-negotiation;
- Port VLAN management;
- Classification & Marking function of port;
- EthLinkStatus connected to port;
- Port speed restriction function;
- Multicast function management of port

h) PON port management, mainly including:

- Reset PON port;
- Set the polling rates of DBA on various priority levels;
- Triple churning management (Enabled/Disabled);

i) Unit protection switching management. Assign, delete and modify system protection functions:

- Main controller;
- PON port disk (optional);
- Power module.

j) Configure the environmental monitoring parameters of network elements, e.g., board temperature inquiry, temperature warning threshold, etc. Temperature thresholds for automatic turn-on and turn-off of fans can be set.

k) Support off-line inquiry about various information of ONU. All configuration information shall be configured automatically when ONU is recovered from power failure.

3） User and service management

a) Support ONU service configuration in the mode of service template, and select different templates (optional) according to Requirement. Service templates shall function in self-defining, and customized templates can be applicable to full network equipment;
b) Function to configure users or SLA parameters of each service of users, e.g., assured bandwidth, maximum bandwidth and service priority. Maximum assured bandwidth configured shall not exceed maximum system bandwidth of PON;
c) Function to configure Ethernet services of user or port, e.g., VLAN, frame filtration and Multicast;
d) Function to support management of such safety functions as frame filtration, capable of configuring frame filtration according to source MAC address, target MAC address, Ethernet type, VLAN marking, IP protocol type, source IP, target IP, L4 source port, L4 target port, DSCP (Differentiated Service Code Point), life cycle and target physical port;
e) Function to configure PON system function such as churning and optical protection switching;
f) Function in automatic update when network topology structure changes;
g) QoS management of services include traffic flow classification rule, queuing rule, priority marking method, dispatching algorithm, rate limiting parameter, etc.;
h) Support IPTV and Multicast service management: Enable/Disable of Multicast services, IGMP feature, controllable Multicast protocol configuration for China Telecom and management of relevant parameters; EMS shall also support management Requirement for Multicast services below (some for performance management):
   - Display of Multicast information: Online Multicast group, group members and status;
   - Statistics of Multicast information: Request times, total request time length and average request time length for f each Multicast group; request times, total time length and average request time length for each user port;
   - Multicast log display and storage: User port, Multicast address, status, time for entrance and exit;
   - User configuration template: Configure authorities for each user port in different Multicast groups inclusive of permission, forbiddance and preview;
   - Preview: Included are four parameters, in other words, maximum duration for single preview, times of the previews permitted, preview interval, preview reset time;
   - Pre-join group: Transmit messages to uplink port automatically to joint pre-configured Multicast group;
   - Trans-VLAN Multicast: When users and uplink ports (program sources) or users are respectively in different VLANs, users may also order Multicast program.

EMS optionally supports and monitors the following controllable Multicast information of network equipment: statistics of Multicast upstream groups; number of user online request ports; log information of user requests as counted on the basis of ports; Multicast template configuration; statistical information of Multicast as per port and group; Multicast preview parameter configuration and display; Multicast port implementation configuration; upstream group information statistics; upstream port information statistics (CDR function).

i) EDM configuration (optional): Configure and inquire about TDM service data;
j) VoIP configuration (Optional): Configure and inquire about user data such as physical address (port No.), protocol address, V5 serial number, service type and telephone number;
k) Management of broadcast suppression, etc.;
l) Function to mark various dedicated service lines, client data, etc. in network administration configuration information for rapid inquiry;
m) Support management of DHCP 60 and 82 features. The specific DHCP option82 format shall meet the requirements specified in “Code format requirements for PON system user access line (port) of CTC”

4） Resource management

EMS shall support resource management for the whole network. Mainly included are occupancy statistics and management of the equipment resources such as network elements, slots and boards, PON port, ONU/ONT and the UNI port of ONU/ONT. Provide the features of report statistics and report storage and printout.

5） Data management configuration

a) Configure data validity check: When network or equipment configuration is altered, check validity of network element configuration data:
   - Whether such configurations can be made available;

- Whether any conflict with other configurations exists;
- Whether enough authority exists;
- If any error occurs, report to user promptly and generate relevant logs.

b) Copy configuration data: Copy successfully arranged configuration data of a network element to one or more network elements of the configuration same with or similar to this network element and then modify configuration data. For example, copy configuration of an OLT or ONU and then copy it to newly added OLT or ONU. Then, modify certain attributes (including rate, etc.) and further generate services.

c) Uploading and downloading functions:

- Each network element stores relevant network element data in its control disk;
- User can obtain configuration data of network elements via certain orders to make configuration data of MES consistent with data on the network elements;
- User can also use existing data of EMS to download network element configuration information to control disk of network elements;
- EMS provides template data, and directly downloads template data to network elements or downloads it to network elements after modifying it.

6）Periodical configuration inspection

The periodical configuration inspection (every half a month or a month) for EMS (optional) compares existing configuration of equipment (especially ONUs) and previously stored backup data (or configuration data in user database) to gain the collection of configuration modifications.

### 18.2.4 Performance Management Requirement

EMS shall make available 15 minute /24-hour performance monitoring for ports on network side, PON port at the endpoint of OLT, PON port at the endpoint of ONU and ports at the endpoint of subscriber. In addition, it shall offer report statistics of historical performance data and such graphical performance analysis means as line graph, histogram and piegraph. Performance monitoring shall cover Ethernet basic performances, PON performance, environmental monitoring performance, etc. As EMS system requires, real-time monitoring of Ethernet ports shall be available, and graphical port shall be provided to display real-time variation tendency of Ethernet port rate, flow, etc. Function to inquire about historical records of system performance in view of different conditions and to store inquiry and statistics results into external files for output. Please describe details of the support to above Requirement.

1.) Real-time performance collection

Network administration system shall be able to initiate measurement of particular performance parameters for particular monitoring objects (network elements, unit disks, ports, functional blocks, etc. designated) and implement analysis and processing of measured data. The results may be displayed in broken line graph or histogram.

There are the following ways for performance parameter collection:

a) Support the two modes for collection of performance parameters (15 minute and 24-hour options);
b) Set the start and stop time for performance parameter collection;

2.) Parameters for performance monitoring;

EMS shall allow users to set, inquire about and modify the attributes of network element performance monitoring below:

a) Performance monitoring objects (network elements, unit disks, ports, channels, functional blocks, etc. designated);
b) Names of the parameters to be monitored;
c) Monitoring cycle (15 minutes or 24 hours);
d) Monitoring status (On/Off);
e) Time started;
f) Closing time;
g) Automatic reporting or not.

3.) PON port performance collection parameters

a) The statistical parameters shall include PON port performance parameters, port parameters on the network side, etc.;

- OMCIPDU frame statistics (optional);
- OAMPDU statistics (optional);
- Number of the byte packets received and sent;

- Statistics of the sizes of various frames received and sent.

b) Statistics of utilization of PON system and bandwidth of each ONU;

c) Measurement of transmission and receiving optic power (optional)

d) Performance Statistics based on GEM port (optional)
   - Number of inserted packet
   - Number of lost packet
   - Number of transmission burst
   - Number of received packet
   - Number of receiving burst
   - Number of receiving burst error

e) ONT Line Quality Statistics (Optional)
   - Number of ONT LOFI Warning
   - Number of ONT Upstream BIP Error Frame
   - Number of ONT Upstream delimitation failure Frame
   - Number of ONT Downstream BIP Error Frame

4.) Collection and monitoring of Ethernet performance parameters (optional)

The system optionally supports collection and monitoring of the following Ethernet performance parameters for ports on network side and those at the endpoint of subscriber (optional):

a) Statistics of packets of various lengths

b) Overall performance statistics
   - Unicast packets received (required)
   - Multicast packets received (required)
   - Broadcast packets received (optional)
   - Unicast packets sent (required)
   - Multicast packets sent (required)
   - Broadcast packets sent (optional)
   - PAUSE flow control frames received (optional)
   - PAUSE flow control frames sent (optional)
   - Total bytes of good packets received (required)
   - Total bytes of good packets sent (required)
   - Total bytes of bad packets received (required)
   - Total bytes of bad packets sent (required)

c) Collision and Error
   - Number of monitored event for discarded packet
   - Number of CRC error
   - Number of forwarded frame after single collision
   - Number of forwarded frame after multiple collisions
   - Graphical display of Ethernet performance monitoring (optional)

5.) Multicast service performance monitoring (optional)

Statistics of multicast VLAN packet：
   - Number of received general query packet
   - Number of received specific group query packet
   - Number of received IGMP V2 join group
   - Number of received IGMP V3 join group
   - Number of received general query error
   - Number of received join error group
   - Number of received leave group
   - Number of received leave error group
   - Number of transmitted specific group query packet
   - Number of transmitted general query packet
   - Number of transmitted IGMP V1 join group
   - Number of transmitted IGMP V2 join group
   - Number of transmitted leave group
   - Number of received IGMP V2 join error group
   - Number of received IGMP V3 join group
   - Number of transmitted IGMP V3 join group

- Number of received invalid packet

Statistics of multicast program bitrate：

- Real-time multicast bitrate

6.) Environmental monitoring

EMS shall function in monitoring such environmental parameters as temperature of equipment or particular components, fan operating status and power supply status.

7.) Performance data threshold

The system shall be able to set threshold for statistical performance data, which produces relevant alarms when such data is beyond the threshold (including limit alarm for Network administrative server processes, CPU, Memory, database state, CPU of OLT main control board, memory, ONU CPU, use of memory, and etc).

8.) Performance monitoring data reporting

Network elements shall support reporting of performance monitoring data. Reporting of such data can be conducted in accordance with relevant instructions given by MES. It's also feasible that network elements report automatically performance data within the cycle after each monitoring cycle (e.g., 15 minutes) arrives. (The former necessarily chosen and the latter optional)

EMS has performance data stored into database with performance data including:

a) Monitoring objects;
b) Monitoring attributes and the values;
c) Monitoring cycle;
d) Closing time for monitoring interval.

9.) Polling and statistics of performance data

a) The system shall be able to inquire historical records of system performance. The inquiry results can be displayed optionally in such tables and graphics as broken line graph, histogram and piegraph.
b) The system can store inquiry and statistical results into external documents for output.
c) Print out inquiry and statistical results.

10.) Performance data storage

a) Performance data is stored in EMS storage device (15 minute and 24-hour options).
   - Measured data with measurement cycle as 15 minutes: 30 days;
   - Measured data with measurement cycle as 24 hours: 60 days.
b) Set storage life and storage capacity of performance data. Prompt users to archive and delete the performance data beyond time limit or capacity.
c) Dump measured performance data to the storage media of large capacity (such as magnetic tape units) in text or table form for off-line analysis by users. (Optional)

### 18.2.5 Security Management Requirement

1） User Access Authority Management

The network administration system provides the security measures for access of Administrator/OS through defining personal access right, in order to deny the logging on of illegal users and the ones with wrong passwords. The administrators of different levels have different access right, assuring that the asker of access request can execute management operations only in his access authority. Sensitive information, authentication attributes of fixed user terminal, database and configuration data can only be processed by authorized personnel and the management system.

The system optionally supports the division of management field, allocating different resources to different management fields and managing the corresponding resource in different management fields. The authority assignment of all management operations shall be supported, and the access rights of query and configuration can be assigned respectively.

Locking User Supported. If a user input the wrong password for 3 times, the user will be locked and cannot try to log on.

User Account Rules can be customized, such as Limit of Password Length, Weak Password Policy and Password Expiration Rules, etc.

The stsem is recommended to support two levels ACL access control as following:

a) System ACL Control: manages access control of the entire network management system, all users can only log on to the network management server from specified IP address or subnet.
b) User ACL Control: manages access control of a specific user, the user can only log on to the network management server from specified IP address or subnet.

2） User Level Management

EMS shall categorize users into several levels, the users of which have different access right and high level users have higher operation access right. For instance, users can be catrgorized into the levels as below:

a) System Management. Responsible for the management of the network administration system, can control the network and set the passwords of all levels of users, add , modify, delete users and manage logs.
b) System Maintenance. Responsible for daily maintenance work of the system, can access, backup and manage the data of dabase.
c) System Operation. Responsible for service maintenance, can New or Clear users and their service configuration, deal with alarms, select configuration and manage failures.
d) System Monitoring. Can only monitor the system alam status, observe and explore all monitoring results and the access results of all reports. These operations are major in check (read.)

3） Operation Log

The operation log records all operations of users executed in the system, for preventing error operations of users. The system makes specific records for all kinds of oerations of users executed in the system.

a) The operation log shall record all operations of users including user name, operation time, oeration type. Security alarms shall be made when an illegal user logs on the network admiistration, and the attempt of unauthorized oerations will be recorded by the system log and security alarms will be made for notification.
b) The save time and amount of log files for operation, alarm, event,security and performance can be set.
c) The system can inquire and delete the oeration log according to given conditions;
d) The operation log shall be able to be backed up to peripheral storage devices.

18.2.6 Log Management

1) The log operation shall be supported, such as query and backup (Add, Delete, Modify Operations are not suitable o logs);
2) The log management shall support the management for operation log, security log and system log;
3) The operation log shall record the specific information of user operations including Log ID, Operation Level, User Name, Operation Name, Host Address, Command, Specific Information, Operation Result, Failure Reason, Access Method, Operation Objects, Start Time of Operation, End Time of Operation and Associated Log;
4) The security log can record the security events of the system, such as User Log On and Log Off (including logging on of illegal users), Change Access Authority of Users, EMS System Attacked;
5) The system log shall be able to record all system events of EMS system, including System On and Off, Software and Hardware Update, OS Failure (such as the events during system starting), Network Administration Software Failure, Hardware Failure, Load Failure of Certain Application during Booting.
6) Authority management of log operations shall be supported.

18.2.7 Policy Management

1) Two types of policies shall be supported: Timed Policy, Policy Triggered by Event.
2) User customization policy shall be supported.

18.3 ONU Remote Management

18.3.1 Implementation for Remote Management of SFU and SBU types of ONUs

SFU and SBU types of ONU shall support ONU remote management through OMCI. SFU type of ONU with VoIP can support TR-069 optionally.

18.3.2 Implementation for Remote Management of HGU type of ONUs

The remote management protocol of HGU type of ONU shall adopt OMCI and DSL Forum TR－069.

1） OMCI: The OLT as proxy of SNMP implements ONU remote management through OMCI.
2） TR-069: The remote management of ONU is implemented by ACS through TR-069. As described in 17.3.1, About the relation and work division between OAM and TR-069, WT-142 (Revision 3) shall be refered to. OAM is in charge of remote management of L2 of HGU and L2 Lower Layer function, and ACS is to implement remote management of L3 of ONU and higher level functions. The specific requirement specified for TR-069 of HGU.

18.3.3 Implementation for Remote Management of MDU and MTU types of ONUs

MDU and MTU types of ONU shall support OMCI and SNMP for remote management. OMCI implements L2 and lower layer of remote management. SNMP implements L3 and higher level of remote management.

18.4 Requirement of ONU Local Management

18.4.1 Basic Requirement

1) ONU shall maintain its local operation through the attached Ethernet User Port or Console Port;
2) The operation maintenance management of ONU shall have the functions of Configuration Management, Failure Management, Performance Management and Security Management;
3) Chinese, Web or Graphic port is recommended to be used in the management system.

Does ONU local management need to be authorized by OLT? The OLT authorizes the ONU through OMCI message. Is there the authorization mechanism?

19 Other Requirements

19.1 Environment Requirement

19.1.1 Requirement for Fiber Temperature Alternation

When the fiber between OLT and ONU is in the environment with temperature alternation of -25℃--55℃, OLT and ONU can function normally, and the service performance shall be worsened or interupted.

19.1.2 Temperature, humidity requirement

The equipment shall operate well in the condition within the following scopes, among which, OLT shall support at least Category 1, ONU shall support one of the three categories:

Category 1: Temperature: 0℃-40℃ Relative Humidity: 10%-90% (not condense)

Category 2: Temperature: -30℃-40℃ Relative Humidity: 10%-90% (not condense)

Category 3: Temperature: -10℃-55℃ Relative Humidity: 10%-90% (not condense)

Note: The temperature above is 2m above the ground and 0.4m in front of the equipment.

19.1.3 Dustproof Requirement

In the dustproof environment as below, GPON equipments shall be able to work normally:

The desity of dust whose particle diameter is more than 5μm $\leq 3\times10^4/m^3$, not electric, magnetic or erosive.

19.1.4 Atmospheric Pressure

Within the atmospheric pressure scope of 86kPa-106kPa, the equipment shall operate well, minimum 62kPa is recommended.

19.2 Power Requirement

OLT shall support DC and AC, and can work normally in a) or b) condition.

ONU shall support AC, and can function normally in b) condition. The spare battery is optionally supported.

a) Requirement for AC and its dithering range:

Nominal Voltage: -48V

Voltage Dithering: The -48V voltage tested on the DC input end allows the range of -57V— -40V.

b) Requirement for AC Voltage and its Dithering Range:

Single Phase 220V±10%,Frequency 50Hz±5%,Aberation rate of line voltage wave shall be less than 5%.

In the normal circumstance, the insulating resistance between the equipment shell and the power shall not be less than 50MΩ.

19.3 Requirement of Electric Safety

19.3.1 Insulating Resistance

In the normal circumstance, the insulating resistance shall not be less than 50MΩ.

19.3.2 Requirement for Earth Connection of Equipments

The earth connection resistance shall be less than 5Ω.

### 19.3.3 Power Interruption Notification of ONU

ONU shall have Dying Gasp by PLOAM so as to notify OLT the self power interruption event.

### 19.3.4 Over voltage and Over current Protection

Equipments shall be installed with protectors of overvoltage and overflow. The protectors of overvoltage and overflow protect the kernel part of equipments when the external power is abnormal.

Equipments shall meet the norms such as simulation lightning strike, power line induction and power line contact that required by YD/T 1082-2000.

### 19.3.5 Electromagnetic Compatibility

The electromagnetic compatibility of equipments shall conform to GB 9254-1998 and GB/T 17618-1998.