G-PON Common Technical Specification

History:

Version	Date	Object	State
1.0	12th Dec 2005	Publication of the first CTS version to vendors	First shared version
2.0	20th Jan 2006	Publication of the CTS for filling in of excel file	New version
3.0	8th Feb 2006	Publication of CTS version after filling in of excel file	Last version

INDEX

1 Scope and system configuration

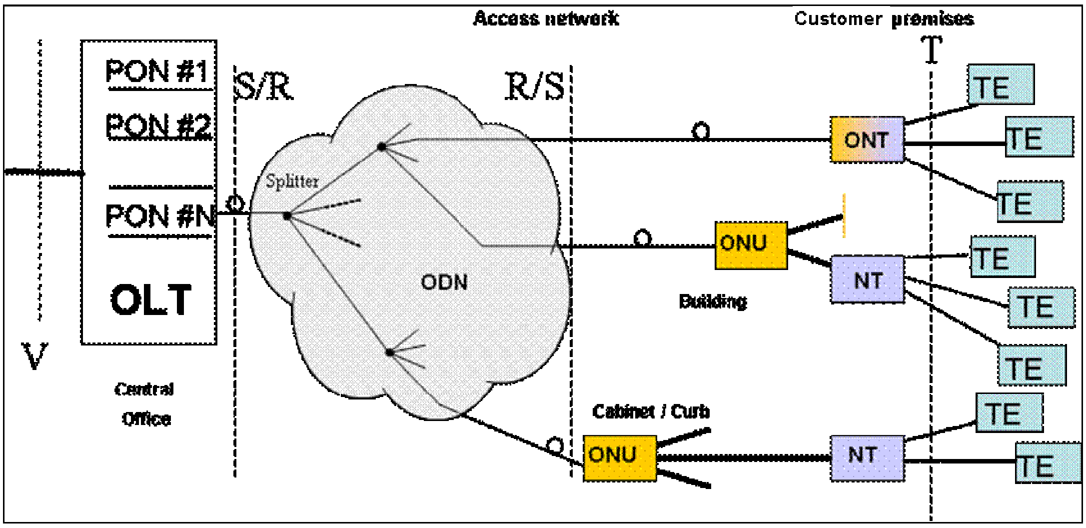
1.1 Introduction

This document describes the system specification for G-PON fiber access technology (in conformance with *ITU-T G984.x* recommendations) supporting business services and triple play service capabilities for residential with the appropriate quality of service. It covers the requirements of AT&T, BT, DT, FT, KT, NTT and TI and is opened to several physical deployment scenarios like FTTH (Fiber To The Home), FTTB (Fiber To The Building) or FTTC (Fiber To The Curb). The resulting access network will be a future proof solution for the delivery of broadband services and applications to both SMB (Small and Medium Business) and residential customers.

This CTS document has been summarized to assist vendors to implement products with common functionalities that can be offered in all the markets represented by the sponsoring operators, thereby achieving economies of scale.

1.2 System configuration

The following figure illustrates, at a high level, the system configuration for the FTTH/B/C/Cab network architectures objective of this CTS document. In essence the network termination can be either an ONT or an ONU with a VDSL2 drop (in that case a NT terminates the copper line at the user end of the link), Fast Ethernet (in that case a NT can terminate the Ethernet link at the user end of the link) and/or DS1/E1 line cards.



V: Service Network Interface (Ethernet, SDH, ATM), **OLT**: Optical Line Terminal, **ODN**: Optical Distribution Network, **ONU**: Optical Network Unit, **ONT**: Optical Network Termination, **TE**: Terminal Equipment, **PON #M**: Single optical interface at the S/R reference point

This CTS document deals with common requirements on access system defined between V and T interfaces (OLT, ODN and ONTs/ONUs). The various ONT/ONU types that are taken into consideration in this CTS document are:

- SFU (Single Family Unit): a residential ONT that does not include Home Gateway features (FTTH architecture).
- HGU (Home Gateway Unit): a residential ONT that includes Home Gateway features (FTTH architecture).

- SBU (Single Business Unit): a business ONT dedicated to a single business customer (FTTH architecture).

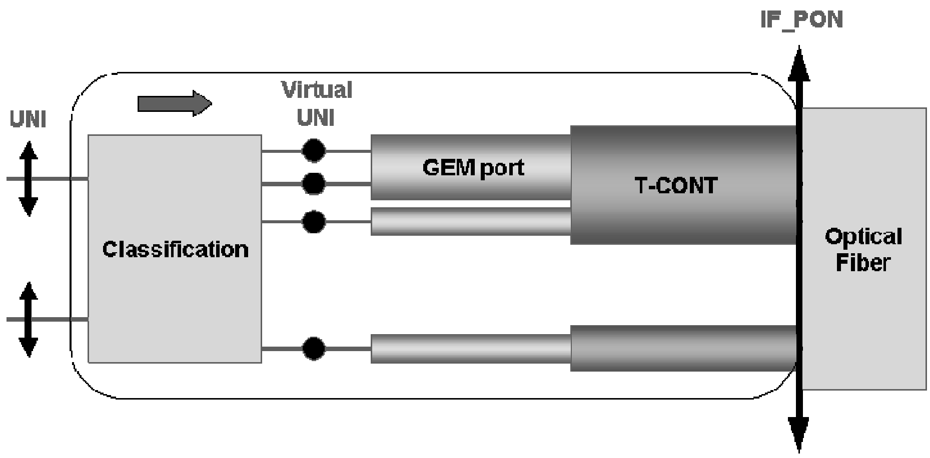
- MDU (Multi-Dwelling Unit): a multi-user residential ONU (FTTB/FTTC architecture).

- MTU (Multi-Tenant Unit): a multi-user business ONU (FTTB/FTTC architecture).

- CBU (Cellular Backhaul Unit): an ONT aiming at collecting 2G (TDM-based) and 3G (ATM-based and IP-based in the future) mobile wireless flows.

The platform over which residential and business services shall be provided has been recognized by the majority of Telco Operators to be Ethernet based, however in the short term and for facilitating the migration from present legacy services, TDM/ATM features and interfaces are specified in the CTS. (TDM not required on all ONT types that may be defined in CTS, single Ethernet for example).

The reference architecture and definitions used in the CTS document are in conformance with Figure 2 of *ITU-T G.984.1.* However, an additional notion has been defined at the ONT/ONU: the "virtual UNI". The virtual UNI is the virtual interface resulting from the classification step done at each UNI. The relation between the UNI, virtual UNI, GEM port, T-CONT and IF_PON is represented on the figure below.



2 Services: definitions and QoS requirements

The main target of this CTS document is to enable the realization of a broadband access network for multiple customer types. This section provides information on operators' QoS requirements for services.

The G-PON system uses the notion of "network connection" in order to transfer transparently the services over the access network and the application layer is never taken into consideration. A connection is defined by its type of connectivity (unicast, multicast or broadcast), its transfer direction (unidirectional or bidirectional) and its various traffic parameters summarized below in a CoS (Class of Service).

2.1 Service classification in CoS:

Each of the services supported by the G-PON is more or less tolerant to network impairments, the best solution would be to have very high performance for all, but the objective is to fill in the network capacity at its maximum since in its turn this will maximize the quantity of information to/from users, thus maximizing the exploitation of the network performance. It becomes necessary to accept an amount of degradation in the service provisioning, provided that it is confined to tolerable values, different from service to service.

Operators identified four CoS for G-PON transfer capabilities that shall be satisfied:

- **CoS4**: *Low* Delay, *Low* Jitter, *Low* PLR
- **CoS3**: *Medium* Delay, *Medium* Jitter, *Low* PLR
- **CoS2**: *Medium* Delay, *Medium* Jitter, *Medium* PLR
- **CoS1**: *High* Delay, *High* Jitter, *High* PLR (this CoS type includes Best effort traffics).

With the following QoS parameters objectives defined between the UNI and the SNI:

	Low	***Medium***	***High***
Delay	5 ms	100 ms	500 ms
Jitter	2/5 ms (DS/US)	15 ms	40 ms
PLR	10^{-6}	10^{-5}	10^{-4}

Table 1

NB: by the term "UNI", it is meant User Network Interface i.e. the interface that is directly connected to the user equipment. However note that when POTS or TDM interfaces are concerned, each required delay parameter does not include added packetization delays (i.e. the impact of the AF).

NB: by the term "SNI", it is meant Service Node Interface i.e. the interface that is directly connected to the edge node (Ethernet, SDH or ATM backhaul). Whatever is the technology, each required CoS behavior takes into account the delays introduced by all various steps before leaving the OLT to the edge node (and inversely).

NB: by the term "delay" it is meant one way latency experienced by the packet in the optical access network between UNI and SNI.

NB: by the term "jitter" it is meant the packet jitter introduced by the optical access network between SNI and UNI. Two different "Low" values have been defined for Jitter as operators have considered the impact of DBA in the upstream direction as a maximum additive value of 3ms. When DBA is not used, the "Low" jitter value is at most 2 ms in both directions.

NB: by the term "PLR" it is meant the Packet Loss Ratio introduced by the optical access network between SNI and UNI.

2.2 SLA definition

1 – The G-PON system allows the operator to define for each service of each user (that could be transferred for example in a dedicated connection like a GEM port between the IF_PON port of the ONT/ONU and the IF_PON port of the OLT) the following parameters between the UNI and the SNI: CoS level (1, 2, 3 or 4), downstream Guaranteed Bandwidth, downstream Maximum Bandwidth, upstream Guaranteed Bandwidth and upstream Maximum Bandwidth. One or several of these bandwidth values can be set to 0 and the bandwidth allocation can be either symmetric or asymmetric.

NB: The notion of "Guaranteed Bandwidth" is in conformance with *ITU-T G.983.4* i.e. the sum of "Assured Bandwidth" and "Fixed Bandwidth". In the upstream direction, as required in paragraph **4.2.2**, the operator can have the possibility to configure the Assured and Fixed Bandwidth according to the service.

NB: The notion of "Maximum Bandwidth" is in conformance with *ITU-T G.983.4* i.e. the sum of Guaranteed Bandwidth and the upper limit of Additional Bandwidth.

2 – The G-PON system allows the operator to define for each user the following parameters: downstream Guaranteed Bandwidth, downstream Maximum Bandwidth, upstream Guaranteed Bandwidth and upstream Maximum Bandwidth. One or two of these bandwidth values can be set to 0 and the bandwidth allocation can be either symmetric or asymmetric.

3 – The G-PON system allows the operator to configure each Guaranteed Bandwidth parameter with a granularity of at least 64 kbps from 0 to 1.024 Mbps, 512 kbps from 1.024 to 50,176 Mbps and 1.024 Mbps from 50.176 Mbps to the maximal bandwidth value supported by the system.

4 – The G-PON system allows the operator to configure each Maximum Bandwidth parameter with a granularity of at least 64 kbps from 0 to 1.024 Mbps, 512 kbps from 1.024 to 50.176 Mbps and 1.024 Mbps from 50.176 Mbps to the maximal bandwidth value supported by the system.

5 – The G-PON system is able to support bursty traffics coming from the user or from the backhaul network as efficiently as possible.

6 – The G-PON system supports a CAC function that aims at controlling the creation of connections to transfer services according to the SLA parameters associated to each service of each user.

7 – The CAC function allows the operator to overprovision services according to a configurable parameter per CoS.

8 – The system measures the values of the three QoS parameters (Delay, Jitter and PLR) per CoS. The results of the measures are guaranteed with a ±10% margin of error. It is possible to configure the sampling period of this measure through the management system.

9 – The system is able to measure the values of the three QoS parameters (Delay, Jitter and PLR) per service of each user (for example when business users are concerned). The results of the measures are guaranteed with a ±10% margin of error. It is possible to configure the sampling period of this measure through the management system.

10 – The system allows the operator to measure the values of the bandwidth parameters defined in the SLA per service of each user. The results of the measures are guaranteed with a ±10% margin of error. It is possible to configure the sampling period of this measure through the management system.

NB: See paragraph **11.3** for requirements about OAM (Connectivity check, Loopback, Performance monitoring…).

3 ODN

The ODN provides the optical transmission medium for the physical connection of the ONTs/ONUs to the OLT. It consists of the following passive optical elements: single mode optical fibers, optical connectors, splitters, jumpers and splices.

3.1 Optical fibers and connectors

11 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction).

12 – Transmission is done on *ITU-T G.652* fiber performances (including chromatic dispersion and attenuation characteristics).

13 – The maximum physical reach (in conformance with *ITU-T G.984.1*) is 20 km.

3.2 Protection

The ODN could be realized foreseeing both a main link between the OLT and the ONT/ONU and an alternative path with the target to realize a network with the required reliability, using the methods in conformance with *ITU-T G.983.5*. Protection should be possible on per ONT/ONU basis, as there is no need to protect all the OLT-ONT/ONU links.

14 – Type C configuration protection. This configuration requires a fully duplicated optical path between the protected ONT/ONU and the OLT and duplicated optical interfaces in the OLT and in the protected ONT/ONU.

15 – Both OLT and ONT/ONU are able to support functionalities allowing the switching between the main and the backup optical link, overcoming failure in the OLT-ODN-ONT/ONU.

4 OLT

4.1 General requirements

The OLT is seen as a single network element which interfaces the aggregation network to the access one. However it consists in a number of network elements, feeding several ODNs, performing switching functionalities between access and core interfaces, and managing all the access devices (ONTs/ONUs) connected to it.

4.1.1 Physical level

16 – The OLT shelf is provided with multiple PON cards.

17 – A single IF_PON port of the OLT is able to manage multiple ONx types (single-user/multi-user, residential/business, FTTH/FTTB…).

18 – The OLT is able to manage up to 64 ONTs/ONUs per IF_PON port.

19 – The OLT is able to manage up to 128 ONTs/ONUs per IF_PON port.

4.1.2 Transfer/forwarding

20 – The OLT is able to aggregate users' flows with an allocation of network resources on a per service basis according to traffic and QoS parameters.

21 – The OLT is able to achieve scheduling and priorization of services using mechanisms based on traffic and QoS parameters.

22 – The OLT is able to allow overprovisioning of network resources during services provisioning.

23 – The OLT is able to handle network congestion using mechanisms allowing a fair allocation of network resources for similar CoS.

24 – The OLT inhibits local Ethernet switching between ONTs/ONUs.

25 – The OLT allows local ATM switching between ONTs/ONUs.

4.1.3 Synchronization

26 – The OLT is able to recover the timing signal from a redundant external synchronization interface (BITS interface) of 2048 kHz in conformance with *ITU-T G.703* and *G.823*.

27 – The OLT is able to recover the timing signal from a redundant external synchronization interface (BITS interface) in conformance with GR-1244-CORE and Line Timing in conformance with GR-253-CORE.

28 –The OLT is able to recover the timing signal from a redundant external synchronization interface (BITS interface) of 64 kHz + 8 kHz or 64 kHz + 8 kHz + 400 Hz clock.

29 – The OLT is able to recover the timing signal from any selected synchronous interface (STM-1, OC-3...). The SSM byte information is used at the SNI. As far as jitter and wander specifications are concerned, STM-1 interfaces comply with *ITU-T G.825* and *G.813*.

30 –The OLT is able to recover the timing signal from an Ethernet-based SNI following *ITU-T contribution 2005/05 D197* ("Transporting synchronization over Ethernet").

31 – The OLT is able to use a free run clock with 20 ppm accuracy (only when all other available input clocks are lost).

32 – The OLT is able to switch the reference clock source from one source to another one. The choice of the active source is ruled by a configurable priority level scheme. This switching is hitless for the traffic.

33 – Revertive mode with waiting time to restore and forced switching on a valid synchronization source is possible. The switching is hitless for the traffic.

4.1.4 Redundancy

34 – Some parts of the OLT are completely redundant and there does not exist a single point of failure (power supply, card…). When a working card is identified as failed, it is automatically switched to the standby card in duplicated configurations.

35 – For systems supporting PON interface protection, optical G-PON termination is fully redundant in conformance with the C protection scheme of *ITU-T G.983.5*.

36 – For systems supporting PON interface protection, extra traffic option of *ITU-T G.983.5* is supported.

37 – NT equipment protection switching 1+1 revertive and not revertive modes are supported.

38 – NT equipment protection switching 1:n revertive (n = max 8) mode is supported.

4.2 PON cards

39 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

40 – The OLT supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

41 – The OLT permits hot swappable insertion of additional IF_PON extension cards.

42 – Insertion or extraction of a card in a shelf does not affect the correct operation of other cards in the same shelf.

4.2.1 Line code

43 – The OLT uses NRZ coding and scrambling in both directions.

4.2.2 G-PON Transmission Convergence

44 – The PON card supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

45 – The PON card realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

46 – The PON card realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

47 – The PON card realizes the mapping of TDM data into GEM frames (and inversely extracts TDM data from GEM frames) in conformance with *ITU-T G.984.3 Appendix I.2*.

48 – The PON card realizes the mapping of ATM cells into GTC payload (and inversely extracts ATM cells from GTC payload) in conformance with *ITU-T G.984.3*.

49 – The PON card implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction.

- **Option 1: Single T-CONT per ONT/ONU**

  50 – The PON card is able to support a single T-CONT per ONT/ONU whatever is the number of users connected at the ONT/ONU.

- **Option 2: Single T-CONT per user**

  51 – The PON card is able to support a single T-CONT per user at the ONT/ONU.

- **Option 3: Multiple T-CONTs per ONT**

  52 – The PON card is able to support at least 4 T-CONTs per termination (single or multi-user) i.e. 1 T-CONT per CoS per ONT/ONU (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

- **Option 4: Multiple T-CONTs per user**

  53 – The PON card is able to support at least 1 T-CONT per CoS per user whatever is the number of users per termination (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

54 – The PON card is able to use a static allocation in order to provision the configurable upstream Fixed Bandwidth part of the upstream Guaranteed Bandwidth of each T-CONT.

55 - The PON card is able to connect a NSR-ONT/ONU in conformance with *ITU-T G.984.3*.

56 – The PON card is able to use a DBA function in order to optimize bandwidth allocation between ONTs/ONUs when needed by taking into account the configurable upstream Guaranteed Bandwidth (note the DBA only takes into account the Assured Bandwidth) and upstream Maximum bandwidth of each T-CONT.

57 – The PON card is able to use a DBA function in order to optimize bandwidth allocation between ONTs/ONUs when needed by taking into account the configurable upstream Guaranteed Bandwidth (note the DBA only takes into account the Assured Bandwidth) and upstream Maximum bandwidth of each user.

58 The PON card is able to connect a SR-ONT/ONU in conformance with *ITU-T G.984.3*.

59 The PON card supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

60 – The PON card is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

61 – The PON card is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

62 – The PON card uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

63 – The PON card implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

4.2.3 Upstream

Nominal line rate:

64 – The PON card supports a 1244 Mbps upstream line rate.

Optical performances:

65 – The PON card supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

66 – The PON card supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

67 – The PON card is able to support upstream FEC.

4.2.4 Downstream

Nominal line rate:

68 – The PON card supports a 2488 Mbps downstream line rate.

Optical performances:

69 – The PON card supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

70 – The PON card supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *G.984.2 Amd1*.

71 – The PON card is able to support downstream FEC.

4.2.5 RF video option

72 – The PON card supports the video overlay optical budget in conformance with *ITU-T G.984.2 Amd1*.

4.3 Ethernet/IP part

4.3.1 SNI

73 – The OLT provides at least four GbE interfaces in conformance with *IEEE 802.3z*.

74 – The OLT is able to provide a hardware redundancy for the four GbE interfaces.

75 – The OLT provides at least one 10GbE interface in conformance with *IEEE 802.3ae*.

76 – The OLT is able to provide a hardware redundancy for the 10GbE interface.

77 – Each Ethernet SNI supports by default auto-negotiation.

78 – For each Ethernet SNI, it is possible to configure manually duplex mode as half or full.

79 – All SNI interfaces are pluggable on the OLT.

80 – Insertion or extraction of an Ethernet SNI card in a shelf does not affect the correct operation of other cards in the same shelf.

NB: Protection functions of the SNIs are described in paragraph **4.3.7** (Link Aggregation when single attachment is considered or STP when double attachment is considered).

4.3.2 Quality of service

81 – The OLT deals with at least four separate classes of service (as defined in paragraph **2**).

82 – The OLT is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

83 – The OLT allows the operator to configure one or several "*OLT CoS parameter(s)*".

84 – For each S-VLAN, [S-VLAN, C-VLAN] pair or C-VLAN (when dual stack is not used), the OLT allows the operator to configure the 802.1ad priority field of the "Outer VLAN Tag" as the corresponding "*OLT CoS parameter*".

85 – For each S-VLAN, [S-VLAN, C-VLAN] pair or C-VLAN (when dual stack is not used), the OLT allows the operator to configure the ToS/DSCP field as the corresponding "*OLT CoS parameter*".

Scheduling (possibly with congestion avoidance):

86 – The OLT uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the ONT/ONU level).

87 – The scheduling features take into account the "*OLT CoS parameter*" in order to differentiate the flows and give priority to some flows.

88 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

89 – The OLT allows the operator to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

90 – The traffic is put into different queues according to the type of CoS. As four different CoS have been defined, there are at least four queues before each potential congestion point.

91 – For each user (i.e. for each device if an ONT is used or for each UNI if a MDU/MTU is used), there are counters of forwarded frames and counters of dropped frames due to queue congestion.

92 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

93 – For each service of each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

94 – For each SNI, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

95 – For each IF_PON, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

Conformity of the flows with the SLAs:

96 – The OLT verifies the conformity of the downstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

97 – The OLT verifies the conformity of the downstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

98 – The OLT verifies the conformity of the downstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

99 – The OLT verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (DBA…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

100 – The OLT verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (DBA…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

101 – The OLT verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (DBA…). This feature is implemented by trying to optimize the throughput when the traffic is susceptible to be bursty.

102 – If policing/shaping is used, this functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the traffic as a result of the metering.

103 – For each user (i.e. per device if an ONT is used or per UNI if a MDU/MTU is used), the OLT supports forwarded, discarded and remarked frames counters.

104 – For each CoS, the OLT supports forwarded, discarded and remarked frames counters.

105 – For each service of each user, the OLT supports forwarded, discarded and remarked frames counters.

4.3.3 Filtering/Transparency

106 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames.

107 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream BPDU frames.

108 – For each SNI Ethernet (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream BPDU frames on an 802.1ad S-VLAN ID basis.

109 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream BPDU frames on an 802.1ad C-VLAN ID basis.

110 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream BPDU frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

111 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream BPDU frames.

112 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream BPDU frames on an 802.1ad S-VLAN ID basis.

113 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream BPDU frames on an 802.1ad C-VLAN ID basis.

114 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream BPDU frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

115 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream broadcast frames.

116 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream broadcast frames on an 802.1ad S-VLAN ID basis.

117 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream broadcast frames on an 802.1ad C-VLAN ID basis.

118 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream broadcast frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

119 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream broadcast frames.

120 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream broadcast frames on an 802.1ad S-VLAN ID basis.

121 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream broadcast frames on an 802.1ad C-VLAN ID basis.

122 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream broadcast frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

123 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination MAC address criteria.

124 – For each 802.1ad S-VLAN ID of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination MAC address criteria.

125 – For each 802.1ad C-VLAN ID of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination MAC address criteria.

126 – For each 802.1ad [S-VLAN ID, C-VLAN ID] pair of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination MAC address criteria.

127 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific 802.1ad S-VLAN ID value(s).

128 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific 802.1ad C-VLAN ID value(s).

129 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific 802.1ad [S-VLAN ID, C-VLAN ID] pair value(s).

130 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames without double VLAN tags.

131 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames without a single VLAN tag.

132 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream VLAN untagged frames.

133 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream multicast frames.

134 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream multicast frames on an 802.1ad S-VLAN ID basis.

135 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream multicast frames on an 802.1ad C-VLAN ID basis.

136 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream multicast frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

137 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream multicast frames.

138 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream multicast frames on an 802.1ad S-VLAN ID basis.

139 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream multicast frames on an 802.1ad C-VLAN ID basis.

140 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to be transparent to downstream multicast frames on an 802.1ad [S-VLAN, C-VLAN] pair basis.

141 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

142 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific Ethertype value(s) on an 802.1ad S-VLAN ID basis. At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

143 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific Ethertype value(s) on an 802.1ad C-VLAN ID basis. At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

144 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames with specific Ethertype value(s) on an 802.1ad [S-VLAN, C-VLAN] pair basis. At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

145 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination IP address criteria.

146 – For each 802.1ad S-VLAN of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination IP address criteria.

147 – For each 802.1ad C-VLAN of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination IP address criteria.

148 – For 802.1ad [S-VLAN, C-VLAN] pair of each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to filter downstream frames on source/destination IP address criteria.

149 – For each source virtual UNI, the OLT is able to filter upstream frames.

150 – For each source virtual UNI, the OLT is able to filter upstream BPDU frames.

151 – For each source virtual UNI, the OLT is able to be transparent to upstream BPDU frames.

152 – For each source virtual UNI, the OLT is able to filter upstream broadcast frames.

153 – For each source virtual UNI, the OLT is able to be transparent to upstream broadcast frames.

154 – For each source virtual UNI, the OLT is able to filter upstream frames on source/destination MAC address criteria.

155 – For each source virtual UNI, the OLT is able to filter upstream frames with specific VLAN ID value(s).

156 – For each source virtual UNI, the OLT is able to filter upstream VLAN untagged frames.

157 – For each source virtual UNI, the OLT is able to filter upstream multicast frames.

158 – For each source virtual UNI, the OLT is able to be transparent to upstream multicast frames.

159 – For each source virtual UNI, the OLT is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

160 – For each source virtual UNI, the OLT is able to filter upstream frames on source/destination IP address criteria.

161 – The OLT permits IPSec pass-through.

162 – The OLT permits GRE pass-through.

163 – The OLT permits L2TP pass-through.

164 – The OLT permits PPTP pass-through.

4.3.4 Traffic limitation

165 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream broadcast frames.

166 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream broadcast frames on an 802.1ad S-VLAN ID basis.

167 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream broadcast frames on an 802.1ad C-VLAN ID basis.

168 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream broadcast frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

169 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream multicast frames.

170 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream multicast frames on an 802.1ad S-VLAN ID basis.

171 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream multicast frames on an 802.1ad C-VLAN ID basis.

172 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to limit the rate of downstream multicast frames on an 802.1ad [S-VLAN ID, C-VLAN ID] pair basis.

4.3.5 VLAN remarking and (de)stacking

173 – The OLT is S-VLAN/C-VLAN aware in conformance with *IEEE 802.1ad*.

174 – The OLT provides full functionalities and support of VLAN ID numbering from 0 through 4095.

175 – It is possible to re-use the same S-VLAN ID between several Ethernet SNIs or PON card of the OLT.

176 – It is possible to re-use the same C-VLAN ID between several Ethernet SNIs or PON card of the OLT.

177 – It is possible to re-use the same [S-VLAN ID, C-VLAN ID] pair between several Ethernet SNIs or PON cards of the OLT.

Remarking:

178 – For each source virtual UNI, the OLT is able to remark VLAN ID to upstream VLAN-tagged (added by the ONT/ONU or corresponding to the preserved 802.1Q VLAN-tagged added by the user) frames.

179 – For each source virtual UNI, the OLT is able to remark 802.1D user priority field to upstream Layer 2 priority-tagged frames.

180 – For each source virtual UNI, the OLT is able to automatically remark 802.1D user priority field to upstream Layer 2 priority-tagged frames according to the CoS corresponding to this GEM port.

181 – For each destination virtual UNI, the OLT is able to remark 802.1ad C-VLAN ID to downstream frames.

182 – For each destination virtual UNI, the OLT is able to remark 802.1ad C-Tag priority field to downstream frames.

183 – For each destination virtual UNI, the OLT is able to automatically remark 802.1ad C-Tag priority field to downstream frames according to the CoS corresponding to the destination GEM port of the frames.

(De)Stacking:

184 – For each source virtual UNI, the OLT is able to attach a S-Tag to upstream untagged frames. The S-VLAN ID and S-Tag priority are configurable

185 – For each source virtual UNI, the OLT is able to attach a S-Tag and C-tag to upstream untagged frames. The C-VLAN ID, C-Tag priority, S-VLAN ID and S-Tag priority are configurable.

186 – For each source virtual UNI, the OLT is able to attach a S-Tag to upstream C-tagged (the 802.1Q tag value is preserved as the C-Tag) frames.

187 – For each source virtual UNI, the OLT is able to remove VLAN tag to upstream C-VLAN-tagged frames.

188 – For each destination virtual UNI, the OLT removes the S-Tag from downstream frames received from the Ethernet SNIs before sending them to this GEM port.

189 – For each destination virtual UNI, the OLT is able to remove both S-Tag and C-Tag from downstream frames received from the Ethernet SNIs before sending them to this GEM port.

190 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

191 – For each GEM port, the OLT allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

192 – For each virtual UNI the OLT is able to allow the operator to indicate whether to copy the 802.1D user priority field of the 802.1Q tag to the S-Tag or use configurable priority for the S-Tag.

193 – For each virtual UNI port, the OLT is able to allow the operator to indicate a list of C-VLAN IDs, denoted as the port's VLAN "membership list", that are acceptable for this virtual port. In this case, the OLT is able to discard any frame received from a port with non-compliant C-VLAN ID.

194 – For each virtual UNI port, the OLT is able to allow the operator to configure a VLAN replacement table consisting of an entry for each VLAN in the virtual port's VLAN "membership list". This table can be used for indicating a S-VLAN ID to replace the GEM port's C-VLAN ID, if the C-Tag needs to be replaced with a S-Tag. This table can be used for indicating both a C-VLAN ID and a S-VLAN ID, if the C-VLAN ID coming from the IF_PON has to be overwritten and the frame needs also S-Tag attachment.

195 – For each virtual UNI, the OLT is able to allow the operator to indicate whether to accept (i.e. forward ‘as is’) the received VLAN priority markings or rewrite the priority to a configurable value.

196 – The OLT allows the operator to configure each port to receive priority-tagged frames.

197 – The OLT is able to assign the same S-VLAN ID to a configurable group of virtual UNIs of various IF_PONs. This paradigm is denoted *N:1 VLAN* to indicate many-to-one mapping between ports and VLAN.

198 – The OLT is able to assign a unique VLAN identification to each virtual UNI of each IF_PON using either a unique S-VLAN ID or a unique [S-VLAN ID, C-VLAN ID] pair. The uniqueness of the S-VLAN ID is maintained in the aggregation network. This paradigm is denoted *1:1 VLAN* to indicate a one-to-one mapping between a virtual UNI of an IF_PON and a VLAN.

4.3.6 ToS/DSCP

199 – For each flow coming from a source virtual UNI, the OLT is able to mark ToS/DSCP tag to upstream L3 priority-untagged packets.

200 – For each flow going to a source virtual UNI, the OLT is able to mark ToS/DSCP tag to upstream L3 priority-untagged packets.

201 – For each flow coming from a source virtual UNI, the OLT is able to remark ToS/DSCP tag to upstream L3 priority-tagged packets.

202 – For each flow coming from a source virtual UNI, the OLT is able to automatically mark ToS/DSCP tag to upstream L3 priority-untagged packets according to the CoS corresponding to this GEM port.

203 – For each flow coming from a source virtual UNI, the OLT is able to automatically remark ToS/DSCP tag to upstream L3 priority-tagged packets according to the CoS corresponding to this GEM port.

204 – For each flow going to a destination virtual UNI, the OLT is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

205 – For each flow going to a destination virtual UNI, the OLT is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

206 – For each flow going to a destination virtual UNI, the OLT is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to this GEM destination port.

207 – For each flow going to a destination virtual UNI, the OLT is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to this destination GEM port.

4.3.7 Forwarding

208 – The OLT is able to permit legal interception by duplicating an upstream or downstream flow on a Port-ID basis. This flow is forwarded to any SNI with or without adding a configurable [S-VLAN tag, C-VLAN tag] pair or only a S-VLAN tag.

209 – For each GEM port, the OLT is able to forward the flows coming from this GEM port or going to this GEM port according to either a 1:1 (one VLAN per user) or N:1 (one VLAN per service) model.

1:1 model:

210 – For each GEM port configured in a 1:1 forwarding model, the OLT disables address learning in order to have a simple cross-connection.

211 – For each GEM port configured in a 1:1 forwarding model, the OLT is able to forward Ethernet frames according to a cross-connection between a S-VLAN and this GEM port.

212 – For each GEM port configured in a 1:1 forwarding model, the OLT is able to forward Ethernet frames according to a cross-connection between a C-VLAN and a GEM port.

213 – For each GEM port configured in a 1:1 forwarding model, the OLT is able to forward Ethernet frames according to a cross-connection between a [S-VLAN, C-VLAN] pair and a GEM port.

N:1 model:

214 – For each destination GEM port configured in a N:1 forwarding model, the OLT is able to forward the downstream flows going to this GEM port according to a combination of an *IEEE 802.1ad* forwarding (Provider Bridge with auto-learning of MAC addresses) and the use of the corresponding "*OLT CoS parameter*". Consequently, each downstream flow is identified and forwarded to a single GEM port according to a [destination address, OLT CoS parameter] pair.

215 – For each source GEM port configured in a N:1 forwarding model, the OLT is able to forward the upstream flows coming from this GEM port in conformance with an *IEEE 802.1ad* forwarding (Provider bridge with auto-learning of MAC addresses).

216 – For each VLAN instance, the OLT allows the operator to configure the FDB aging time.

217 – The OLT allows the operator to configure static MAC addresses in the FDB.

218 – The OLT allows the operator to read the FDB.

219 – The OLT allows the operator to flush the FDB.

220 – The OLT allows the operator to delete some MAC addresses from the FDB.

221 – The OLT supports IVL (Independent VLAN learning).

222 – The OLT is able to work in IVL (Independent VLAN learning) mode for a configurable group of VLANs.

223 – The OLT supports SVL (Shared VLAN learning).

224 – The OLT is able to work in SVL (Shared VLAN learning) mode for a configurable group of VLANs.

225 – The OLT is able to limit the number of MAC addresses learned per GEM port.

226 – The OLT is able to limit the number of MAC addresses learned per S-VLAN.

227 – The OLT is able to limit the number of MAC addresses learned per C-VLAN.

228 – The OLT is able to limit the number of MAC addresses learned per [S-VLAN, C-VLAN] pair.

229 – The OLT is able to limit the number of MAC addresses learned per device.

230 – For each GEM port, the OLT is able to forward Ethernet frames according to a N:1 model by preventing forwarding traffic between GEM ports on various IF_PONs (forced forwarding rule).

Flow control:

231 – For each Ethernet SNI (or for each LAG when Link Aggregation is used), the OLT is able to support "Flow Control" with PAUSE functionality in conformance with *IEEE 802.3 Annex 31*.

Link Aggregation:

232 – At the Ethernet SNIs, the OLT supports Link Aggregation in conformance with *IEEE 802.3ad* for link resiliency reasons.

233 – At the Ethernet SNIs, the OLT supports Link Aggregation in conformance with *IEEE 802.3ad* for load balancing reasons. Load balancing is programmable and uses algorithms based on MAC addresses, VLAN IDs…

234 – It is possible to distribute 802.3ad aggregated links on different Ethernet SNI boards or subracks.

235 – It is possible to have an 802.3ad LAG (Link Aggregation Group) with any number of Ethernet ports between 1 and the maximum number of Ethernet ports per trunk.

Spanning Tree:

236 – At the Ethernet SNIs, the OLT is able to perform Rapid Spanning tree in conformance with *IEEE 802.1w*.

237 – The OLT supports only one Rapid Spanning Tree instance on all physical ports of the bridge at any given time.

238 – The OLT supports several Rapid Spanning Tree instances on all physical ports of the bridge at any given time (Multiple RSTP).

239 – Rapid Spanning Tree runs in the core with no interaction with any type of possible user BPDU frames.

240 – The OLT allows the operator to configure the Bridge priority per domain.

241 – The OLT allows the operator to configure the Port path cost per domain.

242 – The OLT allows the operator to monitor the Rapid Spanning Tree topology.

4.3.8 L2/L3 security considerations (when N:1 model is considered)

Theft of service:

243 – The OLT provides a mechanism to prevent user IP address spoofing.

244 – For each GEM port, the OLT is able to use a DHCP snooping function in order to build a correspondence table between each GEM port and the allocated IP address(es) that has (have) been snooped.

245 – For each source GEM port, the OLT is able to block upstream traffic by using an IP spoofing prevention feature where upstream traffic is filtered to ensure that a client is not able to send traffic with an IP address not currently assigned to the GEM port where this packet comes from.

246 – For each GEM port, the OLT is able to use a PPPoE snooping function in order to build a correspondence table between each GEM port and the allocated PPPoE_Session_ID(s) that has (have) been snooped.

247 – For each source GEM port, the OLT is able to block upstream traffic by using a PPPoE session spoofing prevention feature where upstream traffic is filtered to ensure that a client is not able to send traffic with a PPPoE_Session_ID not currently assigned to the GEM port where this packet comes from.

Denial of service:

248 – The OLT provides a mechanism to prevent user MAC address spoofing.

249 – The OLT avoids DoS threats via MAC address duplication.

250 – The OLT allows the operator to configure a virtual MAC address for this device that is used to hide users' MAC addresses to the aggregation node for FDB scalability reasons.

4.3.9 802.1x

251 – The OLT is able to support a part of the functions of an Authenticator in conformance with *IEEE 802.1x* and the other part is implemented at the ONT/ONU. The particularity of a P2MP system is that access control and filtering/blocking of upstream traffic is not mandatory at the OLT ports. It's rather the ONT/ONU that needs to filter/block upstream flows at one or several of its physical/virtual UNIs. Note that this feature is never used for a POTS UNI.

252 – For enhanced security purpose, the OLT is also able to filter/block upstream flows at one or several of its GEM ports.

253 – The OLT is able to run one 802.1x connection per ONT/ONU.

254 – The OLT is able to run several 802.1x connections simultaneously per ONT/ONU (one per physical UNI or configurable groups of physical UNIs).

255 – The OLT is able to run several 802.1x connections simultaneously per ONT/ONU (one per virtual UNI or configurable groups of virtual UNIs).

256 – The physical/virtual UNI(s) at the ONT/ONU remain(s) in the 802.1x unauthorized state as long as the user is not successfully authenticated. Only EAPoL frames are accepted by the ONT/ONU and transmitted to the OLT.

257 – The GEM port(s) at the OLT remain(s) in in the 802.1x unauthorized state as long as the user is not successfully authenticated. Only EAPoL frames are accepted by the OLT and transmitted to the SNI.

258 – When the user is authenticated, the OLT sends an OMCI message to inform the ONT/ONU just after the EAP-Success reception, the corresponding physical/virtual UNI(s) of this ONT/ONU is (are) administratively "UP" and allowed flows are transferred from the physical/virtual UNI(s) to the OLT.

259 – When the user is authenticated, the OLT sets the corresponding GEM port(s) as administratively "UP" just after the EAP-Success reception and allowed flows are transferred from the OLT's IF_PON port to the SNI.

260 – The OLT is able to force disconnection i.e. the Authenticator is able to switch the controlled port to "DOWN" state in conformance with *IEEE 802.1x*.

261 – The OLT is able to force reauthentication i.e. the Authenticator is able to send specific messages to the supplicant (in order to trigger new EAPoL messages exchange).

4.3.10 Radius

262 – The OLT supports a Radius client in conformance with *IETF RFC 286*5.

263 – The Radius client relies on a configuration file that potentially describes standard and Vendor-Specific Radius Attributes in conformance with *IETF RFC 286*5, *RFC 2867*, *RFC 2868*, *RFC 2869* and *RFC 3576*.

264 – For each GEM port, the OLT is able to add the "Client Circuit Identifier" into the Radius attributes 31 and/or 87.

265 – The OLT can be managed by RADIUS protocol. It is able to execute some specific local actions upon receiving standard or vendor-specific Radius AVP values. For example, the following actions could be configured for each GEM port: forwarding model (N:1 or 1:1), access control, VLAN remarking/(de)stacking, ToS/DSCP (re)marking, downstream policing/shaping parameters, upstream static/dynamic bandwidth allocation, filtering/transparency/traffic limitation parameters, Multicast.

266 – After receiving standard or vendor-specific Radius AVP values, the OLT is able to send specific OMCI messages in order to force the ONT/ONU to execute some specific local actions. For example, the following actions could be configured at the ONT/ONU for each user or physical/virtual UNI(s): Access control, VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency, Multicast.

267 – The OLT supports Radius accounting compliant to *IETF RFC 2866*. At least, the duration, volume and number of connection attempts parameters are taken into account.

268 – The OLT is able to manage "Layer 2 user sessions".

269 – The OLT is able to manage "Layer 3 user sessions".

270 – The OLT is able to periodically verify the connectivity of the user session.

271 – The OLT is able to generate an accounting ticket (Accounting Start) at the beginning of a user session.

272 – The OLT is able to generate an accounting ticket (Accounting Interim) at intermediate events (duration between two interims must be configured in the OLT for each user session).

273 – The OLT is able to detect the end of the session: expiration of session timeout provided by RADIUS or configured statically, disconnect message provided by RADIUS, detection of user's disconnection, detection of loss of connection.

274 – When OLT detects the end of the session, it is able to generate an accounting ticket (Accounting Stop).

275 – The OLT is able to generate an accounting ticket (Accounting Stop) after reception of a Radius 27 Session-Timeout message.

276 – Several RADIUS servers can be configured in the OLT in order to manage differently authentication and accounting. For each GEM port, the OLT allows the operator to configure the corresponding Radius server.

4.3.11 User identification and characterization (when N:1 model is considered)

277 – When performing the function of a Relay the OLT only supports PPPoE sessions.

278 – When performing the function of a Relay the OLT only supports DHCP sessions ("Layer 3" user sessions as defined in paragraph **4.3.10**).

279 – When performing the function of a Relay the OLT is able to support multiple PPPoE and DHCPsessions ("Layer 3" user session as defined in paragraph **4.3.10**) but not in the same GEM port.

280 – When performing the function of a Relay the OLT is able to support multiple PPPoE and DHCP sessions ("Layer 3" user session as defined in paragraph **4.3.10**) per GEM port.

DHCP Relay Agent:

281 – For each GEM port, the OLT is able to function as a Layer 2 DHCP Relay Agent (Option 82) function in conformance with *Appendix D of DSL Forum WT-101 Revision 9*.

282 – For each GEM port, the Layer 2 DHCP Relay Agent is able to relay requests to different DHCP servers according to 802.1ad S-VLAN.

283 – For each GEM port, the Layer 2 DHCP Relay Agent is able to relay requests to different DHCP servers according to 802.1ad C-VLAN.

284 – For each GEM port, the Layer 2 DHCP Relay Agent is able to relay requests to different DHCP servers according to 802.1ad [S-VLAN, C-VLAN] pair.

285 – The Layer 2 DHCP Relay Agent is able to relay packets with option 82 already filled in.

286 – The Layer 2 DHCP Relay Agent is able to add information into an already filled in option 82.

287 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, adds Option 82 with the "*circuit-id*" and/or *"remote-id*" sub-options to the DHCP request from the client before forwarding to the aggregation node. The formats of the "*circuit-id*" and "*remote-id*" suboptions are configurable per GEM port.

288 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, removes Option 82 on the DHCP reply message received from the aggregation node before forwarding to the GEM port.

289 – A server-originated broadcast DHCP packet is not bridged to selected GEM ports by an OLT except through the action of the Layer 2 Relay Agent. Through examination of Option 82 and/or the "*chaddr*" field, the Layer 2 DHCP Relay Agent transmits these packets, after removal of Option 82, only to the selected GEM port for which it is intended. In this mode, the OLT does not use MAC address to forward flows.

290 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, does not convert the DHCP request coming from a GEM port from a broadcast to a unicast packet.

291 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, does not set the "*giaddr*" on the DHCP request coming from the GEM port.

292 – The OLT spies all DHCP traffic, when performing the function of a Layer 2 DHCP Relay Agent, and filters out any DISCOVER and REQUEST packets from the "Client Circuit" designed to spoof relayed packets. This would include packets with nonzero "*giaddr*" and REQUEST packets with zero "*ciaddr*". This requirement refers to both unicast and broadcast DHCP packets.

293 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, discards any broadcast or unicast DHCP request packet containing an Option 82 that enters from a GEM port.

294 – The OLT, when performing the function of a Layer 2 DHCP Relay Agent, is able to only forward DHCP requests to the upstream designated Ethernet SNI to prevent flooding or spoofing.

295 – For each GEM port, the Layer 2 DHCP Relay Agent is able to encode the "Client Circuit Identifier" (access loop identification) in the "*Agent Circuit ID*" sub-option (sub-option 1). The encoding uniquely identifies the OLT and the GEM port on the OLT on which the DHCP message was received. The "*Agent Circuit ID*" contains a locally administered ASCII string generated by the OLT, representing the corresponding "Client Circuit Identifier" (GEM port).

296 – For each GEM port, the Layer 2 DHCP Relay Agent is able to use the "*Agent Remote ID*" sub-option (sub-option 2) to further refine the "Client Circuit Identifier" (access loop logical port identification). The "*Agent Remote ID*" contains an operator-configured string of 63 characters maximum that (at least) uniquely identifies the user on the associated GEM port on the OLT on which the DHCP discovery message was received.

297 – For each GEM port, the Layer 2 DHCP Relay Agent option 82 is able to snoop upstream unicast DHCP messages.

PPPoE Intermediate Agent

298 – For each GEM port, the OLT is able to provide a PPPoE Intermediate Agent function in conformance with *DSL Forum WT-101 Revision 9*.

299 – The OLT supports the PPPoE "Client Circuit Identifier" (access loop identification tag) in conformance with *DSL Forum WT-101 Revision 9*. For each GEM port, the OLT is able to insert a PPPoE TAG. The OLT uses PPPoE TAG "*Circuit-ID*" and "*Remote-ID*" suboptions.

300 – For each GEM port, the OLT is able to encode the "Client Circuit Identifier" (access loop identification) in the "*Agent Circuit ID*" sub-option (sub-option 1). The encoding uniquely identifies the OLT and the "Client Circuit Identifier" (access loop logical port i.e. GEM port of the IF_PON on the OLT on which the discovery stage PPPoE packet was received. The "*Agent Circuit ID*" contains a locally administered ASCII string generated by the OLT, representing the corresponding "Client Circuit Identifier" (GEM port).

301 – For each GEM port, the OLT is able to encode the user identification in the "*Agent Remote ID*" sub-option (sub-option 2). The "*Agent Remote ID*" contains an operator-configured string of 63 characters maximum that uniquely identifies the user on the associated "Client Circuit Identifier" (GEM port of the IF_PON) on the OLT on which the PPPoE discovery packet was received.

302 – For each GEM port, the OLT is able to replace the DSL Forum PPPoE vendor-specific tag with its own if the tag has also been provided by a PPPoE client.

303 – For each GEM port, the PPPoE Intermediate Agent is able to intercept all upstream PPPoE discovery packets coming from the ONT/ONU and to add a TAG to the upstream packet sent to the aggregation node.

304 – For each GEM port, the PPPoE Intermediate Agent is able to intercept all downstream PPPoE discovery packets and remove the TAG to the downstream packet sent to the ONT/ONU.

4.3.12 IP Multicast

305 – In coordination with the ONT/ONU, the OLT supports multicast group changing on the order of at most 10s of milliseconds.

306 – The OLT supports multiple multicast VLANs. The OLT allows the operator to configure which VLAN(s) is (are) multicast VLAN(s).

307 – IGMP hosts are connected to GEM ports that are members of the multipoint VLAN(s) that will carry (receive) the multicast frames.

308 – IGMP hosts are transmitted in the same VLAN from which the multicast packet will be received.

309 – User GEM ports can be members of multiple VLANs.

310 – The OLT receives the multicast streams from one or several multicast VLANs using a N:1 forwarding model.

311 – The multicast streams distribution (coming from one or several multicast VLANs) on the G-PON (from the OLT to the ONTs/ONUs) are carried out using a single GEM port (for each IF_PON port) dedicated to multicast streams and that is not AES encrypted. Consequently, the GEM port dedicated to multicast streams has a meaning only in the downstream direction. Therefore, IGMP signaling is not transported on the multicast GEM port used for the multicast streams distribution.

312 – For each multicast VLAN, the OLT allows the operator to configure the guaranteed and maximal downstream bandwidth parameters at the GEM port (dedicated to multicast streams distribution) level.

313 – For each IF_PON, the OLT allows the operator to configure the GEM port dedicated to transport multicast streams.

314 – For each IF_PON, the OLT is able to automatically configure the GEM port dedicated to multicast streams between OLT and ONTs/ONUs.

315 – For all multicast VLANs, the OLT supports a single IGMP v2 and v3 snooping with proxy reporting in conformance with *DSL Forum WT-101 Revision 9*.

316 – For each multicast VLAN, the OLT supports an independent IGMP v2 and v3 snooping with proxy reporting instance in conformance with *DSL Forum WT-101 Revision 9*.

- This function monitors the source and destination IP group address in IGMP signaling messages exchanged between the downstreaming hosts (from GEM ports) and the upstreaming routers (from the Ethernet SNIs). It supports the identification of user-initiated IGMP messages to be used for further processing. For each GEM port, the OLT supports matching groups conveyed by IGMP messages to the list of groups corresponding to a multicast VLAN associated with this GEM port. When there is no match, the IGMP message must be forwarded as regular user data. When there is a match, the IGMP message must be forwarded in the context of a multicast VLAN, and enter the IGMP snooping function.
- This function sets dynamically (create and delete) the corresponding MAC/IP group address filters. The MAC/IP multicast table is filled in by MAC/IP multicast addresses to configure the multicast transfer plane and adjust multicast MAC/IP forwarding filters such that packet replication is restricted to those user GEM ports that requested receipt.
- This function performs the forwarding i.e. the replication of the requested multicast streams (coming from the one or several multicast VLANs at Ethernet SNIs) towards the dedicated multicast GEM port of the IF_PONs from whom requests arrived.
- This function processes report suppression, last leave and query suppression as part of the proxy reporting. It supports IGMP immediate leave and proxy query functions. It detects topology changes and issues an IGMP proxy query to aid access network convergence. When there is no active IGMP querier this function initiates an IGMP querier election process by issuing an IGMP proxy query.

317 – At the multicast GEM port, the OLT supports IGMP FAST LEAVE i.e. the OLT stops sending multicast streams at the first IGMP LEAVE message (if there is no other device connected to this stream on the same port).

318 – For each multicast VLAN, the OLT provides statistics on all active groups on a per multicast VLAN and per user basis.

319 – The OLT allows the operator to configure which user GEM ports are members of a multicast VLAN.

320 – The OLT allows the operator to configure the IP multicast groups or ranges of multicast groups per multicast VLAN based on: Source address matching or Group address matching.

321 – For each multicast VLAN, the OLT is able to configure the maximum number of simultaneous multicast channels allowed per user.

322 – The OLT is able to configure the maximum number of simultaneous multicast channels allowed per multicast VLAN.

323 – The OLT implements a CAC function in order to control the availability of bandwidth (provided to the multicast VLAN containing the requested TV channel) before requesting a TV channel that is not currently transferred in the G-PON system.

324 – The OLT supports enabling IGMP identification on a per GEM port basis.

325 – The OLT supports configuring the IGMP identification and snooping to drop or ignore IGMP v1 messages.

4.4 SONET/SDH part

4.4.1 SNI

326 – The OLT supports a STM-1 electrical interface in conformance with *ITU-T G.703*, optical S-1.1, I-1, L-1.1 and/or L-1.3 (in conformance with *ITU-T G.664*, *G.707*, *G.825*, *G.957*).

327 – The OLT supports a STM-4 electrical interface in conformance with *ITU-T G.703*, optical S-4.1 I-4, L-4.1, L-4.3, V-4.1, V-4.3 and/or U-4.3 (in conformance with *ITU-T G.664*, G.707, G.825, G.957).

328 – All interfaces are pluggable on the OLT.

329 – Insertion or extraction of a SDH/SONET card in a shelf does not affect the correct operation of other cards in the same shelf.

4.4.2 TDM transfer plane

330 – Upstream TDM signals, which are transmitted on upstream GEM frames, are mapped on Virtual Container (VC). Downstream TDM signals, which are transmitted on VC of SDH/SONET frames received from SNI, are encapsulated on downstream GEM frames.

4.5 ATM part

4.5.1 SNI

331 – The OLT supports a STM-1 optical I-1, L-1.1 and/or L-1.3 in conformance with *ITU-T G.707*, *G.957* and *I.361*.

332 – The OLT supports a STM-1 optical interface in conformance with NTT specifications and *ITU-T G.707* and *I.361*.

333 – The OLT supports a STM-4 optical I-4, L-4.1, L-4.3 and/or V-4.1 in conformance with *ITU-T G.691*, *G.707*, *G.957* and *I.361*.

334 – Insertion or extraction of an ATM card in a shelf does not affect the correct operation of other cards in the same shelf.

4.5.2 ATM transfer plane

Handled VPI/VCI field length

335 – The OLT identifies the following VPI/VCI field length: Access line (28 bits i.e. 12 bits [VPI] + 16 bits [VCI]) and Transport line (28 bits i.e. 12 bits [VPI] + 16 bits [VCI])

Set up connections

336 – The OLT supports 1024 connections per 155.52 Mbps interface and 4096 connections per 622.08 Mbps interface in total of VPC and VCC.

Cell switching function

337 – Cell switching function has 8x8 or more in terms of the 622.08 Mbps switch port and non-blocking characteristics.

338 – Connections between access lines, between transport lines and between access and transport lines are set up.

339 – Point to point (1:1) connections are set up.

340 – A duplicated or non-duplicated configuration of the cell switching function is arbitrarily selectable.

341 – Hitless switching is performed for a forced switch operation in the duplicated configuration of the cell switching function.

ATM transfer capability (ATC)

342 – The OLT supports the following ATCs in conformance with *ITU-T I.371* and QoS classes in conformance with *ITU-T I.356*: DBR [class 1], DBR [class 2], DBR [class U], SBR3 [class 3] and GFR1.

Priority control and traffic shaping

343 – The OLT multiplexes different ATCs into a transport line and an access line so as to increase the line utilization factor retaining QoS of each ATC.

344 – The OLT supports cell loss priority control selectively for each QoS class buffer.

345 – The OLT supports EPD/PPD for GFR.

UPC/NPC function

346 – The UPC/NPC function is in conformance with *ITU-T I.371*.

347 – UPC works for all set-up connections in an access line interface.

348 – NPC works for all set-up connections in a transport line interface.

349 – UPC/NPC parameters are set up for each connection.

350 – CLP=0+1 or CLP=0 is set up for each connection in conformance with *ITU-T I.371*.

351 – The UPC/NPC function discards, tag or passes non-conforming cells for each connection.

352 – The OLT measures the number of passed cells, non-conforming cells and discarded cells.

353 – The number of connections handled is 1024 per 155.52 Mbps interface and 4096 per 622.08 Mbps interface.

Cell congestion control

354 – The OLT detects QoS degradation for DBR [class 2] and DBR [class U].

OAM function

355 – The OLT supports the following OAM functions (F4 and F5 flows) specified in *ITU-T I.610*; AIS and RDI, Performance monitoring, Loopback, Continuity check

356 – The number of supported connections is the following.

(1) The number of all connections set up in the OLT is handled for AIS and RDI.
(2) The number of connections listed in the Table 2 is handled for performance monitoring functions.
(3) The number of connections listed in the Table 2 is handled for loopback functions.

(4) The number of connections listed in the Table 2 is handled for continuity check functions.

357 – The OLT supports a loopback point of LB cells for arbitrary set up connection.

VP protection switching function

358 – A VP non-revertive protection switching function is supported. The feature is 1:1 bi-directional protection switching including automatic and forced switch.

VP/VC testing function

359 – VP/VC testing function measures the number of bit errors, lost cells and so on by test cells. VP/VC testing function is performed both under out-of-service and in-service conditions. Test cells are inserted at any point and in any direction with any rate as indicated by OpS. Test cells are dropped and monitored at any point and in any direction as indicated by OpS. The dropped and monitored cells are then checked. The connections of the number shown in the Table 2 are handled.

GFR connection test function

360 – GFR connection test function tests a GFR connection by test cells. This test is performed under out-of-service condition. Test cells are inserted at any point and in any direction with any rate as indicated by OpS. Test cells are monitored and checked at any point and in any direction as indicated by OpS. The connections of the number shown in the Table 2 are handled.

No.	Item	Performance monitoring	Loopback test	Continuity check	VP/VC test	GFR connection test
1	The number of connections per interface	16 or more	1 or more	128 or more	1 or more (note 1)	1 or more (note 1)
2	The number of connections per OLT	64 or more	4 or more	1024 or more	4 or more (note 2)	4 or more (note 2)
Note 1: Total number of VP/VC test and GFR connection test is 1 or more. Note 2: Total number of VP/VC test and GFR connection test is 7 or more.						

Table 2

5 SFU (Single Family Unit)

5.1 General requirements

361 – The SFU is able to concentrate upstream user' flows with a traffic allocation on a per service basis according to priority (SFU CoS parameter).

362 – The SFU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

5.1.1 Synchronization:

363 – The SFU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

364 – The SFU supports internal timing for holdover operation with 20 ppm accuracy. The SFU uses the free run clock only if the input clock is lost.

5.2 PON features

365 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

366 – The SFU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

5.2.1 Line code

367 – The SFU uses NRZ coding and scrambling in both directions.

5.2.2 G-PON Transmission Convergence

368 – The SFU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

369 – The SFU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

370 – The SFU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

371 – The SFU is able to send frames according to a static allocation provisioned at the OLT.

372 – The SFU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

373 – The SFU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

374 – The SFU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

375 – The SFU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

376 – The SFU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per SFU**

  377 – The SFU is able to support a single T-CONT.

- **Option 2: Multiple T-CONTs per SFU**

  378 – The SFU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS.

379 – The SFU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

380 – The SFU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

381 – The SFU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

382 – The SFU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

5.2.3 Upstream

Nominal line rate:

383 – The SFU supports a 1244 Mbps line rate.

Optical performances:

384 – The SFU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

385 – The SFU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

386 – The SFU is able to support upstream FEC.

5.2.4 Downstream

Nominal line rate:

387 – The SFU supports a 2.488 Mbps line rate.

Optical performances:

388 – The SFU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

389 – The SFU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

390 – The SFU is able to support downstream FEC.

5.2.5 RF video option

391 – The SFU supports the video overlay optical budget in conformance with *ITU-T G.984.2 Amd1*.

5.3 UNI (User Network Interface)

5.3.1 Ethernet

392 – The SFU supports a single 10/100BASE-T interface in conformance with *IEEE 802.3u*.

393 – The SFU supports a single 10/100/1000BASE-T interface in conformance with *IEEE 802.3u and 802.3z*.

394 – The SFU supports two 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

395 – The SFU supports two 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u and 802.3z*.

396 – The Ethernet UNI(s) support(s) by default auto-negotiation of speed and duplex mode.

397 – For each Ethernet UNI, it is possible to configure manually the linerate as 10 or 100 Mbps**.**

398 – For each Ethernet UNI, it is possible to configure manually the linerate as 10, 100 or 1000 Mbps**.**

399 – For each Ethernet UNI, it is possible to configure manually duplex mode as half or full.

400 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

401 – For each Ethernet UNI, the SFU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

5.3.2 POTS

402 – The SFU supports one FXS interface with analog/VoIP adaptation for POTS.

403 – The SFU supports two FXS interfaces with analog/VoIP adaptation for POTS.

404 – Each FXS interface is in conformance with specific national requirements concerning DC, ringing, AC, DTMF dialing (*ITU-T Q.23*), tones (alerting patterns and call progress tones) characteristics and on hook/off hook/flash-hook detection.

405 – The SFU detects fax signals in order to switch to *ITU-T G.711* codec or use *ITU-T T.38*.

406 – The SFU detects modem signals (excluding fax) in order to switch to *ITU-T G.711* codec or use *ITU-T V.150.1*.

407 – The SFU supports local loop echo cancellation in conformance with *ITU-T G.165* and *G.168*.

Encoding:

408 – The electronic part of the SFU only supports the [300Hz – 3400Hz] narrow band frequency range.

409 – The electronic part of the SFU supports the [50Hz – 7000Hz] wide band frequency range.

410 – Audio levels are in conformance with *ITU-T G.121*, *ETSI ETS 300 245-3, ETSI TBR 8 and ITU-T P.1010*.

411 – The SFU supports an audio codec in conformance with *ITU-T G.711 A/µ law*.

412 – The SFU supports an audio codec in conformance with *ITU-T G.722*.

413 – The SFU supports an audio codec in conformance with *ITU-T G.722.2 (WB-AMR)*.

414 – The SFU supports an audio codec in conformance with *ITU-T G.723.1*.

415 – The SFU supports an audio codec in conformance with *ITU-T G.726*.

416 – The SFU supports an audio codec in conformance with *ITU-T G.728*.

417 – The SFU supports an audio codec in conformance with *ITU-T G.729 Main*.

418 – The SFU supports an audio codec in conformance with *ITU-T G.729a*.

419 – The SFU supports an audio codec in conformance with *ITU-T G.729a+*.

420 – The SFU supports an audio codec in conformance with *ITU-T G.729b*.

421 – The SFU supports an audio codec in conformance with *ITU-T G.729e*.

422 – The SFU supports an audio codec in conformance with *ITU-T G.729EV*.

423 – The SFU allows the operator to configure the audio codec preference order.

424 – The SFU allows the operator to configure the number of frames per VoIP packet for each audio codec.

425 – The SFU manages asymmetrical communications as well from the codec point of view as from the number of frames per packet.

426 – The SFU is able to use DTX (including VAD). This function is disabled if the distant device asks so. If the distant terminal sends SID frames and stops transmission, CNG is generated.

427 – The SFU provides a PLC to detect and fill in for dropped voice packets (CNG, replay of last, interpolation…).

428 – The SFU implement a packet loss correction algorithm that ensures no annoying degradation for packet loss ratios up to 5%.

429 – The SFU supports adaptive jitter buffer.

Addressing:

430 – The SFU is able to connect one or several terminals and to register one or several phone numbers.

431 – The SFU supports one *E.164* phone numbers per specific connected phone.

432 – The SFU supports one *E.164* phone number for all connected phones and consequently placing/receiving several calls simultaneously with the same phone number.

433 – The SFU supports at least two simultaneous calls.

Transport protocol:

434 – The SFU supports RTP/RTCP in conformance with *IETF RFC 3550*.

Signaling protocol:

435 – The SFU is in conformance with *IETF RFC 2833* for DTMF Digits, Telephony Tones and Telephony Signals.

SIP:

- *SIP UA:*

436 – The SFU supports a SIP UA in conformance with *IETF RFC 3261*.

437 – The SFU supports a SIP UA in conformance with *ETSI TISPAN ES 283.003* profile. The SIP-based SFU plays the role of a UE with regards to the P-CSCF.

438 – The SFU supports a SIP UA in conformance with the latest draft version of *ETSI ES 03019* profile. The SIP-based SFU plays the role of a UE with regards to the P-CSCF.

- *SIP Proxy:*

439 – The SFU supports a SIP Proxy in conformance with *IETF RFC 3261*.

440 – The SFU supports a SIP Proxy in conformance with *ETSI TISPAN ES 283.003* profile.

441 – The SFU supports a SIP Proxy in conformance with the latest draft version of *ETSI 03019* profile.

H.248/MEGACO:

- *In-band Mode: Basic Function with Class 5 Telephone Office Service Control:*

442 – The SFU is in conformance with *ITU-T H.248.1* (05/2002), Gateway Control Protocol: Version 2.

443 – The SFU is in conformance with *IETF RFC 3525*.

444 – The SFU is in conformance with *ITU-T H.248.26*.

445 – The SFU is in conformance with *ITU-T H.248.13*.

446 – The SFU is in conformance with *ITU-T H.248.25*.

447 – The SFU is in conformance with *ITU-T H.248.30*.

448 – The SFU is in conformance with *ITU-T H.248.31*.

449 – The SFU is in conformance with *ITU-T H.248.35*.

450 – The SFU is in conformance with *IETF RFC 2327* for Session Description Protocol functionality. The textual encoding of H.248.1 uses SDP to describe the characteristics of media. SDP value attributes provide a means extend SDP. To enable the carriage of package defined properties in the local and remote descriptors of the text encoded H.248.1 protocol the Package attribute is used.

451 – The SFU support the new SDP attribute in conformance with *ITU-T H.248.15* for allowing for the carriage of properties in the local and remote descriptor in the textual H.248 encoding.

- *Out-of-band Mode: Extended function with H.248 MGC Service Control also used with compression codec operation*

452 – The SFU is in conformance with *ITU-T H.248.2*.

453 – The SFU is in conformance with *ITU-T H.248.3*.

454 – The SFU is in conformance with *ITU-T H.248.6*.

455 – The SFU is in conformance with *ITU-T H.248.16*.

456 – The SFU is in conformance with *ITU-T H.248.23.*

CLASS services / network services:

457 – The SFU supports Voice Messaging (FSK signaling)

458 – The SFU supports Caller ID (CLIP/CLIR).

459 – The SFU supports Call Waiting ID (CLIP/CLIR).

460 – The SFU supports Three Way Calling / Three Way Conferencing.

461 – The SFU supports Call Forwarding / Call Transfer.

462 – The SFU supports Call Waiting.

463 – The SFU supports Speed Dialing.

464 – The SFU supports Call Return.

465 – The SFU supports Repeat Dialing.

466 – The SFU supports Disable Call Waiting.

467 – The SFU supports Call Blocking.

468 – The SFU supports Voice Dialing.

469 – The SFU supports Distinctive Ringing.

470 – The SFU supports Message Waiting Indicator.

471 – The SFU supports Call Hold.

472 – The SFU supports Call Toggle.

473 – The SFU supports Call Pick-up.

5.4 Ethernet/IP part

5.4.1 Quality of service

474 – The SFU deals with four separate classes of service (as defined in paragraph **2**).

475 – The SFU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

476 – The SFU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

477 – The SFU is able to classify a flow in accordance with Ethernet UNI physical port.

478 – The SFU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable

CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

479 – The SFU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

480 – The SFU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

481 – The SFU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

482 – The SFU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

483 – The SFU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

484 – The SFU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

485 – When several classification parameters are considered, it is possible to define which one is priority in order to deal with potential contradictions. For example, if the Layer 3 priority implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the Layer 3 parameter is the priority classification parameter.

486 – The SFU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from the Ethernet UNI corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

487 – The flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port. It means that four GEM ports are necessary as four CoS have been defined.

488 – The SFU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

489 – All GEM ports are mapped into the same T-CONT.

490 – Each GEM port is mapped into a single T-CONT.

491 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Downstream forwarding:

492 – The SFU forwards the downstream flows coming from the GEM ports to the adequate destination virtual UNIs according to the various classifications that have been done in the upstream direction.

Conformity of the upstream flows with the SLAs:

493 – The SFU verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

494 – The SFU verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

495 – The SFU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

496 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

497 – For each user, the SFU supports forwarded, discarded and remarked frames counters.

498 – For each CoS, the SFU supports forwarded, discarded and remarked frames counters.

499 – For each service of each user, the SFU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

500 – The SFU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

501 – There is a scheduling/congestion avoidance function for each Ethernet UNI. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

502 – The scheduling features take into account a "SFU CoS parameter" in order to differentiate the flows and give priority to some flows.

503 – In the upstream direction, the "US SFU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

504 – In the downstream direction, the SFU allows the operator to configure this "DS SFU CoS parameter" as 802.1D user priority.

505 – In the downstream direction, the SFU allows the operator to configure this "DS SFU CoS parameter" as 802.1Q VLAN ID.

506 – In the downstream direction, the SFU allows the operator to configure this "DS SFU CoS parameter" as ToS/DSCP.

507 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

508 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

509 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

510 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

511 – For each service of each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

5.4.2 Filtering/Transparency

512 – For each Ethernet UNI, the SFU is able to filter upstream BPDU frames.

513 – For each virtual UNI, the SFU is able to filter upstream BPDU frames.

514 – For each Ethernet UNI, the SFU is able to be transparent to upstream BPDU frames.

515 – For each virtual UNI, the SFU is able to be transparent to upstream BPDU frames.

516 – For each Ethernet UNI, the SFU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

517 – For each virtual UNI, the SFU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

518 – For each Ethernet UNI, the SFU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

519 – For each virtual UNI, the SFU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

520 – For each Ethernet UNI, the SFU is able to filter upstream broadcast frames.

521 – For each virtual UNI, the SFU is able to filter upstream broadcast frames.

522 – For each Ethernet UNI, the SFU is able to be transparent to upstream broadcast frames.

523 – For each virtual UNI, the SFU is able to be transparent to upstream broadcast frames.

524 – For each Ethernet UNI, the SFU is able to filter upstream IGMP query messages.

525 – For each virtual UNI, the SFU is able to filter upstream IGMP query messages.

526 – For each Ethernet UNI, the SFU is able to be transparent to upstream IGMP query messages.

527 – For each virtual UNI, the SFU is able to be transparent to upstream IGMP query messages.

528 – For each Ethernet UNI, the SFU is able to filter upstream frames with specific Ethertype value. At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

529 – For each virtual UNI, the SFU is able to filter upstream frames with specific Ethertype value. At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

530 – For each Ethernet UNI, the SFU is able to filter frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

531 – For each virtual UNI, the SFU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

532 – For each Ethernet UNI, the SFU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

533 – For each virtual UNI, the SFU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

534 – For each Ethernet UNI, the SFU is able to filter upstream 802.1Q VLAN untagged frames.

535 – For each Ethernet UNI, the SFU is able to be transparent to upstream 802.1Q VLAN untagged frames.

536 – For each virtual UNI, the SFU is able to filter upstream 802.1Q VLAN untagged frames.

537 – For each virtual UNI, the SFU is able to be transparent to upstream 802.1Q VLAN untagged frames.

538 – The SFU permits IPSec pass-through.

539 – The SFU permits GRE pass-through.

540 – The SFU permits L2TP pass-through.

541 – The SFU permits PPTP pass-through.

5.4.3 Traffic limitation

542 – For each Ethernet UNI, the SFU is able to limit the rate of upstream broadcast frames.

543 – For each virtual UNI, the SFU is able to limit the rate of upstream broadcast frames.

5.4.4 VLAN remarking and (de)stacking

544 – The SFU supports untagged frames.

545 – The SFU supports 802.1D priority-tagged frames.

546 – The SFU supports 802.1Q VLAN-tagged frames.

547 – The SFU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

Remarking:

548 – For each Ethernet UNI, the SFU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

549 – For each virtual UNI, the SFU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

550 – For each Ethernet UNI, the SFU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

551 – For each virtual UNI, the SFU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

552 – For each virtual UNI, the SFU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

553 – For each Ethernet UNI, the SFU is able to attach a VLAN tag to untagged upstream frames. The VLAN ID and priority values are configurable.

554 – For each virtual UNI, the SFU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

555 – For each Ethernet UNI, the SFU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

556 – For each virtual UNI, the SFU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

557 – For each Ethernet UNI, the SFU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

558 – For each virtual UNI, the SFU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

559 – For each destination Ethernet UNI, the SFU allows the operator to configure this physical port to receive priority-tagged frames.

5.4.5 ToS/DSCP

560 – For each source Ethernet UNI, the SFU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

561 – For each source Ethernet UNI, the SFU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

562 – For each source virtual UNI, the SFU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

563 – For each source virtual UNI, the SFU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

564 – For each source Ethernet UNI, the SFU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI.

565 – For each source Ethernet UNI, the SFU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI.

566 – For each source virtual UNI, the SFU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source virtual UNI.

567 – For each source virtual UNI, the SFU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source virtual UNI.

568 – For each destination Ethernet UNI, the SFU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

569 – For each destination Ethernet UNI, the SFU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

570 – For each destination virtual UNI, the SFU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

571 – For each destination virtual UNI, the SFU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

572 – For each destination Ethernet UNI, the SFU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

573 – For each destination Ethernet UNI, the SFU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

574 – For each destination virtual UNI, the SFU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

575 – For each destination virtual UNI, the SFU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

5.4.6 IP Multicast

576 – In coordination with the OLT, the SFU supports multicast group changing on the order of at most 10s of milliseconds.

577 – The SFU supports one or several multicast VLANs using a N:1 forwarding model for each of them.

578 – IGMP hosts are connected to the Ethernet UNIs that are members of the multipoint VLAN(s) that will carry (receive) the multicast frames.

579 – IGMP hosts are transmitted in the same VLAN from which the multicast packet will be received.

580 – Each Ethernet UNI can be member of multiple VLANs.

581 – The multicast streams distribution (coming from one or several multicast VLANs) on the G-PON (from the OLT to the SFU) are carried out using the same GEM port dedicated to multicast streams as other ONTs/ONUs of the same IF_PON port. This GEM port is not AES encrypted. IGMP signaling is not transported on the multicast GEM port used for the multicast streams distribution.

582 – The SFU is able to learn the Port-ID dedicated to transport multicast streams that has been configured (automatically or manually) at the OLT.

583 – For all multicast VLANs, the SFU supports a single IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

584 – For each multicast VLAN, the SFU supports an independent IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

- This function monitors the source and destination IP group address in IGMP signaling messages exchanged between the downstreaming hosts (from the Ethernet UNIs) and the upstreaming routers (from the GEM port transporting IGMP messages). It supports the identification of user-initiated IGMP messages to be used for further processing. The SFU supports matching groups conveyed by IGMP messages to the list of groups corresponding to a multicast VLAN associated with the Ethernet UNIs. When there is no match, the IGMP message is forwarded as regular user data. When there is a match, the IGMP message is forwarded in the context of a multicast VLAN, and enters the IGMP snooping function.
- This function sets dynamically (create and delete) the corresponding MAC/IP group address filters. The MAC/IP multicast table is filled in by MAC/IP multicast addresses to configure the multicast transfer plane and adjust multicast MAC/IP forwarding filters such that multicast streams are transferred and duplicated to the Ethernet UNIs only if they have been requested by the hosts.
- This function performs the forwarding of the requested multicast streams (coming from the GEM port dedicated to multicast) towards the Ethernet UNIs.

585 – For each multicast Ethernet UNI, the SFU supports IGMP FAST LEAVE i.e. the SFU stops sending multicast streams at the first IGMP LEAVE message (if there is no other device connected to this stream on the same port).

5.4.7 802.1x

586 – The SFU is able to filter/block all upstream flows. All the Ethernet UNIs remain in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SFU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SFU just after the EAP-Success reception, all the Ethernet UNIs are administratively "UP" and allowed flows are transferred from all the Ethernet UNIs to the OLT. This feature is never used for UNIs corresponding to POTS.

587 – The SFU is able to filter/block upstream flows at each Ethernet UNI. The Ethernet UNI remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SFU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SFU just after the EAP-Success reception, the Ethernet UNI is administratively "UP" and allowed flows are transferred from the Ethernet UNI to the OLT. This feature is never used for a UNI corresponding to POTS.

588 – The SFU is able to filter/block upstream flows at each configurable group of virtual UNIs. The group of virtual UNIs remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SFU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SFU just after the EAP-Success reception, the corresponding group of virtual UNIs is administratively "UP" and allowed flows are transferred from the virtual UNIs to the OLT. This feature is never used for virtual UNIs corresponding to POTS.

5.4.8 Auto-configuration

589 – After receiving specific OMCI messages (triggered by the reception of standard or vendor-specific Radius AVP values at the OLT) the SFU is able to execute some specific local actions. For example, the following actions could be configured at the SFU for each user or physical/virtual UNI(s): access control, VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency, Multicast.

6 HGU (Home Gateway Unit)

6.1 General requirements

590 – The HGU is able to concentrate upstream user' flows with a traffic allocation on a per service basis according to priority (HGU CoS parameter).

591 – The HGU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

6.1.1 Synchronization

592 – The HGU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

593 – The HGU supports internal timing for holdover operation with 20 ppm accuracy. The HGU uses the free run clock only if the input clock is lost.

6.2 PON features

594 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

595 – The HGU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

6.2.1 Line code

596 – The HGU uses NRZ coding and scrambling in both directions.

6.2.2 G-PON Transmission Convergence

597 – The HGU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

598 – The HGU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

599 – The HGU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

600 – The HGU is able to send frames according to a static allocation provisioned at the OLT.

601 – The HGU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

602 – The HGU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

603 – The HGU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

604 – The HGU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

605 – The HGU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per HGU**

  606 – The HGU is able to support a single T-CONT.

- **Option 2: Multiple T-CONTs HGU**

  607 – The HGU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS.

608 – The HGU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

609 – The HGU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

610 – The HGU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

611 – The HGU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

6.2.3 Upstream

Nominal line rate:

612 – The HGU supports a 1244 Mbps line rate.

Optical performances:

613 – The HGU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

614 – The HGU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

615 – The HGU is able to support upstream FEC.

6.2.4 Downstream

Nominal line rate:

616 – The HGU supports a 2.488 Mbps line rate.

Optical performances:

617 – The HGU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

618 – The HGU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

619 – The HGU is able to support downstream FEC.

6.2.5 RF video option

620 – The HGU supports the video overlay optical budget in conformance with *ITU-T G.984.2 Amd1*.

6.3 UNI (User Network Interface)

6.3.1 Ethernet

621 – The HGU supports one 10/100BASE-T interface in conformance with *IEEE 802.3u*.

622 – The HGU supports one 10/100/1000BASE-T interface in conformance with *IEEE 802.3u and 802.3z*.

623 – The HGU supports two 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

624 – The HGU supports two 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u and 802.3z*.

625 – The HGU supports four 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

626 – The HGU supports four 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u and 802.3z*.

627 – Each Ethernet UNI supports by default auto-negotiation of speed and duplex mode.

628 – For each Ethernet UNI, it is possible to configure manually the linerate as 10 or 100 Mbps**.**

629 – For each Ethernet UNI, it is possible to configure manually the linerate as 10, 100 or 1000 Mbps**.**

630 – For each Ethernet UNI, it is possible to configure manually duplex mode as half or full.

631 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

632 – For each Ethernet UNI (excluding POTS), the HGU is abe to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality at the UNIs.

633 – The HGU allows the operator to configure one of the Ethernet UNIs as a lifeline port.

6.3.2 PLT

634 – The HGU supports a PLT station in conformance with *Homeplug AV* standard of *Homeplug Alliance*.

6.3.3 Wireless

WiFi:

635 – The HGU supports a WiFi interface in conformance with *IEEE 802.11a*.

636 – The HGU supports a WiFi interface in conformance with *IEEE 802.11b*.

637 – The HGU supports a WiFi interface in conformance with *IEEE 802.11e*.

638 – The HGU supports a WiFi interface in conformance with *IEEE 802.11g*.

639 – The HGU supports a WiFi interface in conformance with *IEEE 802.11h*.

640 – The HGU supports a WiFi interface in conformance with *IEEE 802.11i*.

641 – The HGU supports a WiFi interface in conformance with *IEEE 802.11n*.

642 – The WiFi interface of the HGU is multi-SSID.

643 – The WiFi interface of the HGU supports DFS mode.

644 – The HGU allows the operator to switch off the WiFi interface.

UWB:

645 – The HGU supports an UWB interface in conformance with *IEEE 802.15.3a*.

646 – The HGU allows the operator to switch off the UWB interface.

6.3.4 POTS

647 – The HGU supports one FXS interface with analog/VoIP adaptation for POTS.

648 – The HGU supports two FXS interfaces with analog/VoIP adaptation for POTS.

649 – Each FXS interface is in conformance with specific national requirements concerning DC, ringing, AC, DTMF dialing (*ITU-T Q.23*), tones (alerting patterns and call progress tones) characteristics and on hook/off hook/flash-hook detection.

650 – The HGU detects fax signals in order to switch to *ITU-T G.711* codec or use *ITU-T T.38*.

651 – The HGU detects modem signals (excluding fax) in order to switch to *ITU-T G.711* codec or use *ITU-T V.150.1*.

652 – The HGU supports local loop echo cancellation in conformance with *ITU-T G.165* and *G.168*.

Encoding:

653 – The electronic part of the HGU only supports the [300Hz – 3400Hz] narrow band frequency range.

654 – The electronic part of the HGU supports the [50Hz – 7000Hz] wide band frequency range.

655 – Audio levels are in conformance with *ITU-T G.121*, *ETSI ETS 300 245-3, ETSI TBR 8 and ITU-T P.1010*.

656 – The HGU supports an audio codec in conformance with *ITU-T G.711 A/μ law*.

657 – The HGU supports an audio codec in conformance with *ITU-T G.722*.

658 – The HGU supports an audio codec in conformance with *ITU-T G.722.2 (WB-AMR)*.

659 – The HGU supports an audio codec in conformance with *ITU-T G.723.1*.

660 – The HGU supports an audio codec in conformance with *ITU-T G.726*.

661 – The HGU supports an audio codec in conformance with *ITU-T G.728*.

662 – The HGU supports an audio codec in conformance with *ITU-T G.729 Main*.

663 – The HGU supports an audio codec in conformance with *ITU-T G.729a*.

664 – The HGU supports an audio codec in conformance with *ITU-T G.729a+*.

665 – The HGU supports an audio codec in conformance with *ITU-T G.729b*.

666 – The HGU supports an audio codec in conformance with *ITU-T G.729e*.

667 – The HGU supports an audio codec in conformance with *ITU-T G.729EV*.

668 – The HGU allows the operator to configure the audio codec preference order.

669 – The HGU allows the operator to configure the number of frames per VoIP packet for each audio codec.

670 – The HGU manages asymmetrical communications as well from the codec point of view as from the number of frames per packet.

671 – The HGU is able to use DTX (including VAD). This function is disabled if the distant device asks so. If the distant terminal sends SID frames and stops transmission, CNG is generated.

672 – The HGU provides a PLC to detect and fill in for dropped voice packets (CNG, replay of last, interpolation…).

673 – The HGU implement a packet loss correction algorithm that ensures no annoying degradation for packet loss ratios up to 5%.

674 – The HGU supports adaptive jitter buffer.

Addressing:

675 – The HGU is able to connect one or several terminals and to register one or several phone numbers.

676 – The HGU supports one *E.164* phone numbers per specific connected phone.

677 – The HGU supports one *E.164* phone number for all connected phones and consequently placing/receiving several calls simultaneously with the same phone number.

678 – The HGU supports at least two simultaneous calls.

Transport protocol:

679 – The HGU supports RTP/RTCP in conformance with *IETF RFC 3550*.

Signaling protocol:

680 – The HGU is in conformance with *IETF RFC 2833* for DTMF Digits, Telephony Tones and Telephony Signals.

<u>SIP:</u>

- SIP UA:

681 – The HGU supports a SIP UA in conformance with *IETF RFC 3261*.

682 – The HGU supports a SIP UA in conformance with *ETSI TISPAN ES 283.003* profile. The SIP-based HGU plays the role of a UE with regards to the P-CSCF.

683 – The HGU supports a SIP UA in conformance with the latest draft version of *ETSI ES 03019* profile. The SIP-based HGU plays the role of a UE with regards to the P-CSCF.

- SIP Proxy:

684 – The HGU supports a SIP Proxy in conformance with *IETF RFC 3261*.

685 – The HGU supports a SIP Proxy in conformance with *ETSI TISPAN ES 283.003* profile.

686 – The HGU supports a SIP Proxy in conformance with the latest draft version of *ETSI 03019* profile.

H.248/MEGACO:

- *In-band Mode: Basic Function with Class 5 Telephone Office Service Control*

687 – The HGU is in conformance with *ITU-T H.248.1* (05/2002), Gateway Control Protocol: Version 2.

688 – The HGU is in conformance with *IETF RFC 3525*.

689 – The HGU is in conformance with *ITU-T H.248.26*.

690 – The HGU is in conformance with *ITU-T H.248.13*.

691 – The HGU is in conformance with *ITU-T H.248.25*.

692 – The HGU is in conformance with *ITU-T H.248.30*.

693 – The HGU is in conformance with *ITU-T H.248.31*.

694 – The HGU is in conformance with *ITU-T H.248.35*.

695 – The HGU is in conformance with *IETF RFC 2327* for Session Description Protocol functionality. The textual encoding of H.248.1 uses SDP to describe the characteristics of media. SDP value attributes provide a means extend SDP. To enable the carriage of package defined properties in the local and remote descriptors of the text encoded H.248.1 protocol the Package attribute is used.

696 – The HGU support the new SDP attribute in conformance with *ITU-T H.248.15* for allowing for the carriage of properties in the local and remote descriptor in the textual H.248 encoding.

- *Out-of-band Mode: Extended function with H.248 MGC Service Control also used with compression codec operation*

697 – The HGU is in conformance with *ITU-T H.248.2*.

698 – The HGU is in conformance with *ITU-T H.248.3*.

699 – The HGU is in conformance with *ITU-T H.248.6*.

700 – The HGU is in conformance with *ITU-T H.248.16*.

701 – The HGU is in conformance with *ITU-T H.248.23.*

CLASS services / network services:

702 – The HGU supports Voice Messaging (FSK signaling)

703 – The HGU supports Caller ID (CLIP/CLIR).

704 – The HGU supports Call Waiting ID (CLIP/CLIR).

705 – The HGU supports Three Way Calling / Three Way Conferencing.

706 – The HGU supports Call Forwarding / Call Transfer.

707 – The HGU supports Call Waiting.

708 – The HGU supports Speed Dialing.

709 – The HGU supports Call Return.

710 – The HGU supports Repeat Dialing.

711 – The HGU supports Disable Call Waiting.

712 – The HGU supports Call Blocking.

713 – The HGU supports Voice Dialing.

714 – The HGU supports Distinctive Ringing.

715 – The HGU supports Message Waiting Indicator.

716 – The HGU supports Call Hold.

717 – The HGU supports Call Toggle.

718 – The HGU supports Call Pick-up.

6.4 Ethernet/IP part

6.4.1 Quality of service

719 – The HGU deals with four separate classes of service (as defined in paragraph **2**).

720 – The HGU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

721 – The HGU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

722 – The HGU is able to classify a flow in accordance with UNI physical port.

723 – The HGU is able to classify and aggregate several flows in accordance with several UNI physical ports.

724 – For each UNI, the HGU is able to classify a flow in accordance with a source/destination MAC address.

725 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of source/destination MAC addresses and particularly masked MAC addresses.

726 – For each UNI, the HGU is able to classify a flow in accordance with the fact that it is a unicast or a multicast flow.

727 – For each UNI, the HGU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

728 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

729 – For each UNI, the HGU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

730 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

731 – For each UNI, the HGU is able to classify a flow in accordance with Ethertype field. At least, PPPoE (Ethertype = "0x8863" and "0x8864"), IPoE (Ethertype = "0x8000") and ARP (Ethertype = "0x0806") are taken into account.

732 – For each UNI, the HGU is able to classify a flow in accordance with a source/destination IP address.

733 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of source/destination IP addresses and particularly masked IP addresses.

734 – For each UNI, the HGU is able to classify a flow in accordance with IP Protocol ID. At least IGMP classification is supported (IP Protocol ID = "2").

735 – For each UNI, the HGU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

736 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

737 – For each UNI, the HGU is able to classify a flow in accordance with DHCP options

738 – For each UNI, the HGU is able to classify a flow in accordance with source/destination UDP/TCP port.

739 – For each UNI, the HGU is able to classify and aggregate several flows in accordance with a set of source/destination UDP/TCP ports.

740 – For each UNI, the HGU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

741 – When several classification parameters are considered, it is possible to define for each UNI which one is priority in order to deal with potential contradictions. For example, if the Layer 4 parameter implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the TCP/UDP port parameter is the priority classification parameter.

742 – The HGU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from Ethernet UNI #1 corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

743 – The flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port. It means that four GEM ports are necessary as four CoS have been defined.

744 – The HGU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

745 – All GEM ports are mapped into the same T-CONT.

746 – Each GEM port is mapped into a single T-CONT.

747 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Downstream forwarding:

748 – The HGU forwards the downstream flows coming from the GEM ports to the adequate destination virtual UNIs according to the various classifications that have been done in the upstream direction.

Conformity of the upstream flows with the SLAs:

749 – The HGU verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

750 – The HGU verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

751 – The HGU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

752 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

753 – For each user, the HGU supports forwarded, discarded and remarked frames counters.

754 – For each CoS, the HGU supports forwarded, discarded and remarked frames counters.

755 – For each service of each user, the HGU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

756 – The HGU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

757 – There is one separate scheduling/congestion avoidance function per UNI interface. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

758 – The scheduling features take into account a "HGU CoS parameter" in order to differentiate the flows and give priority to some flows.

759 – In the upstream direction, the "US HGU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

760 – In the downstream direction, the HGU allows the operator to configure this "DS HGU CoS parameter" as 802.1D user priority.

761 – In the downstream direction, the HGU allows the operator to configure this "DS HGU CoS parameter" as VLAN ID of the 802.1Q header.

762 – In the downstream direction, the HGU allows the operator to configure this "DS ONT CoS parameter" as ToS/DSCP.

763 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

764 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

765 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

766 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

767 – For each service of each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

6.4.2 Filtering/Transparency

768 – For each source UNI, the HGU is able to filter upstream BPDU frames.

769 – For each source virtual UNI, the HGU is able to filter upstream BPDU frames.

770 – For each source UNI, the HGU is able to be transparent to upstream BPDU frames.

771 – For each source virtual UNI, the HGU is able to be transparent to upstream BPDU frames.

772 – For each source UNI, the HGU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

773 – For each source virtual UNI, the HGU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

774 – For each source UNI, the HGU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

775 – For each source virtual UNI, the HGU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

776 – For each source UNI, the HGU is able to filter upstream broadcast frames.

777 – For each source virtual UNI, the HGU is able to filter upstream broadcast frames.

778 – For each source UNI, the HGU is able to be transparent to upstream broadcast frames.

779 – For each source virtual UNI, the HGU is able to be transparent to upstream broadcast frames.

780 – For each source UNI, the HGU is able to filter upstream IGMP query messages.

781 – For each source virtual UNI, the HGU is able to filter upstream IGMP query messages.

782 – For each source UNI, the HGU is able to be transparent to upstream IGMP query messages.

783 – For each source virtual UNI, the HGU is able to be transparent to upstream IGMP query messages.

784 – For each source UNI, the HGU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

785 – For each source virtual UNI, the HGU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

786 – For each source UNI, the HGU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

787 – For each source virtual UNI, the HGU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

788 – For each source UNI, the HGU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

789 – For each source virtual UNI, the HGU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

790 – For each source UNI, the HGU is able to filter upstream frames on source/destination TCP/UDP port criteria.

791 – For each source virtual UNI, the HGU is able to filter upstream frames on source/destination TCP/UDP port criteria.

792 – For each source UNI, the HGU is able to filter upstream 802.1Q VLAN untagged frames.

793 – For each source UNI, the HGU is able to be transparent to upstream 802.1Q VLAN untagged frames.

794 – For each source virtual UNI, the HGU is able to filter upstream 802.1Q VLAN untagged frames.

795 – For each source virtual UNI, the HGU is able to be transparent to upstream 802.1Q VLAN untagged frames.

796 – The HGU permits IPSec pass-through.

797 – The HGU permits GRE pass-through.

798 – The HGU permits L2TP pass-through.

799 – The HGU permits PPTP pass-through.

6.4.3 Traffic limitation

800 – For each source UNI, the HGU is able to limit the rate of upstream broadcast frames.

801 – For each source virtual UNI, the HGU is able to limit the rate of upstream broadcast frames.

6.4.4 VLAN remarking and (de)stacking

802 – The HGU supports untagged frames.

803 – The HGU supports 802.1D priority-tagged frames.

804 – The HGU supports 802.1Q VLAN-tagged frames.

805 – The HGU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

Remarking:

806 – For each source UNI, the HGU is able to remark VLAN ID to upstream 802.1Q-tagged frames received from a virtual UNI at the upstream direction.

807 – For each source virtual UNI, the HGU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

808 – For each source UNI, the HGU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

809 – For each source virtual UNI, the HGU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

810 – For each source virtual UNI, the HGU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

811 – For each source UNI, the HGU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

812 – For each source virtual UNI, the HGU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

813 – For each source UNI, the HGU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

814 – For each source virtual UNI, the HGU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

815 – For each source UNI, the HGU allows the operator to attach two different VLAN tags to upstream untagged frames according to the fact that the flow is unicast of multicast.

816 – For each source virtual UNI, the HGU allows the operator to attach two different VLAN tags to upstream untagged frames according to the fact that the flow is unicast of multicast.

817 – For each source UNI, the HGU allows the operator to attach two different VLAN tags to upstream untagged frames according to two different Ethertype fields. At least, PPPoE (Ethertype = 0x8863 and 0x8864) and IPoE (Ethertype = 0x8000) are taken into account.

818 – For each source virtual UNI, the HGU allows the operator to attach two different VLAN tags to upstream untagged frames according to two different Ethertype fields. At least, PPPoE (Ethertype = 0x8863 and 0x8864) and IPoE (Ethertype = 0x8000) are taken into account.

819 – For each UNI, the HGU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

820 – For each virtual UNI, the HGU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

821 – For each destination UNI, the HGU allows the operator to configure this physical port to receive priority-tagged frames.

6.4.5 ToS/DSCP

822 – For each source UNI, the HGU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

823 – For each source UNI, the HGU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

824 – For each source virtual UNI, the HGU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

825 – For each source virtual UNI, the HGU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

826 – For each source UNI, the HGU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI.

827 – For each source UNI, the HGU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI.

828 – For each source virtual UNI, the HGU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the virtual source UNI.

829 – For each source virtual UNI, the HGU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the virtual source UNI.

830 – For each destination UNI, the HGU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

831 – For each destination UNI, the HGU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

832 – For each destination virtual UNI, the HGU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

833 – For each destination virtual UNI, the HGU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

834 – For each destination UNI, the HGU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

835 – For each destination UNI, the HGU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

836 – For each destination virtual UNI, the HGU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

837 – For each destination virtual UNI, the HGU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

6.4.6 Forwarding and protocols

IF_PON side:

838 – When performing the function of a Client the HGU only supports PPPoE sessions.

839 – When performing the function of a Client the HGU only supports DHCP sessions.

840 – When performing the function of a Client the HGU is able to support multiple PPPoE and DHCP sessions but not in the same GEM port.

841 – When performing the function of a Client the HGU is able to support multiple PPPoE and DHCP sessions per GEM port.

Session mode:

842 – The HGU is able to act as a PPPoE client in conformance with *IETF RFC 2516*.

843 – The PPPoE connection initiated by the HGU is in conformance with *IETF RFC 1332*, *RFC 1334*, *RFC 1570, RFC 1661* and *RFC 1994*.

844 – The PPPoE connection is an always up connection but the HGU allows the operator to configure it as "*auto-connect*" (the connection goes up when outgoing traffic is detected and goes down after a specified delay without traffic) or as "*manual-connect*" (the session is only initiated or terminated via the management system).

845 – When performing the function of a Client the HGU is able to initiate and manage multiple PPPoE sessions on a single GEM port of the IF_PON. These multiple sessions are running simultaneously and the HGU forwards the IP traffic to the adequate virtual UNIs.

Non-session mode:

Static:

846 – The HGU allows the operator to statically configure its IP address.

847 – For each UNI, the HGU allows the operator to configure a different static IP address to reach this physical interface.

848 – For each virtual UNI, the HGU allows the operator to configure a different static IP address to reach this virtual interface.

Dynamic:

849 – The HGU is able to act as a DHCP client in conformance with *IETF RFC 2131* and *RFC 2132*.

850 – The HGU has one internal dedicated IP address for VoIP service.

851 – Each DHCP client supports DHCP Force Renew procedure in conformance with *IETF RFC 3203*.

852 – For each UNI configured with a DHCP client, the HGU allows the operator to configure differently the option 60 Vendor Class-Identifier and Option 77 User Class-identifier.

853 – The use of DHCP options with proprietary code or other proprietary options complies with the definition methodology in conformance with *IETF RFC 2939*.

854 – Each DHCP client uses the IF_PON-side MAC address of the HGU as the "*chaddr*" in the DHCP request.

855 – Each DHCP client takes into account IP parameters and the DHCP options sent by the server: client IP address, Option 51 (Address Lease Time) and Option 54 (Server Identifier).

856 – Each DHCP client supports NACK management in conformance with *IETF RFC 2131*: when receiving a NACK message, the HGU goes back to INIT and sends a DISCOVER message.

857 – The HGU management of timer lease time is in conformance with T1 and T2 of *IETF RFC 3261*.

858 – The HGU supports DHCP INFORM message in conformance with *IETF RFC 2131*.

859 – The HGU sends a DHCP RELEASE message when it's being shut down.

802.1x:

860 – The HGU is able to act as a supplicant in conformance with *IEEE 802.1x*. This feature is never used for physical/virtual UNIs corresponding to POTS or lifeline VoIP phone.

861 – The HGU is able to have simultaneously several 802.1x connections (one instance per UNI).

862 – The HGU is able to have simultaneously several 802.1x connections (one instance per configurable group of virtual UNIs).

863 – The HGU is able to have use a proprietary authentication mode where a single 802.1x connection manage all UNIs at the same time.

864 – The HGU is able to start/stop/restart the 802.1x supplicant.

865 – The HGU is able to filter/block upstream flows at the physical/virtual UNIs. The physical/virtual UNIs remain in the 802.1x unauthorized state as long as the user is not successfully authenticated. EAPoL frames are exchanged between the HGU and the OLT. When the user is authenticated, after receiving the EAP-Success the OLT sends an OMCI message to inform the HGU that the physical/virtual UNIs become administratively "UP" and flows are allowed to be transferred to the OLT.

866 – The HGU is able to support the EAP-MD5 authenticating method.

867 – The HGU is able to support the EAP-TLS authenticating method.

868 – The HGU is able to support the EAP-TTLS authenticating method.

Autoconfiguration

869 – After receiving specific OMCI messages (triggered by the reception of standard or vendor-specific Radius AVP values at the OLT) the HGU is able to execute some specific local actions. For example, the following actions could be configured at the HGU for each user or physical/virtual UNI(s): access control, VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency, Multicast.

UNIs side:

870 – For each UNI, the HGU allows the operator to either bridge or route the upstream flows to the configured destination VLAN of this physical UNI.

871 – For each virtual UNI, the HGU allows the operator to either bridge or route the upstream flows to the configured destination VLAN of this virtual UNI.

Bridged mode:

872 – The HGU is able to support several independent learning Bridge instances in conformance with *IEEE 802.1D* for "bridged" physical/virtual UNIs.

873 – The HGU allows local switching between "bridged" physical/virtual UNIs in the same instance.

874 – The HGU is able to support a VLAN-aware bridge in conformance with *IEEE 802.1Q* for "bridged" physical/virtual UNIs.

875 – For each VLAN instance, the HGU allows the operator to configure the FDB aging time.

876 – The HGU allows the operator to configure static MAC addresses in the FDB.

877 – The HGU allows the operator to read the FDB.

878 – The HGU allows the operator to flush the FDB.

879 – The HGU allows the operator to delete some MAC addresses from the FDB.

880 – The HGU supports IVL (Independent VLAN learning).

881 – The HGU is able to work in IVL (Independent VLAN learning) mode for a configurable group of VLANs.

882 – The HGU supports SVL (Shared VLAN learning).

883 – The HGU is able to work in SVL (Shared VLAN learning) mode for a configurable group of VLANs.

884 – The HGU is able to limit the number of source MAC addresses learned per physical UNI.

885 –The HGU is able to limit the number of source MAC addresses learned per virtual UNI.

886 – The HGU is able to limit the number of source MAC addresses learned per VLAN.

887 – The HGU is able to limit the number of source MAC addresses learned per device.

888 – At the UNIs, the HGU supports Spanning Tree Protocol in conformance with *IEEE 802.1D*. STP is not running on the IF_PON.

889 – The HGU allows a single destination MAC address to be mapped on different GEM ports belonging to different 802.1D Bridge instances.

Routed mode:

890 – All routed virtual UNIs of the HGU are in the same bridge interface. That means that all devices are in the same local IP subnet.

891 – The HGU allows local routing between "routed" physical/virtual UNIs.

892 – Routing is based on static routes dynamically configured during DHCP or PPPoE session establishment.

893 – The HGU supports IPv4 stack.

894 – The HGU allows a future migration to dual IPv4/v6 stack.

895 – The HGU supports dual IPv4/v6 stack.

896 – The HGU accepts RIPv2 routes announcement coming from the IF_PON but does not generate RIPv2 routes announcement on the IF_PON.

897 – The HGU supports PPPoE Pass-through function.

898 – The HGU permits IPSec pass-through.

899 – The HGU permits GRE pass-through.

900 – The HGU permits L2TP pass-through.

901 – The HGU permits PPTP pass-through.

DHCP server:

902 – The HGU is able to act as a DHCP server in conformance with *IETF RFC 2131* and *RFC 2132* that serves devices connected on routed physical/virtual UNIs.

903 – The HGU supports DHCP Force Renew Procedure as described in *IETF RFC 3203*.

904 – The HGU allows the operator to switch off the DHCP server.

905 – The HGU allows the operator to configure the router in an "*auto-detection*" mode. In this mode, the HGU is able to detect another DHCP server at the UNIs and automatically switches off its DHCP server and gets an IP address from this local DHCP server.

906 – The DHCP server is able to be configured to specify the DHCP Pool.

907 – The DHCP server is able to allocate specific IP address based on MAC address of LAN devices.

908 – The DHCP server is able to accept or reject DHCP DISCOVER messages depending on some criteria. The different criteria are physical/virtual UNI, MAC address, DHCP options.

NAPT/ALG:

909 – In routed mode, the HGU operates as full NATP router in conformance with *IETF RFC 2663*, *RFC 3022* and *RFC 3027*.

910 – The HGU supports static NATP for inbound or outbound sessions for UDP, TCP or ICMP traffics. The translated port can be different from the original one.

911 – The NATP mechanism is able to forward all traffic to any specific physical/virtual UNI.

912 – The HGU includes ALG allowing applications (SIP, IPSec, ICQ, FTP Client…) to run properly with NATP.

Firewall:

913 – The HGU embeds a statefull firewall in conformance with *ICSA 4.0 Residential Certification*.

914 – The HGU supports configurable DMZ capabilities.

IP Multicast:

915 – In coordination with the OLT, the HGU supports multicast group changing on the order of at most 10s of milliseconds.

916 – The HGU supports one or several multicast VLANs using a N:1 forwarding model for each of them.

917 – IGMP hosts are connected to the UNIs that are members of the multipoint VLAN(s) that will carry (receive) the multicast frames.

918 – IGMP hosts are transmitted in the same VLAN from which the multicast packet will be received.

919 – The UNIs can be members of multiple VLANs.

920 – The multicast streams distribution (coming from one or several multicast VLANs) on the G-PON (from the OLT to the HGU) are carried out using the same GEM port dedicated to multicast streams as other ONTs/ONUs of the same IF_PON. This GEM port is not AES encrypted. IGMP signaling is not transported on the multicast GEM port used for the multicast streams distribution.

921 – The HGU is able to learn the Port-ID dedicated to transport multicast streams that has been configured (automatically or manually) at the OLT.

922 – For each multicast virtual UNI, the HGU supports IGMP FAST LEAVE i.e. the HGU stops sending multicast streams at the first IGMP LEAVE message (if there is no other device connected to this stream on the same port).

Bridged mode:

923 – The HGU is able to bridge the multicast flow between a virtual UNI and a multicast VLAN.

924 – For all multicast VLANs, in bridged mode, the HGU supports a single IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

925 – For each multicast VLAN, in bridged mode, the HGU supports an independent IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

- This function monitors the source and destination IP group address in IGMP signaling messages exchanged between the downstreaming hosts (from UNIs) and the upstreaming routers (from the GEM port). It supports the identification of user-initiated IGMP messages to be used for further processing. For each UNI, the HGU supports matching groups conveyed by IGMP messages to the list of groups corresponding to a multicast VLAN associated with these UNIs. When there is no match, the IGMP message is forwarded as regular user data. When there is a

match, the IGMP message is forwarded in the context of a multicast VLAN, and enters the IGMP snooping function.
- This function sets dynamically (create and delete) the corresponding MAC/IP group address filters. The MAC/IP multicast table is filled in by MAC/IP multicast addresses to configure the multicast transfer plane and adjust multicast MAC/IP forwarding filters such that packet replication is restricted to those user UNIs that requested receipt.
- This function performs the forwarding i.e. the replication of the requested multicast streams (coming from the one or several multicast VLANs at the GEM port dedicated to multicast) towards the UNIs from whom requests arrived.

Routed mode:

926 – The HGU is able to route the multicast flow between any virtual multicast UNI and any multicast VLAN.

927 – For all multicast VLANs, in routed mode, the HGU supports a single IGMP Proxy-Routing function in conformance with *DSL Forum WT-101 revision 9*.

928 – For each multicast VLAN, in routed mode, the HGU supports an independent IGMP Proxy-Routing function in conformance with *DSL Forum WT-101 revision 9*.

929 – The HGU supports IGMP forwarding with local NAT and firewall features including establishing any pin-holes in the firewall for the multicast streams received (after join).

930 – When the HGU is configured with multiple IF_PON-facing IP interfaces (e.g. PPPoE or IPoE), the IGMP Proxy-Routing function is able to multicast upstream IGMP messages to all or a configured subset of those interfaces.

931 – The HGU is configurable as to which interfaces IGMP messages should be forwarded to in the upstream direction. The default behavior is to forward messages to all provisioned interfaces.

932 – When the HGU receives an IGMP membership query on a given IF_PON-facing IP interface, the IGMP Proxy-Routing function only sends a corresponding membership report on this specific interface.

933 – The HGU is able to classify IGMP requests according to source IP/MAC address or incoming virtual UNI to distinguish between multicast services (e.g. IPTV and some other BE Internet IGMP application).

934 – The HGU has a way of suppressing the flooding of multicast on selected ports, either through dedicated ports connecting to IGMP hosts or IGMP Proxy-Routing.

935 – For each multicast VLAN, the HGU supports forwarding user initiated IGMP messages to a given multicast VLAN to which that user is attached.

6.5 Gateway management

936 – The management features allows the operator to provision and auto-configure the HGU PON-side interface (Layer 3 and above) through an ACS based on a variety of criteria. It complements OMCI.

937 – The HGU management supports all parameters (Layer 3 and above) in the data model in conformance with *DSL Forum TR-69*.

938 – The HGU management supports all parameters (Layer 3 and above) in the data model in conformance with *DSL Forum TR-98*.

939 – The HGU management supports all parameters (Layer 3 and above) in the data model in conformance with *DSL Forum TR-104*.

940 – The HGU management supports all parameters (Layer 3 and above) in the data model in conformance with *DSL Forum TR-106*.

941 – The HGU management supports all parameters (Layer 3 and above) in the data model in conformance with *DSL Forum TR-107*.

942 – The management features allows the operator to provision and auto-configure the HGU LAN interfaces with a GUI or with the data model in conformance with *DSL Forum TR-64*.

7 SBU (Single Business Unit)

7.1 General requirements

943 – The SBU is able to concentrate upstream user' flows with a traffic allocation on a per service basis according to priority (SBU CoS parameter).

944 – The SBU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

7.1.1 Synchronization

945 – The SBU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

946 – The SBU supports internal timing for holdover operation with 20 ppm accuracy. The SBU uses the free run clock only if the input clock is lost.

7.2 PON features

947 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

948 – The SBU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

7.2.1 Line code

949 – The SBU uses NRZ coding and scrambling in both directions.

7.2.2 G-PON Transmission Convergence

950 – The SBU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

951 – The SBU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

952 – The SBU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

953 – The SBU realizes the mapping of TDM data into GEM frames (and inversely extracts TDM data from GEM frames) in conformance with *ITU-T G.984.3 Appendix I.2*.

954 – The SBU realizes the mapping of ATM cells into GTC payload (and inversely extracts ATM cells from GTC payload) in conformance with *ITU-T G.984.3*.

955 – The SBU is able to send frames according to a static allocation provisioned at the OLT.

956 – The SBU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

957 – The SBU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

958 – The SBU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

959 – The SBU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

960 – The SBU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per SBU**

  961 – The SBU is able to support a single T-CONT.

- **Option 2: Multiple T-CONTs per SBU**

  962 – The SBU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS.

963 – The SBU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

964 – The SBU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

965 – The SBU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

966 – The SBU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

7.2.3 Upstream

Nominal line rate:

967 – The SBU supports a 1244 Mbps line rate.

Optical performances:

968 – The SBU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

969 – The SBU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

970 – The SBU is able to support upstream FEC.

7.2.4 Downstream

Nominal line rate:

971 – The SBU supports a 2.488 Mbps line rate.

Optical performances:

972 – The SBU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

973 – The SBU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

974 – The SBU is able to support downstream FEC.

7.3 UNI (User Network Interface)

7.3.1 Ethernet

975 – The SBU supports one 10/100BASE-T interface in conformance with *IEEE 802.3u*.

976 – The SBU supports one 10/100/1000BASE-T interface in conformance with *IEEE 802.3u* and *802.3z*.

977 – The SBU supports one 1000BASE-X interface in conformance with *IEEE 802.3z*.

978 – The SBU supports two 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

979 – The SBU supports two 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

980 – The SBU supports two 1000BASE-X interfaces in conformance with *IEEE 802.3z*.

981 – The SBU supports four 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

982 – The SBU supports four 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

983 – The SBU supports eight 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

984 – The SBU supports eight 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

985 – Each Ethernet UNI supports by default auto-negotiation of speed and duplex mode.

986 – For each Ethernet UNI, the SBU allows the operator to configure manually the linerate as 10 or 100 Mbps**.**

987 – For each Ethernet UNI, the SBU allows the operator to configure manually the linerate as 10, 100 or 1000 Mbps**.**

988 – For each Ethernet UNI, the SBU allows the operator to configure manually duplex mode as half or full.

989 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

990 – For each Ethernet UNI (excluding TDM and POTS), the SBU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

7.3.2 TDM

991 – The SBU supports one E1 interface in conformance with *ITU-T G.703*, *G.704* and *G.823* (jitter and wander levels) specifications clauses dealing with frequency stability and accuracy.

992 – The SBU supports two DS1 interfaces in conformance to the jitter and wander requirements set forth in *GR-499-CORE*, *ITU-T G.824*, and *ANSI T1.403*.

993 – The SBU supports two E1 interfaces in conformance with *ITU-T G.703*, *G.704*, *G.823* (jitter and wander levels), *ETSI EN 300 912* and *3GPP TS 125 402* specifications clauses dealing with frequency stability and accuracy.

994 – The SBU allows the operator to only transfer the TDM flows in an unstructured way in conformance with *ITU-T G.703*.

995 – The SBU allows the operator to configure each E1 interface as "TDM unstructured" (in conformance with *ITU-T G.703*) or "TDM structured" (in conformance with *ITU-T G.703* and *G.704*).

996 – The SBU supports one or more 192 kbps interfaces (reference point T) in conformance with *ITU-T I.430* and *JT-I430-a*.

997 – The SBU supports one or more 1.544 Mbps interfaces (reference point T) in conformance with *ITU-T I.431* and *JT-I431-a*.

998 – The SBU supports one or more 6.312 Mbps interfaces (reference point T) in conformance with *ITU-T G.703*, *ITU-T G.704* and *JT-G703-a*.

999 – The SBU supports one or more NTT specific 6.312 Mbps interfaces (reference point U).

1000 – The SBU allows the operator to configure whether emulation over Ethernet or TDMoGEM is used for the transfer of TDM data.

1001 – When emulation over Ethernet is used, the SBU allows the operator to configure whether IETF or MEF mechanism is used for TDM flows transport.

1002 – TDMoGEM is always used to transport TDM flows.

1003 – IETF mechanisms are always used to transport TDM flows.

1004 – MEF mechanisms are always used to transport TDM flows.

IETF encapsulation:

1005 – The SBU allows the operator to statically configure the IP address of its interface.

1006 – The SBU allows the operator to statically configure its loopback IP address.

1007 – The SBU allows the operator to statically configure the IP address of the default Gateway.

1008 – The SBU is able to periodically send ARP requests.

<u>MPLS layer:</u>

1009 – The SBU supports static configuration of one or several LSP labels.

1010 – The SBU allows the operator to statically configure the EXP field value of each LSP.

1011 – The SBU supports LDP signaling (in conformance with IETF *RFC 3036*) in order to connect automatically the SBU to one or several distant devices through LSP. The SBU allows the operator to statically configure one or several destination loopback IP address (one per peer Provider Edge).

<u>TDM PW:</u>

1012 – The SBU supports static configuration of one or several TDM PW label.

1013 – When SAToP is used, the SBU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1014 – When CESoPSN is used, the SBU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1015 – deleted.

1016 – The SBU supports Targeted LDP signaling (in conformance with the latest versions of *draft-ietf-pwe3-control-protocol* and *draft-ietf-pwe3-tdm-control-protocol-extensi*) in order to establish automatically the TDM Pseudo-Wire.

1017 – When the TDM UNI is configured as "TDM unstructured", the SBU supports MPLS mode of SAToP in conformance with the latest version of *draft-ietf- pwe3-satop*.

1018 – When the TDM UNI is configured as "TDM structured", the SBU supports MPLS mode of CESoPSN in conformance with the latest version of *draft-ietf-pwe3-cesopsn*.

1019 – When the TDM UNI is configured as "TDM structured", the SBU supports a Dynamic Bandwidth CESoPSN mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1020 – The SBU allows the operator to configure the size of the payload via timer-based threshold.

1021 – The SBU allows the operator to configure the jitter buffer size.

1022 – The SBU is able to use a dynamic jitter buffer size adjust algorithm.

1023 – The SBU allows the operator to configure several TDM Pseudo-wires.

1024 – When the TDM UNI is configured as "TDM unstructured", the SBU allows the operator to map a full DS1/E1 to a TDM Pseudo-Wire.

1025 – When the TDM UNI is configured as "TDM structured", the SBU allows the operator to map a single configurable set of timeslots from a DS1/E1 to a TDM Pseudo-Wire.

MEF encapsulation:

Adaptation layer:

1026 – The SBU supports static configuration of the ECID field.

TDM Emulated Circuit:

1027 – When the TDM UNI is configured as "TDM unstructured", the SBU supports structure-agnostic mode of CESoETH in conformance with *MEF*8.

1028 – When the TDM UNI is configured as "TDM structured", the SBU supports structure-locked mode of CESoETH in conformance with *MEF8*.

1029 – When the TDM UNI is configured as "TDM structured", the SBU supports a Dynamic Bandwidth CESoETH mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1030 – The SBU allows the operator to configure the size of the payload via timer-based threshold.

1031 – The SBU allows the operator to configure the jitter buffer size.

1032 – The SBU supports a dynamic jitter buffer size adjust algorithm.

1033 – The SBU allows the operator to configure several TDM Emulated Circuits.

1034 – When the TDM UNI is configured as "TDM unstructured", the SBU allows the operator to map a full DS1/E1 to a TDM Emulated Circuit.

1035 – When the TDM UNI is configured as "TDM structured", the SBU allows the operator to map a single configurable set of timeslots from a DS1/E1 to a TDM Emulated Circuit.

TDMoGEM:

1036 – The SBU supports the use of TDMoGEM features in conformance with *ITU-T G.984.3 Appendix I.2* in order to transport TDM data in an unstructured way.

7.3.3 ATM

1037 – The SBU supports one or more 25.6 Mbps ATM UNI interfaces in conformance with *ITU-T I.432.5*.

1038 – The SBU supports one or more 44.736 Mbps ATM UNI interfaces in conformance with *ITU-T G.703*.

1039 – The SBU supports one or more 155.52 Mbps ATM UNI SMF interfaces in conformance with *ITU-T I.432.2*.

1040 – The SBU supports one or more 155.52 Mbps ATM UNI MMF interfaces in conformance with *ANSI T1.646*.

7.3.4 POTS

1041 – The SBU supports 8 POTS lines.

1042 – Each POTS interface is in conformance with specific national requirements concerning DC, ringing, AC, DTMF dialing (*ITU-T Q.23*), tones (alerting patterns and call progress tones) characteristics and on hook/off hook/flash-hook detection.

1043 – The SBU detects fax signals in order to switch to *ITU-T G.711* codec or use *ITU-T T.38*.

1044 – The SBU detects modem signals (excluding fax) in order to switch to *ITU-T G.711* codec or use *ITU-T V.150.1*.

1045 – The SBU supports local loop echo cancellation in conformance with *ITU-T G.165* and *G.168*.

Encoding:

1046 – The electronic part of the SBU only supports the [300Hz – 3400Hz] narrow band frequency range.

1047 – The electronic part of the SBU supports the [50Hz – 7000Hz] wide band frequency range.

1048 – Audio levels are in conformance with *ITU-T G.121*, *ETSI ETS 300 245-3, ETSI TBR 8 and ITU-T P.1010*.

1049 – The SBU supports an audio codec in conformance with *ITU-T G.711 A/μ law*.

1050 – The SBU supports an audio codec in conformance with *ITU-T G.722*.

1051 – The SBU supports an audio codec in conformance with *ITU-T G.722.2 (WB-AMR)*.

1052 – The SBU supports an audio codec in conformance with *ITU-T G.723.1*.

1053 – The SBU supports an audio codec in conformance with *ITU-T G.726*.

1054 – The SBU supports an audio codec in conformance with *ITU-T G.728*.

1055 – The SBU supports an audio codec in conformance with *ITU-T G.729 Main*.

1056 – The SBU supports an audio codec in conformance with *ITU-T G.729a*.

1057 – The SBU supports an audio codec in conformance with *ITU-T G.729a+*.

1058 – The SBU supports an audio codec in conformance with *ITU-T G.729b*.

1059 – The SBU supports an audio codec in conformance with *ITU-T G.729e*.

1060 – The SBU supports an audio codec in conformance with *ITU-T G.729EV*.

1061 – The SBU allows the operator to configure the audio codec preference order.

1062 – The SBU allows the operator to configure the number of frames per VoIP packet for each audio codec.

1063 – The SBU manages asymmetrical communications as well from the codec point of view as from the number of frames per packet.

1064 – The SBU is able to use DTX (including VAD). This function is disabled if the distant device asks so. If the distant terminal sends SID frames and stops transmission, CNG is generated.

1065 – The SBU provides a PLC to detect and fill in for dropped voice packets (CNG, replay of last, interpolation…).

1066 – The SBU implements a packet loss correction algorithm that ensures no annoying degradation for packet loss ratios up to 5%.

1067 – The SBU supports adaptive jitter buffer.

Addressing:

1068 – The SBU is able to connect one or several terminals and to register one or several phone numbers.

1069 – The SBU supports one *E.164* phone numbers per specific connected phone.

1070 – The SBU supports one *E.164* phone number for all connected phones and consequently placing/receiving several calls simultaneously with the same phone number.

1071 – The SBU supports at least four simultaneous calls.

Transport protocol:

1072 – The SBU supports RTP/RTCP in conformance with *IETF RFC 3550*.

Signaling protocol:

1073 – The SBU is in conformance with *IETF RFC 2833* for DTMF Digits, Telephony Tones and Telephony Signals.

<u>SIP:</u>

- *<u>SIP UA:</u>*

1074 – The SBU supports a SIP UA in conformance with *IETF RFC 3261*.

1075 – The SBU supports a SIP UA in conformance with *ETSI TISPAN ES 283.003* profile. The SIP-based SBU plays the role of a UE with regards to the P-CSCF.

1076 – The SBU supports a SIP UA in conformance with the latest draft version of *ETSI ES 03019* profile. The SIP-based SBU plays the role of a UE with regards to the P-CSCF.

- *SIP Proxy:*

1077 – The SBU supports a SIP Proxy in conformance with *IETF RFC 3261*.

1078 – The SBU supports a SIP Proxy in conformance with *ETSI TISPAN ES 283.003* profile.

1079 – The SBU supports a SIP Proxy in conformance with the latest draft version of *ETSI 03019* profile.

H.248/MEGACO:

- *In-band Mode: Basic Function with Class 5 Telephone Office Service Control:*

1080 – The SBU is in conformance with *ITU-T H.248.1* (05/2002), Gateway Control Protocol: Version 2.

1081 – The SBU is in conformance with *IETF RFC 3525*.

1082 – The SBU is in conformance with *ITU-T H.248.26*.

1083 – The SBU is in conformance with *ITU-T H.248.13*.

1084 – The SBU is in conformance with *ITU-T H.248.25*.

1085 – The SBU is in conformance with *ITU-T H.248.30*.

1086 – The SBU is in conformance with *ITU-T H.248.31*.

1087 – The SBU is in conformance with *ITU-T H.248.35*.

1088 – The SBU is in conformance with *IETF RFC 2327* for Session Description Protocol functionality. The textual encoding of H.248.1 uses SDP to describe the characteristics of media. SDP value attributes provide a means extend SDP. To enable the carriage of package defined properties in the local and remote descriptors of the text encoded H.248.1 protocol the Package attribute is used.

1089 – The SBU support the new SDP attribute in conformance with *ITU-T H.248.15* for allowing for the carriage of properties in the local and remote descriptor in the textual H.248 encoding.

- *Out-of-band Mode: Extended function with H.248 MGC Service Control also used with compression codec operation*

1090 – The SBU is in conformance with *ITU-T H.248.2*.

1091 – The SBU is in conformance with *ITU-T H.248.3*.

1092 – The SBU is in conformance with *ITU-T H.248.6*.

1093 – The SBU is in conformance with *ITU-T H.248.16*.

1094 – The SBU is in conformance with *ITU-T H.248.23.*

CLASS services / network services:

1095 – The SBU supports Voice Messaging (FSK signaling)

1096 – The SBU supports Caller ID (CLIP/CLIR).

1097 – The SBU supports Call Waiting ID (CLIP/CLIR).

1098 – The SBU supports Three Way Calling / Three Way Conferencing.

1099 – The SBU supports Call Forwarding / Call Transfer.

1100 – The SBU supports Call Waiting.

1101 – The SBU supports Speed Dialing.

1102 – The SBU supports Call Return.

1103 – The SBU supports Repeat Dialing.

1104 – The SBU supports Disable Call Waiting.

1105 – The SBU supports Call Blocking.

1106 – The SBU supports Voice Dialing.

1107 – The SBU supports Distinctive Ringing.

1108 – The SBU supports Message Waiting Indicator.

1109 – The SBU supports Call Hold.

1110 – The SBU supports Call Toggle.

1111 – The SBU supports Call Pick-up.

7.4 Ethernet/IP part

7.4.1 Quality of service

1112 – The SBU deals with four separate classes of service (as defined in paragraph **2**).

1113 – The SBU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

1114 – The SBU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

1115 – The SBU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from UNI #1 corresponds to a virtual UNI of CoS3 type.

1116 – The SBU is able to classify a flow in accordance with UNI physical port.

1117 – The SBU is able to classify and aggregate several flows in accordance with several UNI physical ports.

1118 – For each UNI, the SBU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1119 – For each UNI, the SBU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1120 – For each UNI, the SBU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1121 – For each UNI, the SBU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1122 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the SBU is able to classify a flow according to a LSP label.

1123 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the SBU is able to classify a flow according to a set of LSP labels.

1124 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the SBU is able to classify a flow according to a [LSP label, Pseudo-Wire label] pair.

1125 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the SBU is able to classify a flow according to a set of [LSP label, Pseudo-Wire label] pairs.

1126 – After the TDM emulation over Ethernet adaptation (MEF mechanism), the SBU is able to classify a flow according to an ECID.

1127 – After the TDM emulation over Ethernet adaptation (MEF mechanism), the SBU is able to classify a flow according to a set of ECIDs.

1128 – For each UNI, the SBU is able to classify a flow in accordance with source/destination IP address.

1129 – For each UNI, the SBU is able to classify a flow in accordance with a set of source/destination IP addresses and particularly masked IP addresses.

1130 – For each UNI, the SBU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1131 – For each UNI, the SBU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1132 – For each UNI, the SBU is able to classify a flow in accordance with source/destination UDP/TCP port.

1133 – For each UNI, the SBU is able to classify and aggregate several flows in accordance with a set of source/destination UDP/TCP ports.

1134 – For each UNI, the SBU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

1135 – When several classification parameters are considered, it is possible to define for each UNI which one is priority in order to deal with potential contradictions. For example, if the Layer 4 parameter implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the TCP/UDP port parameter is the priority classification parameter.

1136 – The SBU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from UNI #1 corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

1137 – The flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port. It means that four GEM ports are necessary as four CoS have been defined.

1138 – The SBU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

1139 – All GEM ports are mapped into the same T-CONT.

1140 – Each GEM port is mapped into a single T-CONT.

1141 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Downstream forwarding:

1142 – The SBU forwards the downstream flows coming from the GEM ports to the adequate destination virtual UNIs according to the various classifications that have been done in the upstream direction.

Conformity of the upstream flows with the SLAs:

1143 – The SBU verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1144 – The SBU verifies the conformity of the upstream flows with the agreed SLA per CoS port with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1145 – The SBU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1146 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

1147 – For each user, the SBU supports forwarded, discarded and remarked frames counters.

1148 – For each CoS, the SBU supports forwarded, discarded and remarked frames counters.

1149 – For each service of each user, the SBU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

1150 – The SBU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

1151 – There is one separate scheduling/congestion avoidance function per UNI interface. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

1152 – The scheduling features take into account a "SBU CoS parameter" in order to differentiate the flows and give priority to some flows.

1153 – In the upstream direction, the "US SBU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

1154 – In the downstream direction, the SBU allows the operator to configure this "DS SBU CoS parameter" as 802.1D user priority.

1155 – In the downstream direction, the SBU allows the operator to configure this "DS SBU CoS parameter" as VLAN ID of the 802.1Q header.

1156 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

1157 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

1158 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

1159 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion per CoS.

1160 – For each service of each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

7.4.2 Filtering/Transparency

1161 – For each source UNI, the SBU is able to filter upstream BPDU frames.

1162 – For each source virtual UNI, the SBU is able to filter upstream BPDU frames.

1163 – For each source UNI, the SBU is able to be transparent to upstream BPDU frames.

1164 – For each source virtual UNI, the SBU is able to be transparent to upstream BPDU frames.

1165 – For each source UNI, the SBU is able to filter user VLANs.

1166 – For each source virtual UNI, the SBU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1167 – For each source UNI, the SBU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT (individual VLAN or group of VLANs).

1168 – For each source virtual UNI, the SBU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1169 – For each source UNI, the SBU is able to filter upstream broadcast frames.

1170 – For each source virtual UNI, the SBU is able to filter upstream broadcast frames.

1171 – For each source UNI, the SBU is able to be transparent to upstream broadcast frames.

1172 – For each source virtual UNI, the SBU is able to be transparent to upstream broadcast frames.

1173 – For each source UNI, the SBU is able to filter upstream IGMP query messages.

1174 – For each source virtual UNI, the SBU is able to filter upstream IGMP query messages.

1175 – For each source UNI, the SBU is able to be transparent to upstream IGMP query messages.

1176 – For each source virtual UNI, the SBU is able to be transparent to upstream IGMP query messages.

1177 – For each source UNI, the SBU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1178 – For each source virtual UNI, the SBU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1179 – For each source UNI, the SBU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1180 – For each source virtual UNI, the SBU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1181 – For each source UNI, the SBU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1182 – For each source virtual UNI, the SBU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1183 – For each source UNI, the SBU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1184 – For each source virtual UNI, the SBU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1185 – For each source UNI, the SBU is able to filter upstream 802.1Q VLAN untagged frames.

1186 – For each source UNI, the SBU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1187 – For each source virtual UNI, the SBU is able to filter upstream 802.1Q VLAN untagged frames.

1188 – For each source virtual UNI, the SBU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1189 – The SBU permits IPSec pass-through.

1190 – The SBU permits GRE pass-through.

1191 – The SBU permits L2TP pass-through.

1192 – The SBU permits PPTP pass-through.

7.4.3 Traffic limitation

1193 – For each source UNI, the SBU is able to limit the rate of upstream broadcast frames.

1194 – For each source virtual UNI, the SBU is able to limit the rate of upstream broadcast frames.

7.4.4 VLAN remarking and (de)stacking

1195 – The SBU supports untagged frames.

1196 – The SBU supports 802.1D priority-tagged frames.

1197 – The SBU supports 802.1Q VLAN-tagged frames.

1198 – The SBU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

Remarking:

1199 – For each source UNI, the SBU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1200 – For each source virtual UNI, the SBU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1201 – For each source UNI, the SBU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1202 – For each source virtual UNI, the SBU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1203 – For each source virtual UNI, the SBU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

1204 – For each source UNI, the SBU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1205 – For each source virtual UNI, the SBU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1206 – For each source UNI, the SBU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1207 – For each source virtual UNI, the SBU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1208 – For each UNI, the SBU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

1209 – For each virtual UNI, the SBU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

1210 – For each destination UNI, the SBU allows the operator to configure this physical port to receive priority-tagged frames.

7.4.5 ToS/DSCP

1211 – For each source UNI, the SBU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1212 – For each source UNI, the SBU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1213 – For each source virtual UNI, the SBU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1214 – For each source virtual UNI, the SBU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1215 – For each source UNI, the SBU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI..

1216 – For each source UNI, the SBU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI..

1217 – For each source virtual UNI, the SBU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source virtual UNI..

1218 – For each source virtual UNI, the SBU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source virtual UNI..

1219 – For each destination UNI, the SBU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1220 – For each destination UNI, the SBU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1221 – For each destination virtual UNI, the SBU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1222 – For each destination virtual UNI, the SBU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1223 – For each destination UNI, the SBU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

1224 – For each destination UNI, the SBU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

1225 – For each destination virtual UNI, the SBU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

1226 – For each destination virtual UNI, the SBU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

7.4.6 Forwarding

1227 – The SBU supports Ethernet switching in conformance with *IEEE 802.1D*.

1228 – The SBU allows local switching between "bridged" physical/virtual UNIs in the same instance.

1229 – The SBU supports Ethernet switching in conformance with *IEEE 802.1Q* (VLAN aware).

1230 – The SBU supports replication of Ethernet frames (broadcast, unknown, multicast traffics) in conformance with *IEEE 802.1D*.

1231 – The SBU supports auto-learning of MAC addresses.

1232 – For each VLAN, the SBU allows the operator to activate/deactivate MAC learning process.

1233 – For each VLAN instance, the SBU allows the operator to configure the FDB aging time.

1234 – The SBU allows the operator to configure static MAC addresses in the FDB.

1235 – The SBU allows the operator to read the FDB.

1236 – The SBU allows the operator to flush the FDB.

1237 – The SBU allows the operator to delete some MAC addresses from the FDB.

1238 – The SBU supports IVL (Independent VLAN learning).

1239 – The SBU is able to work in IVL (Independent VLAN learning) mode for a configurable group of VLANs.

1240 – The SBU supports SVL (Shared VLAN learning).

1241 – The SBU is able to work in SVL (Shared VLAN learning) mode for a configurable group of VLANs.

1242 – The SBU is able to limit the number of source MAC addresses learned per physical UNI.

1243 – The SBU is able to limit the number of source MAC addresses learned per virtual UNI.

1244 – The SBU is able to limit the number of source MAC addresses learned per VLAN.

1245 – The SBU is able to limit the number of source MAC addresses learned per device.

1246 – At the Ethernet UNIs, the SBU supports Spanning Tree Protocol in conformance with *IEEE 802.1D.*

1247 – For each Ethernet UNI, the SBU allows the operator to activate/deactivate STP.

1248 – For each Ethernet virtual UNI, the SBU allows the operator to activate/deactivate STP.

1249 – At the Ethernet UNIs, the SBU supports Rapid Spanning Tree Protocol in conformance with *IEEE 802.1w.*

1250 – For each Ethernet UNI, the SBU allows the operator to activate/deactivate RSTP.

1251 – For each Ethernet virtual UNI, the SBU allows the operator to activate/deactivate RSTP.

1252 – At the Ethernet UNIs, the SBU supports Multiple Spanning Tree Protocol in conformance with *IEEE 802.1s.*

1253 – For each Ethernet UNI, the SBU allows the operator to activate/deactivate MSTP.

1254 – For each Ethernet virtual UNI, the SBU allows the operator to activate/deactivate MSTP.

7.4.7 802.1x

1255 – The SBU is able to filter/block all upstream flows. All the Ethernet UNIs remain in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SBU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SBU just after the EAP-Success reception, all the Ethernet UNIs are administratively "UP" and allowed flows are transferred from all the Ethernet UNIs to the OLT. This feature is never used for UNIs corresponding to POTS or DS1/E1.

1256 – The SBU is able to filter/block upstream flows at each Ethernet UNI. The Ethernet UNI remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SBU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SBU just after the EAP-Success reception, the Ethernet UNI is administratively "UP" and allowed flows are transferred from the Ethernet UNI to the OLT. This feature is never used for a UNI corresponding to POTS or DS1/E1.

1257 – The SBU is able to filter/block upstream flows at each configurable group of virtual UNIs. The group of virtual UNIs remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the SBU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the SBU just after the EAP-Success reception, the corresponding group of virtual UNIs is administratively "UP" and allowed flows are transferred from the virtual UNIs to the OLT. This feature is never used for virtual UNIs corresponding to POTS or DS1/E1.

7.4.8 Autoconfiguration

1258 – After receiving specific OMCI messages (triggered by the reception of standard or vendor-specific Radius AVP values at the OLT) the SBU is able to execute some specific local actions. For example, the following actions could be configured at the SBU for each user or physical/virtual UNI(s): access control, VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency, Multicast.

7.5 ATM part

7.5.1 Handled VPI field length

1259 – The SBU identifies the following VPI field length: Access line (12 bits) and ATM UNI (8 bits).

7.5.2 Set up connections

1260 – The SBU supports at least 256 connections.

7.5.3 Accommodation conditions

1261 – The SBU accommodates one or more line cards that provide ATM UNI. When one line card is inserted or removed to/from the SBU, cell stream in this SBU is not degraded on other line cards.

7.5.4 Multiplexing and demultiplexing function

1262 – The SBU demultiplexes cells from an access line to UNIs based on VPIs.

1263 – The SBU multiplexes cells from UNIs to an access line based on VPIs.

7.5.5 OAM function

1264 – The SBU supports AIS, RDI and loopback OAM functions (F4 flow) in conformance with *ITU-T I.610*.

1265 – All set-up VP connections are handled for AIS and RDI functions.

1266 – The SBU supports a loopback point of LB cells for arbitrary set-up connection.

7.6 Specific OAM features

7.6.1 Supervision of the End-to-End service connectivity

IETF mechanisms:

1267 – When the TDM UNI is configured as "TDM unstructured", the SBU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-satop*).

1268 – When the TDM UNI is configured as "TDM structured", the SBU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-cesopsn*).

MEF mechanisms:

1269 – The SBU transfers TDM OAM indications via L, R & M bits of the CESoETH Control Word (in conformance with *MEF8*).

7.6.2 Supervision of the network segment connectivity

IETF mechanisms:

1270 – When frames are not received after a given time, the TDM Pseudo Wire is considered as down.

1271 – The SBU supports BFD feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

1272 – The SBU supports LSP Ping feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

1273 – A "Link down" status on the TDM Pseudo-Wire causes "link down" status on the corresponding TDM UNI.

1274 – A "Link down" status on a TDM UNI does not cause "link down" status on the TDM Pseudo-Wire.

MEF mechanisms:

1275 – When frames are not received after a given time, the TDM Emulated Circuit is considered as down.

1276 – A "Link down" status on the TDM Emulated Circuit causes "link down" status on the corresponding TDM UNI.

1277 – A "Link down" status on a TDM UNI does not cause "link down" status on the TDM Emulated Circuit.

8 MDU (Multi-Dwelling Unit)

8.1 General requirements

1278 – The MDU is able to concentrate upstream users' flows with a traffic allocation on a per service basis according to priority (MDU CoS parameter).

1279 – The MDU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

8.1.1 Synchronization

1280 – The MDU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

1281 – The MDU supports internal timing for holdover operation with 20 ppm accuracy. The MDU uses the free run clock only if the input clock is lost.

8.2 PON features

1282 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

1283 – The MDU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

8.2.1 Line code

1284 – The MDU uses NRZ coding and scrambling in both directions.

8.2.2 G-PON Transmission Convergence

1285 – The MDU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

1286 – The MDU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

1287 – The MDU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

1288 – The MDU is able to send frames according to a static allocation provisioned at the OLT.

1289 – The MDU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

1290 – The MDU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

1291 – The MDU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

1292 – The MDU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

1293 – The MDU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per MDU**

  1294 – The MDU is able to support a single T-CONT.

- **Option 2: Single T-CONT per user at the MDU**

  1295 – The MDU is able to support a single T-CONT per user.

- **Option 3: Multiple T-CONTs per MDU**

  1296 – The MDU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

- **Option 4: Multiple T-CONTs per user**

  1297 – When N are users are connected, the MDU is able to support at least 4 x N T-CONTs i.e. 1 T-CONT per CoS per user (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

1298 – The MDU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

1299 – The MDU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

1300 – The MDU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

1301 – The MDU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

8.2.3 Upstream

Nominal line rate:

1302 – The MDU supports a 1244 Mbps line rate.

Optical performances:

1303 – The MDU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

1304 – The MDU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

1305 – The MDU is able to support upstream FEC.

8.2.4 Downstream

Nominal line rate:

1306 – The MDU supports a 2.488 Mbps line rate.

Optical performances:

1307 – The MDU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

1308 – The MDU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

1309 – The MDU is able to support downstream FEC.

8.2.5 RF video option

1310 – The MDU supports the video overlay optical budget in conformance with *ITU-T G.984.2 Amd1*.

8.3 UNI (User Network Interface)

8.3.1 VDSL2

1311 – The MDU supports twelve VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1312 – The MDU supports twenty four VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1313 – The MDU supports forty eight VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1314 – Each VDSL2 UNI transfers Ethernet frames in conformance with *IEEE 802.3ah*.

1315 – For each VDSL2 UNI, the MDU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

8.3.2 Ethernet

1316 – The MDU supports twelve 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

1317 – The MDU supports twelve 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

1318 – Each Ethernet UNI supports by default auto-negotiation of speed and duplex mode.

1319 – For each Ethernet UNI, the MDU allows the operator to configure manually the linerate as 10 or 100 Mbps**.**

1320 – For each Ethernet UNI, the MDU allows the operator to configure manually the linerate as 10, 100 or 1000 Mbps**.**

1321 – For each Ethernet UNI, the MDU allows the operator to configure manually duplex mode as half or full.

1322 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

1323 – For each Ethernet UNI (excluding POTS), the MDU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

8.3.3 POTS

1324 – The MDU supports twelve POTS interfaces.

1325 – The MDU supports twenty four POTS interfaces.

1326 – The MDU supports forty eight POTS interfaces.

1327 – Each POTS interface is in conformance with specific national requirements concerning DC, ringing, AC, DTMF dialing (*ITU-T Q.23*), tones (alerting patterns and call progress tones) characteristics and on hook/off hook/flash-hook detection.

1328 – The MDU detects fax signals in order to switch to *ITU-T G.711* codec or use *ITU-T T.38*.

1329 – The MDU detects modem signals (excluding fax) in order to switch to *ITU-T G.711* codec or use *ITU-T V.150.1*.

1330 – The MDU supports local loop echo cancellation in conformance with *ITU-T G.165* and *G.168*.

Encoding:

1331 – The electronic part of the MDU only supports the [300Hz – 3400Hz] narrow band frequency range.

1332 – The electronic part of the MDU supports the [50Hz – 7000Hz] wide band frequency range.

1333 – Audio levels are in conformance with *ITU-T G.121*, *ETSI ETS 300 245-3, ETSI TBR 8 and ITU-T P.1010*.

1334 – The MDU supports an audio codec in conformance with *ITU-T G.711 A/µ law*.

1335 – The MDU supports an audio codec in conformance with *ITU-T G.722*.

1336 – The MDU supports an audio codec in conformance with *ITU-T G.722.2 (WB-AMR)*.

1337 – The MDU supports an audio codec in conformance with *ITU-T G.723.1*.

1338 – The MDU supports an audio codec in conformance with *ITU-T G.726*.

1339 – The MDU supports an audio codec in conformance with *ITU-T G.728*.

1340 – The MDU supports an audio codec in conformance with *ITU-T G.729 Main*.

1341 – The MDU supports an audio codec in conformance with *ITU-T G.729a*.

1342 – The MDU supports an audio codec in conformance with *ITU-T G.729a+*.

1343 – The MDU supports an audio codec in conformance with *ITU-T G.729b*.

1344 – The MDU supports an audio codec in conformance with *ITU-T G.729e*.

1345 – The MDU supports an audio codec in conformance with *ITU-T G.729EV*.

1346 – The MDU allows the operator to configure the audio codec preference order.

1347 – The MDU allows the operator to configure the number of frames per VoIP packet for each audio codec.

1348 – The MDU manages asymmetrical communications as well from the codec point of view as from the number of frames per packet.

1349 – The MDU is able to use DTX (including VAD). This function is disabled if the distant device asks so. If the distant terminal sends SID frames and stops transmission, CNG is generated.

1350 – The MDU provides a PLC to detect and fill in for dropped voice packets (CNG, replay of last, interpolation…).

1351 – The MDU implement a packet loss correction algorithm that ensures no annoying degradation for packet loss ratios up to 5%.

1352 – The MDU supports adaptive jitter buffer.

Addressing:

1353 – The MDU is able to connect one or several terminals and to register one or several phone numbers.

1354 – The MDU supports one *E.164* phone numbers per specific connected phone.

1355 – The MDU supports one *E.164* phone number for all connected phones and consequently placing/receiving several calls simultaneously with the same phone number.

1356 – The MDU supports at least two simultaneous calls per user.

Transport protocol:

1357 – The MDU supports RTP/RTCP in conformance with *IETF RFC 3550*.

Signaling protocol:

1358 – The MDU is in conformance with *IETF RFC 2833* for DTMF Digits, Telephony Tones and Telephony Signals.

<u>SIP:</u>

- SIP UA:

1359 – The MDU supports a SIP UA in conformance with *IETF RFC 3261*.

1360 – The MDU supports a SIP UA in conformance with *ETSI TISPAN ES 283.003* profile. The SIP-based MDU plays the role of a UE with regards to the P-CSCF.

1361 – The MDU supports a SIP UA in conformance with the latest draft version of *ETSI ES 03019* profile. The SIP-based MDU plays the role of a UE with regards to the P-CSCF.

- SIP Proxy:

1362 – The MDU supports a SIP Proxy in conformance with *IETF RFC 3261*.

1363 – The MDU supports a SIP Proxy in conformance with *ETSI TISPAN ES 283.003* profile.

1364 – The MDU supports a SIP Proxy in conformance with the latest draft version of *ETSI 03019* profile.

<u>H.248/MEGACO:</u>

- <u>*In-band Mode: Basic Function with Class 5 Telephone Office Service Control*</u>

1365 – The MDU is in conformance with *ITU-T H.248.1* (05/2002), Gateway Control Protocol: Version 2.

1366 – The MDU is in conformance with *IETF RFC 3525*.

1367 – The MDU is in conformance with *ITU-T H.248.26*.

1368 – The MDU is in conformance with *ITU-T H.248.13*.

1369 – The MDU is in conformance with *ITU-T H.248.25*.

1370 – The MDU is in conformance with *ITU-T H.248.30*.

1371 – The MDU is in conformance with *ITU-T H.248.31*.

1372 – The MDU is in conformance with *ITU-T H.248.35*.

1373 – The MDU is in conformance with *IETF RFC 2327* for Session Description Protocol functionality. The textual encoding of H.248.1 uses SDP to describe the characteristics of media. SDP value attributes provide a means extend SDP. To enable the carriage of package defined properties in the local and remote descriptors of the text encoded H.248.1 protocol the Package attribute is used.

1374 – The MDU support the new SDP attribute in conformance with *ITU-T H.248.15* for allowing for the carriage of properties in the local and remote descriptor in the textual H.248 encoding.

- <u>*Out-of-band Mode: Extended function with H.248 MGC Service Control also used with compression codec operation*</u>

1375 – The MDU is in conformance with *ITU-T H.248.2*.

1376 – The MDU is in conformance with *ITU-T H.248.3*.

1377 – The MDU is in conformance with *ITU-T H.248.6*.

1378 – The MDU is in conformance with *ITU-T H.248.16*.

1379 – The MDU is in conformance with *ITU-T H.248.23.*

CLASS services / network services:

1380 – The MDU supports Voice Messaging (FSK signaling)

1381 – The MDU supports Caller ID (CLIP/CLIR).

1382 – The MDU supports Call Waiting ID (CLIP/CLIR).

1383 – The MDU supports Three Way Calling / Three Way Conferencing.

1384 – The MDU supports Call Forwarding / Call Transfer.

1385 – The MDU supports Call Waiting.

1386 – The MDU supports Speed Dialing.

1387 – The MDU supports Call Return.

1388 – The MDU supports Repeat Dialing.

1389 – The MDU supports Disable Call Waiting.

1390 – The MDU supports Call Blocking.

1391 – The MDU supports Voice Dialing.

1392 – The MDU supports Distinctive Ringing.

1393 – The MDU supports Message Waiting Indicator.

1394 – The MDU supports Call Hold.

1395 – The MDU supports Call Toggle.

1396 – The MDU supports Call Pick-up.

8.4 Ethernet/IP part

8.4.1 Quality of service

1397 – The MDU deals with four separate classes of service (as defined in paragraph **2**).

1398 – The MDU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

1399 – The MDU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

1400 – The MDU is able to classify a flow in accordance with UNI physical port.

1401 – The MDU is able to classify and aggregate several flows in accordance with several UNI physical ports.

1402 – For each UNI, the MDU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1403 – For each UNI, the MDU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1404 – For each UNI, the MDU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1405 – For each UNI, the MDU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified as in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1406 – For each UNI, the MDU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified as in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1407 – For each UNI, the MDU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1408 – For each UNI, the MDU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

1409 – When several classification parameters are considered, it is possible to define for each UNI which one is priority in order to deal with potential contradictions. For example, if the Layer 3 priority implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the Layer 3 parameter is the priority classification parameter.

1410 – deleted.

1411 – The MDU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from UNI #1 corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

1412 – The flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port. It means that four GEM ports are necessary as four CoS have been defined.

1413 – For each user, the MDU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

1414 – All GEM ports are mapped into the same T-CONT.

1415 – Each GEM port is mapped into a single T-CONT.

1416 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Downstream forwarding:

1417 – The MDU forwards the downstream flows coming from the GEM ports to the adequate destination virtual UNIs according to the various classifications that have been done in the upstream direction.

Conformity of the upstream flows with the SLAs:

1418 – The MDU verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1419 – The MDU verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1420 – The MDU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1421 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

1422 – For each user, the MDU supports forwarded, discarded and remarked frames counters.

1423 – For each CoS, the MDU supports forwarded, discarded and remarked frames counters

1424 – For each service of each user, the MDU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

1425 – The MDU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

1426 – There is one separate scheduling/congestion avoidance function per UNI interface. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

1427 – The scheduling features take into account a "MDU CoS parameter" in order to differentiate the flows and give priority to some flows.

1428 – In the upstream direction, the "US MDU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

1429 – In the downstream direction, the MDU allows the operator to configure this "DS MDU CoS parameter" as 802.1D user priority.

1430 – In the downstream direction, the MDU allows the operator to configure this "DS MDU CoS parameter" as VLAN ID of the 802.1Q header.

1431 – In the downstream direction, the MDU allows the operator to configure this "DS MDU CoS parameter" as ToS/DSCP.

1432 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

1433 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

1434 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion per user.

1435 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

1436 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

8.4.2 Filtering/Transparency

1437 – For each source UNI, the MDU is able to filter upstream BPDU frames.

1438 – For each source virtual UNI, the MDU is able to filter upstream BPDU frames.

1439 – For each source UNI, the MDU is able to be transparent to upstream BPDU frames.

1440 – For each source virtual UNI, the MDU is able to be transparent to upstream BPDU frames.

1441 – For each source UNI, the MDU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1442 – For each source virtual UNI, the MDU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1443 – For each source UNI, the MDU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1444 – For each source virtual UNI, the MDU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1445 – For each source UNI, the MDU is able to filter upstream broadcast frames.

1446 – For each source virtual UNI, the MDU is able to filter upstream broadcast frames.

1447 – For each source UNI, the MDU is able to be transparent to upstream broadcast frames.

1448 – For each source virtual UNI, the MDU is able to be transparent to upstream broadcast frames.

1449 – For each source UNI, the MDU is able to filter upstream IGMP query messages.

1450 – For each source virtual UNI, the MDU is able to filter upstream IGMP query messages.

1451 – For each source UNI, the MDU is able to be transparent to upstream IGMP query messages.

1452 – For each source virtual UNI, the MDU is able to be transparent to upstream IGMP query messages.

1453 – For each source UNI, the MDU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1454 – For each source virtual UNI, the MDU is able to upstream filter frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1455 – For each source UNI, the MDU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1456 – For each source virtual UNI, the MDU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1457 – For each source UNI, the MDU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1458 – For each source virtual UNI, the MDU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1459 – For each source UNI, the MDU is able to filter upstream 802.1Q VLAN untagged frames.

1460 – For each source UNI, the MDU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1461 – For each source virtual UNI, the MDU is able to filter upstream 802.1Q VLAN untagged frames.

1462 – For each source virtual UNI, the MDU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1463 – The MDU permits IPSec pass-through.

1464 – The MDU permits GRE pass-through.

1465 – The MDU permits L2TP pass-through.

1466 – The MDU permits PPTP pass-through.

8.4.3 Traffic limitation

1467 – For each source UNI, the MDU is able to limit the rate of upstream broadcast frames.

1468 – For each source virtual UNI, the MDU is able to limit the rate of upstream broadcast frames.

8.4.4 VLAN remarking and (de)stacking

1469 – The MDU supports untagged frames.

1470 – The MDU supports 802.1D priority-tagged frames.

1471 – The MDU supports 802.1Q VLAN-tagged frames.

1472 – The MDU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

Remarking:

1473 – For each source UNI, the MDU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1474 – For each source virtual UNI, the MDU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1475 – For each source virtual UNI, the MDU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1476 – For each source virtual UNI, the MDU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

1477 – For each source UNI, the MDU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1478 – For each source virtual UNI, the MDU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1479 – For each source UNI, the MDU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1480 – For each source virtual UNI, the MDU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1481 – For each UNI, the MDU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

1482 – For each virtual UNI, the MDU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

1483 – For each destination UNI, the MDU allows the operator to configure this physical port to receive priority-tagged frames.

8.4.5 ToS/DSCP

1484 – For each source UNI, the MDU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1485 – For each source UNI, the MDU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1486 – For each source virtual UNI, the MDU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1487 – For each source virtual UNI, the MDU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1488 – For each source UNI, the MDU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI.

1489 – For each source UNI, the MDU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI.

1490 – For each source virtual UNI, the MDU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source virtual UNI.

1491 – For each source virtual UNI, the MDU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source virtual UNI.

1492 – For each destination UNI, the MDU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1493 – For each destination UNI, the MDU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1494 – For each destination virtual UNI, the MDU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1495 – For each destination virtual UNI, the MDU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1496 – For each destination UNI, the MDU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

1497 – For each destination UNI, the MDU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

1498 – For each destination virtual UNI, the MDU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

1499 – For each destination virtual UNI, the MDU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

8.4.6 IP Multicast

1500 – In coordination with the OLT, the MDU supports multicast group changing on the order of at most 10s of milliseconds.

1501 – The MDU supports one or several multicast VLANs using a N:1 forwarding model for each of them.

1502 – User UNIs can be members of multiple VLANs.

1503 – IGMP hosts are connected to UNIs that are members of the multipoint VLAN(s) that will carry (receive) the multicast frames.

1504 – IGMP hosts are transmitted in the same VLAN from which the multicast packet will be received.

1505 – The multicast streams distribution (coming from one or several multicast VLANs) on the G-PON (from the OLT to the MDU) are carried out using a single GEM port (for each IF_PON) dedicated to multicast streams and that are not AES encrypted. Consequently, the GEM port dedicated to multicast streams has a meaning only in the downstream direction. Therefore, IGMP signaling is not transported on the multicast GEM port used for the multicast streams distribution.

1506 – The MDU is able to learn the Port-ID dedicated to transport multicast streams that has been configured (automatically or manually) at the OLT.

1507 – For all multicast VLANs, the MDU supports a single IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

1508 – For each multicast VLAN, the MDU supports an independent IGMP v2 and v3 transparent snooping instance in conformance with *DSL Forum WT-101 Revision 9*.

- This function monitors the source and destination IP group address in IGMP signaling messages exchanged between the downstreaming hosts (from UNIs) and the upstreaming routers (from the GEM ports). It supports the identification of user-initiated IGMP messages to be used for further processing. For each UNI, the MDU supports matching groups conveyed by IGMP messages to the list of groups corresponding to a multicast VLAN associated with this UNI. When there is no match, the IGMP message is forwarded as regular user data. When there is a match, the IGMP message is forwarded in the context of a multicast VLAN, and enters the IGMP snooping function.
- This function sets dynamically (create and delete) the corresponding MAC/IP group address filters. The MAC/IP multicast table is filled in by MAC/IP multicast addresses to configure the multicast transfer plane and adjust multicast MAC/IP forwarding filters such that packet replication is restricted to those user UNIs that requested receipt.
- This function performs the forwarding i.e. the replication of the requested multicast streams (coming from the one or several multicast VLANs at the GEM port dedicated to multicast) towards the UNIs from whom requests arrived.

1509 – For each multicast UNI, the MDU supports IGMP FAST LEAVE i.e. the MDU stops sending multicast streams at the first IGMP LEAVE message (if there is no other device connected to this stream on the same port).

8.4.7 802.1x

1510 – The MDU is able to filter/block upstream flows for each UNI. The UNI remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the MDU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the MDU just after the EAP-Success reception, the UNI is administratively "UP" and allowed flows are transferred from the UNI corresponding to the user to the OLT. This feature is never used for UNIs corresponding to POTS.

1511 – The MDU is able to filter/block upstream flows at each configurable group of virtual UNIs of a UNI (i.e. user). The group of virtual UNIs remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the MDU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the MDU just after the EAP-Success reception, the corresponding group of virtual UNIs is administratively "UP" and allowed flows are transferred from the virtual UNIs corresponding to the user to the OLT. This feature is never used for virtual UNIs corresponding to POTS.

8.4.8 Autoconfiguration

1512 – After receiving specific OMCI messages (triggered by the reception of standard or vendor-specific Radius AVP values at the OLT) the MDU is able to execute some specific local actions. For example, the following actions could be configured at the MDU for each user or physical/virtual UNI(s): VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency, Multicast.

9 MTU (Multi-Tenant Unit)

9.1 General requirements

1513 – The MTU is able to concentrate upstream users' flows with a traffic allocation on a per service basis according to priority (MTU CoS parameter).

1514 – The MTU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

9.1.1 Synchronization

1515 – The MTU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

1516 – The MTU supports internal timing for holdover operation with 20 ppm accuracy. The MTU uses the free run clock only if the input clock is lost.

9.2 PON features

1517 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

1518 – The MTU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

9.2.1 Line code

1519 – The MTU uses NRZ coding and scrambling in both directions.

9.2.2 G-PON Transmission Convergence

1520 – The MTU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

1521 – The MTU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

1522 – The MTU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

1523 – The MTU realizes the mapping of TDM data into GEM frames (and inversely extracts TDM data from GEM frames) in conformance with *ITU-T G.984.3 Appendix I.2*.

1524 – The MTU is able to send frames according to a static allocation provisioned at the OLT.

1525 – The MTU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

1526 – The MTU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

1527 – The MTU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

1528 – The MTU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

1529 – The MTU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per MTU**

  1530 – The MTU is able to support a single T-CONT.

- **Option 2: Single T-CONT per user at the MTU**

  1531 – The MTU is able to support a single T-CONT per user.

- **Option 3: Multiple T-CONTs per MTU**

  1532 – The MTU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

- **Option 4: Multiple T-CONTs per user**

  1533 – When N are users are connected, the MTU is able to support at least 4 x N T-CONTs i.e. 1 T-CONT per CoS per user.

1534 – The MTU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

1535 – The MTU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

1536 – The MTU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

1537 – The MTU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

9.2.3 Upstream

Nominal line rate:

1538 – The MTU supports a 1244 Mbps line rate.

Optical performances:

1539 – The MTU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

1540 – The MTU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

1541 – The MTU is able to support upstream FEC.

9.2.4 Downstream

Nominal line rate:

1542 – The MTU supports a 2.488 Mbps line rate.

Optical performances:

1543 – The MTU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

1544 – The MTU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

1545 – The MTU is able to support downstream FEC.

9.3 UNI (User Network Interface)

9.3.1 VDSL2

1546 – The MTU supports twelve VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1547 – The MTU supports twenty four VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1548 – The MTU supports forty eight VDSL2 interfaces in conformance with *ITU-T G.993.2*.

1549 – Each VDSL2 UNI transfers Ethernet frames in conformance with *IEEE 802.3ah*.

1550 – For each VDSL2 UNI, the MTU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

9.3.2 Ethernet

1551 – The MTU supports eight 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

1552 – The MTU supports eight 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

1553 – Each Ethernet UNI supports by default auto-negotiation of speed and duplex mode.

1554 – For each Ethernet UNI, the MTU allows the operator to configure manually the linerate as 10 or 100 Mbps**.**

1555 – For each Ethernet UNI, the MTU allows the operator to configure manually the linerate as 10, 100 or 1000 Mbps**.**

1556 – For each Ethernet UNI, the MTU allows the operator to configure manually duplex mode as half or full.

1557 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

1558 – For each Ethernet UNI, the MTU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality.

9.3.3 TDM

1559 – The MTU supports four E1 interfaces in conformance with *ITU-T G.703*, *G.704*, *G.823* (jitter and wander levels), *ETSI EN 300 912* and *3GPP TS 125 402* specifications clauses dealing with frequency stability and accuracy.

1560 – The MTU supports four DS1 interfaces in conformance to the jitter and wander requirements set forth in *GR-499-CORE*, *ITU-T G.824*, and *ANSI T1.403*.

1561 – The MTU allows the operator to only transfer the TDM flows in an unstructured way in conformance with *ITU-T G.703*.

1562 – The MTU allows the operator to configure each E1 interface as "TDM unstructured" (in conformance with *ITU-T G.703*) or "TDM structured" (in conformance with *ITU-T G.703* and *G.704*).

1563 – The MTU allows the operator to configure whether emulation over Ethernet or TDMoGEM is used for the transfer of TDM data.

1564 – When emulation over Ethernet is used, the MTU allows the operator to configure whether IETF or MEF mechanism is used for TDM flows transport.

1565 – TDMoGEM is always used to transport TDM flows.

1566 – IETF mechanisms are always used to transport TDM flows.

1567 – MEF mechanisms are always used to transport TDM flows.

IETF encapsulation:

1568 – The MTU allows the operator to statically configure the IP address of its interface.

1569 – The MTU allows the operator to statically configure its loopback IP address.

1570 – The MTU allows the operator to statically configure the IP address of the default Gateway.

1571 – The MTU is able to periodically send ARP requests.

<u>MPLS layer:</u>

1572 – The MTU supports static configuration of one or several LSP labels.

1573 – The MTU allows the operator to statically configure the EXP field value of each LSP.

1574 – The MTU supports LDP signaling (in conformance with IETF *RFC 3036*) in order to connect automatically the MTU to one or several distant devices through LSP. The MTU allows the operator to statically configure one or several destination loopback IP address (one per peer Provider Edge).

<u>TDM PW:</u>

1575 – The MTU supports static configuration of one or several TDM PW label.

1576 – When SAToP is used, the MTU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1577 – When CESoPSN is used, the MTU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1578 – deleted.

1579 – The MTU supports Targeted LDP signaling (in conformance with the latest versions of *draft-ietf-pwe3-control-protocol* and *draft-ietf-pwe3-tdm-control-protocol-extensi*) in order to establish automatically the TDM Pseudo-Wire.

1580 – When the TDM UNI is configured as "TDM unstructured", the MTU supports MPLS mode of SAToP in conformance with the latest version of *draft-ietf- pwe3-satop*.

1581 – When the TDM UNI is configured as "TDM structured", the MTU supports MPLS mode of CESoPSN in conformance with the latest version of *draft-ietf-pwe3-cesopsn*.

1582 – When the TDM UNI is configured as "TDM structured", the MTU supports a Dynamic Bandwidth CESoPSN mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1583 – The MTU allows the operator to configure the size of the payload via timer-based threshold.

1584 – The MTU allows the operator to configure the jitter buffer size.

1585 – The MTU is able to use a dynamic jitter buffer size adjust algorithm.

1586 – The MTU allows the operator to configure several TDM Pseudo-wires.

1587 – When the TDM UNI is configured as "TDM unstructured", the MTU allows the operator to map a full DS1/E1 to a TDM Pseudo-Wire.

1588 – When the TDM UNI is configured as "TDM structured", the MTU allows the operator to map a single configurable set of timeslots from a DS1/E1 to a TDM Pseudo-Wire.

MEF encapsulation:

<u>Adaptation layer:</u>

1589 – The MTU supports static configuration of the ECID field.

<u>TDM Emulated Circuit:</u>

1590 – When the TDM UNI is configured as "TDM unstructured", the MTU supports structure-agnostic mode of CESoETH in conformance with *MEF*8.

1591 – When the TDM UNI is configured as "TDM structured", the MTU supports structure-locked mode of CESoETH in conformance with *MEF8*.

1592 – When the TDM UNI is configured as "TDM structured", the MTU supports a Dynamic Bandwidth CESoETH mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1593 – The MTU allows the operator to configure the size of the payload via timer-based threshold.

1594 – The MTU allows the operator to configure the jitter buffer size.

1595 – The MTU supports a dynamic jitter buffer size adjust algorithm.

1596 – The MTU allows the operator to configure several TDM Emulated Circuits.

1597 – When the TDM UNI is configured as "TDM unstructured", the MTU allows the operator to map a full DS1/E1 to a TDM Emulated Circuit.

1598 – When the TDM UNI is configured as "TDM structured", the MTU allows the operator to map a single configurable set of timeslots from a DS1/E1 to a TDM Emulated Circuit.

TDMoGEM:

1599 – The MTU supports the use of TDMoGEM features in conformance with *ITU-T G.984.3 Appendix I.2* in order to transport TDM data in an unstructured way.

9.3.4 POTS

1600 – The MTU supports twelve POTS interfaces.

1601 – The MTU supports twenty four POTS interfaces.

1602 – The MTU supports forty eight POTS interfaces.

1603 – Each POTS interface is in conformance with specific national requirements concerning DC, ringing, AC, DTMF dialing (*ITU-T Q.23*), tones (alerting patterns and call progress tones) characteristics and on hook/off hook/flash-hook detection.

1604 – The MTU detects fax signals in order to switch to *ITU-T G.711* codec or use *ITU-T T.38*.

1605 – The MTU detects modem signals (excluding fax) in order to switch to *ITU-T G.711* codec or use *ITU-T V.150.1*.

1606 – The MTU supports local loop echo cancellation in conformance with *ITU-T G.165* and *G.168*.

Encoding:

1607 – The electronic part of the MTU only supports the [300Hz – 3400Hz] narrow band frequency range.

1608 – The electronic part of the MTU supports the [50Hz – 7000Hz] wide band frequency range.

1609 – Audio levels are in conformance with *ITU-T G.121*, *ETSI ETS 300 245-3, ETSI TBR 8 and ITU-T P.1010*.

1610 – The MTU supports an audio codec in conformance with *ITU-T G.711 A/μ law*.

1611 – The MTU supports an audio codec in conformance with *ITU-T G.722*.

1612 – The MTU supports an audio codec in conformance with *ITU-T G.722.2 (WB-AMR)*.

1613 – The MTU supports an audio codec in conformance with *ITU-T G.723.1*.

1614 – The MTU supports an audio codec in conformance with *ITU-T G.726*.

1615 – The MTU supports an audio codec in conformance with *ITU-T G.728*.

1616 – The MTU supports an audio codec in conformance with *ITU-T G.729 Main*.

1617 – The MTU supports an audio codec in conformance with *ITU-T G.729a*.

1618 – The MTU supports an audio codec in conformance with *ITU-T G.729a+*.

1619 – The MTU supports an audio codec in conformance with *ITU-T G.729b*.

1620 – The MTU supports an audio codec in conformance with *ITU-T G.729e*.

1621 – The MTU supports an audio codec in conformance with *ITU-T G.729EV*.

1622 – The MTU allows the operator to configure the audio codec preference order.

1623 – The MTU allows the operator to configure the number of frames per VoIP packet for each audio codec.

1624 – The MTU manages asymmetrical communications as well from the codec point of view as from the number of frames per packet.

1625 – The MTU is able to use DTX (including VAD). This function is disabled if the distant device asks so. If the distant terminal sends SID frames and stops transmission, CNG is generated.

1626 – The MTU provides a PLC to detect and fill in for dropped voice packets (CNG, replay of last, interpolation…).

1627 – The MTU implement a packet loss correction algorithm that ensures no annoying degradation for packet loss ratios up to 5%.

1628 – The MTU supports adaptive jitter buffer.

Addressing:

1629 – The MTU is able to connect one or several terminals and to register one or several phone numbers.

1630 – The MTU supports one *E.164* phone numbers per specific connected phone.

1631 – The MTU supports one *E.164* phone number for all connected phones and consequently placing/receiving several calls simultaneously with the same phone number.

1632 – The MTU supports at least two simultaneous calls.

Transport protocol:

1633 – The MTU supports RTP/RTCP in conformance with *IETF RFC 3550*.

Signaling protocol:

1634 – The MTU is in conformance with IETF RFC 2833 for DTMF Digits, Telephony Tones and Telephony Signals.

<u>SIP:</u>

- SIP UA:

1635 – The MTU supports a SIP UA in conformance with *IETF RFC 3261*.

1636 – The MTU supports a SIP UA in conformance with *ETSI TISPAN ES 283.003* profile. The SIP-based MTU plays the role of a UE with regards to the P-CSCF.

1637 – The MTU supports a SIP UA in conformance with the latest draft version of *ETSI ES 03019* profile. The SIP-based MTU plays the role of a UE with regards to the P-CSCF.

- SIP Proxy:

1638 – The MTU supports a SIP Proxy in conformance with *IETF RFC 3261*.

1639 – The MTU supports a SIP Proxy in conformance with *ETSI TISPAN ES 283.003* profile.

1640 – The MTU supports a SIP Proxy in conformance with the latest draft version of *ETSI 03019* profile.

H.248/MEGACO:

- *In-band Mode: Basic Function with Class 5 Telephone Office Service Control*

1641 – The MTU is in conformance with *ITU-T H.248.1* (05/2002), Gateway Control Protocol: Version 2.

1642 – The MTU is in conformance with *IETF RFC 3525*.

1643 – The MTU is in conformance with *ITU-T H.248.26*.

1644 – The MTU is in conformance with *ITU-T H.248.13*.

1645 – The MTU is in conformance with *ITU-T H.248.25*.

1646 – The MTU is in conformance with *ITU-T H.248.30*.

1647 – The MTU is in conformance with *ITU-T H.248.31*.

1648 – The MTU is in conformance with *ITU-T H.248.35*.

1649 – The MTU is in conformance with *IETF RFC 2327* for Session Description Protocol functionality. The textual encoding of H.248.1 uses SDP to describe the characteristics of media. SDP value attributes provide a means extend SDP. To enable the carriage of package defined properties in the local and remote descriptors of the text encoded H.248.1 protocol the Package attribute is used.

1650 – The MTU support the new SDP attribute in conformance with *ITU-T H.248.15* for allowing for the carriage of properties in the local and remote descriptor in the textual H.248 encoding.

- *Out-of-band Mode: Extended function with H.248 MGC Service Control also used with compression codec operation*

1651 – The MTU is in conformance with *ITU-T H.248.2*.

1652 – The MTU is in conformance with *ITU-T H.248.3*.

1653 – The MTU is in conformance with *ITU-T H.248.6*.

1654 – The MTU is in conformance with *ITU-T H.248.16*.

1655 – The MTU is in conformance with *ITU-T H.248.23.*

CLASS services / network services:

1656 – The MTU supports Voice Messaging (FSK signaling)

1657 – The MTU supports Caller ID (CLIP/CLIR).

1658 – The MTU supports Call Waiting ID (CLIP/CLIR).

1659 – The MTU supports Three Way Calling / Three Way Conferencing.

1660 – The MTU supports Call Forwarding / Call Transfer.

1661 – The MTU supports Call Waiting.

1662 – The MTU supports Speed Dialing.

1663 – The MTU supports Call Return.

1664 – The MTU supports Repeat Dialing.

1665 – The MTU supports Disable Call Waiting.

1666 – The MTU supports Call Blocking.

1667 – The MTU supports Voice Dialing.

1668 – The MTU supports Distinctive Ringing.

1669 – The MTU supports Message Waiting Indicator.

1670 – The MTU supports Call Hold.

1671 – The MTU supports Call Toggle.

1672 – The MTU supports Call Pick-up.

9.4 Ethernet/IP part

9.4.1 Quality of service

1673 – The MTU deals with four separate classes of service (as defined in paragraph **2**).

1674 – The MTU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

1675 – The MTU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

1676 – The MTU is able to classify a flow in accordance with UNI physical port.

1677 – The MTU is able to classify and aggregate several flows in accordance with several UNI physical ports.

1678 – For each UNI, the MTU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1679 – For each UNI, the MTU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1680 – For each UNI, the MTU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1681 – For each UNI, the MTU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1682 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the MTU is able to classify a flow according to a LSP label.

1683 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the MTU is able to classify a flow according to a set of LSP labels.

1684 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the MTU is able to classify a flow according to a [LSP label, Pseudo-Wire label] pair.

1685 – After the TDM emulation over Ethernet adaptation (IETF mechanism), the MTU is able to classify a flow according to a set of [LSP label, Pseudo-Wire label] pairs.

1686 – After the TDM emulation over Ethernet adaptation (MEF mechanism), the MTU is able to classify a flow according to an ECID.

1687 – After the TDM emulation over Ethernet adaptation (MEF mechanism), the MTU is able to classify a flow according to a set of ECIDs.

1688 – For each UNI, the MTU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1689 – For each UNI, the MTU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1690 – For each UNI, the MTU is able to classify a flow in accordance with source/destination IP address.

1691 – For each UNI, the MTU is able to classify a flow in accordance with a set of source/destination IP addresses and particularly masked IP addresses.

1692 – For each UNI, the MTU is able to classify a flow in accordance with source/destination UDP/TCP port.

1693 – For each UNI, the MTU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

1694 – When several classification parameters are considered, it is possible to define for each UNI which one is priority in order to deal with potential contradictions. For example, if the Layer 3 priority implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the Layer 3 parameter is the priority classification parameter.

1695 – The MTU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from UNI #1 corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

1696 – For each user, the flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port. It means that when a MTU with N users is considered, N x 4 GEM ports are necessary.

1697 – For each user, the MTU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

1698 – All GEM ports are mapped into the same T-CONT.

1699 – Each GEM port is mapped into a single T-CONT.

1700 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Downstream forwarding:

1701 – The MTU forwards the downstream flows coming from the GEM ports to the adequate destination virtual UNIs according to the various classifications that have been done in the upstream direction.

Conformity of the upstream flows with the SLAs:

1702 – The MTU verifies the conformity of the upstream flows with the agreed SLA per user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1703 – The MTU verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1704 – The MTU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1705 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

1706 – For each user, the MTU supports forwarded, discarded and remarked frames counters

1707 – For each CoS, the MTU supports forwarded, discarded and remarked frames counters.

1708 – For each service of each user, the MTU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

1709 – The MTU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

1710 – There is one separate scheduling/congestion avoidance function per UNI interface. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

1711 – The scheduling features take into account a "MTU CoS parameter" in order to differentiate the flows and give priority to some flows.

1712 – In the upstream direction, the "US MTU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

1713 – In the downstream direction, the MTU allows the operator to configure this "DS MTU CoS parameter" as 802.1D user priority.

1714 – In the downstream direction, the MTU allows the operator to configure this "DS MTU CoS parameter" as VLAN ID of the 802.1Q header.

1715 – In the downstream direction, the MTU allows the operator to configure this "DS MTU CoS parameter" as ToS/DSCP.

1716 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

1717 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

1718 – For each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion per user.

1719 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

1720 – For each service of each user, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

9.4.2 Filtering/Transparency

1721 – For each source UNI, the MTU is able to filter upstream BPDU frames.

1722 – For each source virtual UNI, the MTU is able to filter upstream BPDU frames.

1723 – For each source UNI, the MTU is able to be transparent to upstream BPDU frames.

1724 – For each source virtual UNI, the MTU is able to be transparent to upstream BPDU frames.

1725 – For each source UNI, the MTU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1726 – For each source virtual UNI, the MTU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1727 – For each source UNI, the MTU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1728 – For each source virtual UNI, the MTU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1729 – For each source UNI, the MTU is able to filter upstream broadcast frames.

1730 – For each source virtual UNI, the MTU is able to filter upstream broadcast frames.

1731 – For each source UNI, the MTU is able to be transparent to upstream broadcast frames.

1732 – For each source virtual UNI, the MTU is able to be transparent to upstream broadcast frames.

1733 – For each source UNI, the MTU is able to filter upstream IGMP query messages.

1734 – For each source virtual UNI, the MTU is able to filter upstream IGMP query messages.

1735 – For each source UNI, the MTU is able to be transparent to upstream IGMP query messages.

1736 – For each source virtual UNI, the MTU is able to be transparent to upstream IGMP query messages.

1737 – For each source UNI, the MTU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1738 – For each source virtual UNI, the MTU is able to upstream filter frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1739 – For each source UNI, the MTU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1740 – For each source virtual UNI, the MTU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1741 – For each source UNI, the MTU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1742 – For each source virtual UNI, the MTU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1743 – For each UNI, the MTU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1744 – For each virtual UNI, the MTU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1745 – For each source UNI, the MTU is able to filter upstream 802.1Q VLAN untagged frames.

1746 – For each source UNI, the MTU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1747 – For each source virtual UNI, the MTU is able to filter upstream 802.1Q VLAN untagged frames.

1748 – For each source virtual UNI, the MTU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1749 – The MTU permits IPSec pass-through.

1750 – The MTU permits GRE pass-through.

1751 – The MTU permits L2TP pass-through.

1752 – The MTU permits PPTP pass-through.

9.4.3 Traffic limitation

1753 – For each source UNI, the MTU is able to limit the rate of upstream broadcast frames.

1754 – For each source virtual UNI, the MTU is able to limit the rate of upstream broadcast frames.

9.4.4 VLAN remarking and (de)stacking

1755 – The MTU supports untagged frames.

1756 – The MTU supports 802.1D priority-tagged frames.

1757 – The MTU supports 802.1Q VLAN-tagged frames.

1758 – The MTU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

Remarking:

1759 – For each source UNI, the MTU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1760 – For each source virtual UNI, the MTU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1761 – For each source virtual UNI, the MTU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1762 – For each source UNI, the MTU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

1763 – For each source virtual UNI, the MTU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

1764 – For each source UNI, the MTU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1765 – For each source virtual UNI, the MTU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1766 – For each source UNI, the MTU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1767 – For each source virtual UNI, the MTU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1768 – For each UNI, the MTU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

1769 – For each virtual UNI, the MTU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

1770 – For each destination UNI, the MTU allows the operator to configure this physical port to receive priority-tagged frames.

9.4.5 ToS/DSCP

1771 – For each source UNI, the MTU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1772 – For each source UNI, the MTU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1773 – For each source virtual UNI, the MTU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1774 – For each source virtual UNI, the MTU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1775 – For each source UNI, the MTU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI.

1776 – For each source UNI, the MTU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI.

1777 – For each source virtual UNI, the MTU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source virtual UNI.

1778 – For each source virtual UNI, the MTU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source virtual UNI.

1779 – For each destination UNI, the MTU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1780 – For each destination UNI, the MTU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1781 – For each destination virtual UNI, the MTU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1782 – For each destination virtual UNI, the MTU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1783 – For each destination UNI, the MTU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

1784 – For each destination UNI, the MTU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

1785 – For each destination virtual UNI, the MTU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

1786 – For each destination virtual UNI, the MTU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

9.4.6 802.1x

1787 – The MTU is able to filter/block upstream flows for each UNI. The UNI remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the MTU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the MTU just after the EAP-Success reception, the UNI is administratively "UP" and allowed flows are transferred from the UNI corresponding to the user to the OLT. This feature is never used for corresponding to POTS or DS1/E1.

1788 – The MTU is able to filter/block upstream flows at each configurable group of virtual UNIs of a user. The group of virtual UNIs remains in the 802.1x unauthorized state as long as the corresponding user is not successfully authenticated. Only EAPoL frames are accepted by the MTU and transmitted to the OLT. When the user is authenticated, the OLT sends an OMCI message to inform the MTU just after the EAP-Success reception, the corresponding group of virtual UNIs is administratively "UP" and allowed flows are transferred from the virtual UNIs corresponding to the user to the OLT. This feature is never used for virtual UNIs corresponding to POTS or DS1/E1.

9.4.7 Autoconfiguration

1789 – After receiving specific OMCI messages (triggered by the reception of standard or vendor-specific Radius AVP values at the OLT) the MTU is able to execute some specific local actions. For example, the following actions could be configured at the MTU for each user or physical/virtual UNI(s): VLAN remarking/(de)stacking, ToS/DSCP (re)marking, upstream policing/shaping, upstream filtering/transparency.

9.5 Specific OAM features

9.5.1 Supervision of the End-to-End service connectivity

IETF mechanisms:

1790 – When the TDM UNI is configured as "TDM unstructured", the MTU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-satop*).

1791 – When the TDM UNI is configured as "TDM structured", the MTU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-cesopsn*).

MEF mechanisms:

1792 – The MTU transfers TDM OAM indications via L, R & M bits of the CESoETH Control Word (in conformance with *MEF8*).

9.5.2 Supervision of the network segment connectivity

IETF mechanisms:

1793 – When frames are not received after a given time, the TDM Pseudo Wire is considered as down.

1794 – The MTU supports BFD feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

1795 – The MTU supports LSP Ping feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

1796 – A "Link down" status on the TDM Pseudo-Wire causes "link down" status on the corresponding TDM UNI.

1797 – A "Link down" status on a TDM UNI does not cause "link down" status on the TDM Pseudo-Wire.

MEF mechanisms:

1798 – When frames are not received after a given time, the TDM Emulated Circuit is considered as down.

1799 – A "Link down" status on the TDM Emulated Circuit causes "link down" status on the corresponding TDM UNI.

1800 – A "Link down" status on a TDM UNI does not cause "link down" status on the TDM Emulated Circuit.

10 CBU (Cellular Backhaul Unit)

10.1 General requirements

1801 – The CBU is able to concentrate upstream users' flows with a traffic allocation on a per service basis according to priority (CBU CoS parameter).

1802 – The CBU is able to allow overprovisioning by handling congestions on a fair bandwidth allocation basis for similar CoS.

10.1.1 Synchronization

1803 – The CBU supports the use of a clock extracted from the ODN interface in conformance with 6.4.1 of *ITU-T G.984.3*.

1804 – The CBU supports internal timing for holdover operation with 20 ppm accuracy. The CBU uses the free run clock only if the input clock is lost.

10.2 PON features

1805 – Single fiber transmission is used for optical transmission (both in the upstream and downstream direction) and bidirectional transmission is accomplished by use of a WDM technique.

1806 – The CBU supports a maximum logical reach in conformance with *ITU-T G.984.1* (i.e. 60 km).

10.2.1 Line code

1807 – The CBU uses NRZ coding and scrambling in both directions.

10.2.2 G-PON Transmission Convergence

1808 – The CBU supports a GTC that is composed by a "Framing Sublayer" and an "Adaptation Sublayer" in conformance with *ITU-T G.984.3*.

1809 – The CBU realizes the mapping of GEM frames into GTC payload (and inversely extracts GEM frames from GTC payload) in conformance with *ITU-T G.984.3*.

1810 – The CBU realizes the mapping of Ethernet frames into GEM frames (and inversely extracts Ethernet frames from GEM frames) in conformance with *ITU-T G.984.3*.

1811 – The CBU realizes the mapping of TDM data into GEM frames (and inversely extracts TDM data from GEM frames) in conformance with *ITU-T G.984.3 Appendix I.2*.

1812 – The CBU is able to send frames according to a static allocation provisioned at the OLT.

1813 – The CBU supports the Non Status Reporting mode in conformance with *ITU-T G.984.3*.

1814 – The CBU is able to provide the information to the DBA function at the OLT in order to optimize bandwidth allocation between ONTs/ONUs when needed.

1815 – The CBU supports the Status Reporting mode in conformance with *ITU-T G.984.3*.

1816 – The CBU supports at least DBRu mode 0 in conformance with *ITU-T G.984.3*.

1817 – The CBU implements the principle of T-CONT (identified by "Alloc-ID") as the basic control unit for upstream direction in conformance with *ITU-T G.984.3*.

- **Option 1: Single T-CONT per CBU**

  1818 – The CBU is able to support a single T-CONT.

- **Option 2: Multiple T-CONT per CBU**

  1819 – The CBU is able to support at least 4 T-CONTs i.e. 1 T-CONT per CoS.

1820 – The CBU is able to use the activation Discovered SN method in conformance with *ITU-T G.984.3*.

1821 – The CBU is able to use the activation Configured SN method in conformance with *ITU-T G.984.3*.

1822 – The CBU uses the encryption system (128 bits AES) and the Key Exchange mechanism in conformance with *ITU-T G.984.3*.

1823 – The CBU implements an "embedded OAM channel", a "PLOAM channel" and an "OMCI channel" in conformance with *ITU-T G.984.4*.

10.2.3 Upstream

Nominal line rate:

1824 – The CBU supports a 1244 Mbps line rate.

Optical performances:

1825 – The CBU supports Class B (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2*.

1826 – The CBU supports Class B+ (Optical budget, source type, transmitter range, mean launched power min, mean launched power max, extinction ratio…) in conformance with *ITU-T G.984.2 Amd1*.

1827 – The CBU is able to support upstream FEC.

10.2.4 Downstream

Nominal line rate:

1828 – The CBU supports a 2.488 Mbps line rate.

Optical performances:

1829 – The CBU supports Class B (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2*.

1830 – The CBU supports Class B+ (Optical budget, receiver type, maximum reflectance, BER, minimum sensitivity…) in conformance with *ITU-T G.984.2 Amd1*.

1831 – The CBU is able to support downstream FEC.

10.3 UNI (User Network Interface)

10.3.1 TDM

1832 – The CBU supports four E1 interfaces in conformance with *ITU-T G.703*, *G.704*, *G.823* (jitter and wander levels), *ETSI EN 300 912* and *3GPP TS 125 402* specifications clauses dealing with frequency stability and accuracy.

1833 – The CBU supports eight E1 interfaces in conformance with *ITU-T G.703*, *G.704*, *G.823* (jitter and wander levels), *ETSI EN 300 912* and *3GPP TS 125 402* specifications clauses dealing with frequency stability and accuracy.

1834 – The CBU supports sixteen E1 interfaces in conformance with *ITU-T G.703*, *G.704*, *G.823* (jitter and wander levels), *ETSI EN 300 912* and *3GPP TS 125 402* specifications clauses dealing with frequency stability and accuracy.

1835 – The CBU only allows the operator to configure each E1 interface as "TDM unstructured" (in conformance with *ITU-T G.703*).

1836 – The CBU allows the operator to configure each E1 interface as "TDM unstructured" (in conformance with *ITU-T G.703*), "TDM structured" (in conformance with *ITU-T G.703/704*) or "ATM" (in conformance with *ITU-T I.432.3*).

1837 – The CBU is able to group a configurable set of E1 interfaces configured as ATM (from two E1 interfaces to the maximum number of E1 interfaces) in an IMA v1.1 group.

1838 – The CBU supports a STM1 interface in conformance with *ITU-T G.957 S-1.1 and I.432.2*.

1839 – The CBU allows the operator to configure whether emulation over Ethernet or TDMoGEM is used for mobile flows backhaul.

1840 – When emulation over Ethernet is used, the CBU allows the operator to configure whether IETF or MEF mechanism is used for mobile flows backhaul.

1841 – TDMoGEM is always used to transport mobile flows.

1842 – IETF mechanisms are always used to transport mobile flows.

1843 – MEF mechanisms are always used to transport mobile flows.

IETF Encapsulation:

1844 – The CBU allows the operator to statically configure the IP address of its interface.

1845 – The CBU allows the operator to statically configure its loopback IP address.

1846 – The CBU allows the operator to statically configure the IP address of the default Gateway.

1847 – The CBU is able to periodically send ARP requests.

<u>MPLS layer:</u>

1848 – The CBU supports static configuration of one or several LSP labels.

1849 – The CBU allows the operator to statically configure the EXP field value of each LSP.

1850 – The CBU supports LDP signaling (in conformance with IETF *RFC 3036*) in order to connect automatically the MTU to one or several distant devices through a LSP. The CBU allows the operator to statically configure one or several destination loopback IP address (one per device terminating a LSP).

TDM PW:

1851 – The CBU supports static configuration of one or several TDM PW label.

1852 – When SAToP is used, the CBU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1853 – When CESoPSN is used, the CBU allows the operator to statically configure one destination IP address per TDM flow i.e. per TDM Pseudo-Wire.

1854 – deleted.

1855 – The CBU supports Targeted LDP signaling (in conformance with the latest versions of *draft-ietf-pwe3-control-protocol* and *draft-ietf-pwe3-tdm-control-protocol-extensi*) in order to establish automatically the TDM Pseudo-Wire.

1856 – When the TDM UNI is configured as "TDM unstructured", the CBU supports MPLS mode of SAToP in conformance with the latest version of *draft-ietf- pwe3-satop*.

1857 – When the TDM UNI is configured as "TDM structured", the CBU supports MPLS mode of CESoPSN in conformance with the latest version of *draft-ietf-pwe3-cesopsn*.

1858 – When the TDM UNI is configured as "TDM structured", the CBU supports a Dynamic Bandwidth CESoPSN mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1859 – The CBU allows the operator to configure the size of the payload via timer-based threshold.

1860 – The CBU allows the operator to configure the jitter buffer size.

1861 – The CBU is able to use a dynamic jitter buffer size adjust algorithm.

1862 – The CBU allows the operator to configure several TDM Pseudo-wires.

1863 – When the TDM UNI is configured as "TDM unstructured", the CBU allows the operator to map a full DS1/E1 to a TDM Pseudo-Wire.

1864 – When the TDM UNI is configured as "TDM structured", the CBU allows the operator to map a single configurable set of timeslots from a DS1/E1 to a TDM Pseudo-Wire.

ATM PW:

1865 – The CBU supports static configuration of one or several ATM PW label.

1866 – The CBU supports Targeted LDP signalling (in conformance with the latest version of *draft-ietf-pwe3-control-protocol*) in order to establish automatically the ATM Pseudo-Wire.

1867 – When the TDM UNI is configured as "ATM", the CBU is able to support VP Mode of ATMoPSN encapsulation in conformance with the latest version of *draft-ietf-pwe3-atm-encap*.

1868 – When the TDM UNI is configured as "ATM", the CBU is able to support VC Mode of ATMoPSN encapsulation in conformance with the latest version of *draft-ietf-pwe3-atm-encap*.

1869 – The CBU allows the operator to configure the size of the payload via timer-based and length-based (number of ATM cells) threshold.

1870 – The CBU allows the operator to configure several ATM Pseudo-wires.

1871 – The CBU allows the operator to map a single ATM VP (depending of the ATMoPSN mode) to an ATM Pseudo-Wire.

1872 – The CBU allows the operator to map a single ATM VC (depending of the ATMoPSN mode) to an ATM Pseudo-Wire.

MEF mechanism:

Adaptation layer:

1873 – The CBU supports static configuration of the ECID field.

TDM Emulated Circuit:

1874 – When the TDM UNI is configured as "TDM unstructured", the CBU supports structure-agnostic mode of CESoETH in conformance with *MEF8*.

1875 – When the TDM UNI is configured as "TDM structured", the CBU supports raw (structure-locked) mode of CESoETH in conformance with *MEF8*.

1876 – When the TDM UNI is configured as "TDM structured", the CBU supports a Dynamic Bandwidth CESoETH mechanism i.e. a method aiming at detecting active timeslots and at sending only these active timeslots.

1877 – The CBU allows the operator to configure the size of the payload via timer-based threshold.

1878 – The CBU allows the operator to configure the jitter buffer size.

1879 – The CBU supports a dynamic jitter buffer size adjust algorithm.

1880 – The CBU allows the operator to configure several TDM Emulated Circuits.

1881 – When the TDM UNI is configured as "TDM unstructured", the CBU allows the operator to map a full E1 to a TDM Emulated Circuit.

1882 – When the TDM UNI is configured as "TDM structured", the CBU allows the operator to map a single configurable set of timeslots from an E1 to a TDM Emulated Circuit.

TDMoGEM:

1883 – The CBU supports the use of TDMoGEM features in conformance with *ITU-T appendix I.2* in order to transport mobile flows in an unstructured way.

10.3.2 Ethernet

1884 – The CBU supports two 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

1885 – The CBU supports two 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

1886 – The CBU supports four 10/100BASE-T interfaces in conformance with *IEEE 802.3u*.

1887 – The CBU supports four 10/100/1000BASE-T interfaces in conformance with *IEEE 802.3u* and *802.3z*.

1888 – Each Ethernet UNI supports by default auto-negotiation of speed and duplex mode.

1889 – For each Ethernet UNI, the CBU allows the operator to configure manually the linerate as 10 or 100 Mbps**.**

1890 – For each Ethernet UNI, the CBU allows the operator to configure manually the linerate as 10, 100 or 1000 Mbps**.**

1891 – For each Ethernet UNI, the CBU allows the operator to configure manually duplex mode as half or full.

1892 – Each Ethernet UNI supports Auto MDI / MDI-X feature.

1893 – For each Ethernet UNI, the CBU is able to support "Flow Control" (in conformance with *IEEE 802.3 Annex 31B*) with PAUSE functionality at the UNIs.

10.4 Ethernet/IP part

10.4.1 Quality of service

1894 – The CBU deals with four separate classes of service (as defined in paragraph **2**).

1895 – The CBU is aware of the configured CoS type corresponding to each GEM port multiplexed into a T-CONT in the upstream direction.

Upstream mapping of flows into virtual UNIs:

1896 – The CBU is able to classify the upstream flows (on different parameters basis) into various virtual interfaces called "virtual UNIs".

<u>TDM UNI (after the TDM/ATM emulation over Ethernet):</u>

1897 – The CBU is able to classify a flow according to a LSP label after the ATM/TDM emulation over Ethernet adaptation (IETF mechanism).

1898 – The CBU is able to classify a flow according to a set of LSP labels after ATM/TDM emulation over Ethernet adaptation (IETF mechanism).

1899 – The CBU is able to classify a flow according to a [LSP label, Pseudo-Wire label] pair after the ATM/TDM emulation over Ethernet adaptation (IETF mechanism).

1900 – The CBU is able to classify a flow according to a set of [LSP label, Pseudo-Wire label] pairs after the ATM/TDM emulation over Ethernet adaptation (IETF mechanism).

1901 – The CBU is able to classify a flow according to EXP field after the ATM/TDM emulation over Ethernet adaptation (IETF mechanism).

1902 – The CBU is able to classify a flow according to an ECID after the TDM emulation over Ethernet adaptation (MEF mechanism).

1903 – The CBU is able to classify a flow according to a set of ECIDs after the TDM emulation over Ethernet adaptation (MEF mechanism).

<u>Ethernet UNI:</u>

1904 – The CBU is able to classify a flow in accordance with UNI physical port.

1905 – The CBU is able to classify and aggregate several flows in accordance with several UNI physical ports.

1906 – For each Ethernet UNI, the CBU is able to classify a flow in accordance with 802.1D user priority field of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1907 – For each Ethernet UNI, the CBU is able to classify and aggregate several flows in accordance with a set of 802.1D user priority fields of the 802.1Q header. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1908 – For each Ethernet UNI, the CBU is able to classify a flow in accordance with 802.1Q VLAN ID. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1909 – For each Ethernet UNI, the CBU is able to classify and aggregate several flows in accordance with a set of 802.1Q VLAN ID fields. When this mode is activated, untagged frames are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1910 – For each Ethernet UNI, the CBU is able to classify a flow in accordance with ToS/DSCP field. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1911 – For each Ethernet UNI, the CBU is able to classify and aggregate several flows in accordance with a set of ToS/DSCP fields. When this mode is activated, untagged packets are classified in a configurable CoS level if there is no other classification parameter that is able to classify these flows into a virtual UNI.

1912 – For each UNI, the CBU is able to classify a flow in accordance with source/destination IP address.

1913 – For each UNI, the CBU is able to classify a flow in accordance with a set of source/destination IP addresses and particularly masked IP addresses.

1914 – For each Ethernet UNI, the CBU is able to classify a flow in accordance with source/destination UDP/TCP port.

1915 – For each Ethernet UNI, the CBU is able to classify and aggregate several flows in accordance with a set of source/destination UDP/TCP ports.

1916 – For each Ethernet UNI, the CBU is able to classify the flows into a virtual interface on a combination of all these basic parameters.

1917 – When several classification parameters are considered, it is possible to define for each Ethernet UNI which one is priority in order to deal with potential contradictions. For example, if the Layer 4 parameter implies that a flow is classified into the CoS4 virtual interface and the Layer 2 priority implies that this flow is classified into the CoS3 virtual interface, the flow is classified into CoS4 virtual interface if the TCP/UDP port parameter is the priority classification parameter.

1918 – The CBU allows the operator to specify the CoS corresponding to each virtual UNI that is created after the classification step. For example, it is possible to configure (if 802.1D user priority of the 802.1Q header is used as classification parameter for a specific UNI) that Layer 2 priority = "6" coming from UNI #1 corresponds to a virtual UNI of CoS3 type.

Upstream mapping of virtual UNIs into GEM ports:

1919 – The flows coming from all the virtual UNIs with the same CoS are forwarded to the same GEM port.

1920 – The CBU allows the operator to configure that each flow coming from a virtual UNI is either mapped into a single GEM port or grouped with flows coming from other virtual UNIs with the same CoS.

Upstream mapping of GEM ports into T-CONTs:

1921 – All GEM ports are mapped into the same T-CONT.

1922 – Each GEM port is mapped into a single T-CONT.

1923 – All GEM ports corresponding to CoS1 are mapped into the same T-CONT, all GEM ports corresponding to CoS2 are mapped into the same T-CONT, all GEM ports corresponding to CoS3 are mapped into the same T-CONT but each GEM port corresponding to CoS4 is mapped into a single T-CONT (note that this example only indicates one possible configuration of T-CONTs and does not encompass all potential implementations).

Conformity of the upstream flows with the SLAs:

1924 – The CBU verifies the conformity of the upstream flows with the agreed SLA per CoS with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1925 – The CBU verifies the conformity of the upstream flows with the agreed SLA per service of each user with any preferred mechanism (policing/shaping…). This feature is implemented to optimize the upstream throughput when the traffic is susceptible to be bursty.

1926 – This functionality allows operations of forwarding, discarding and remarking (with a lower level of priority) of the upstream traffic as a result of the metering.

1927 – For each user, the CBU supports forwarded, discarded and remarked frames counters.

1928 – For each CoS, the CBU supports forwarded, discarded and remarked frames counters.

1929 – For each service of each user, the CBU supports forwarded, discarded and remarked frames counters.

Scheduling (possibly with congestion avoidance):

1930 – The CBU uses scheduling features (possibly with congestion avoidance) at each concentration point (in both directions, at the ingress and/or at the egress) in order to provide the required SLA for each flow (in coordination with the QoS mechanisms at the OLT).

1931 – There is one separate scheduling/congestion avoidance function per UNI interface. The traffic is put into different queues according to the type of CoS of each flow. As four different CoS have been defined, there are at least four queues before the potential congestion points.

1932 – The scheduling features take into account a "CBU CoS parameter" in order to differentiate the flows and give priority to some flows.

1933 – In the upstream direction, the "US CBU CoS parameter" corresponds to the CoS level configured per virtual UNI during the classification step.

1934 – In the downstream direction, the CBU allows the operator to configure this "DS CBU CoS parameter" as 802.1D user priority. This is configurable per 802.1Q VLAN.

1935 – In the downstream direction, the CBU allows the operator to configure this "DS CBU CoS parameter" as VLAN ID of the 802.1Q header. This is configurable per 802.1Q VLAN.

1936 – In the downstream direction, the CBU allows the operator to configure this "DS CBU CoS parameter" as ToS/DSCP. This is configurable per 802.1Q VLAN.

1937 – The scheduling/congestion avoidance functions use any preferred static/dynamic mechanism (PQ, WFQ, RED, WRED…) in order to guarantee the various SLAs.

1938 – The operator has the possibility to modify the various scheduling parameters (choice of the scheduling method for each queue, weights of the WFQ scheduler…).

1939 – For each CoS, there are counters of forwarded frames and counters of dropped frames due to queue congestion.

1940 – For each mobile flow, there are counters of forwarded frames and counters of dropped frames due to queue congestion.Filtering/Transparency

1941 – For each source UNI, the CBU is able to filter upstream BPDU frames.

1942 – For each source virtual UNI, the CBU is able to filter upstream BPDU frames.

1943 – For each source UNI, the CBU is able to be transparent to upstream BPDU frames.

1944 – For each source virtual UNI, the CBU is able to be transparent to upstream BPDU frames.

1945 – For each source UNI, the CBU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1946 – For each source virtual UNI, the CBU is able to filter upstream user VLANs (individual VLAN or group of VLANs).

1947 – For each source UNI, the CBU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1948 – For each source virtual UNI, the CBU is able to be transparent to upstream user VLANs and S_VLAN tag is only added at the OLT.

1949 – For each source UNI, the CBU is able to filter upstream broadcast frames.

1950 – For each source virtual UNI, the CBU is able to filter upstream broadcast frames.

1951 – For each source UNI, the CBU is able to be transparent to upstream broadcast frames.

1952 – For each source virtual UNI, the CBU is able to be transparent to upstream broadcast frames.

1953 – For each source UNI, the CBU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1954 – For each source virtual UNI, the CBU is able to filter upstream frames with specific Ethertype value(s). At least, PPPoE (Ethertype = 0x8863 and 0x8864), IPoE (Ethertype = 0x8000) and ARP (Ethertype = 0x0806) are taken into account.

1955 – For each source UNI, the CBU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1956 – For each source virtual UNI, the CBU is able to filter upstream frames on source/destination MAC address criteria and particularly on masked MAC addresses criteria.

1957 – For each source UNI, the CBU is able to filter upstream frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1958 – For each source virtual UNI, the CBU is able to upstream filter frames on source/destination IP address criteria and particularly on masked IP addresses criteria.

1959 – For each source UNI, the CBU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1960 – For each source virtual UNI, the CBU is able to filter upstream frames on source/destination TCP/UDP port criteria.

1961 – For each source UNI, the CBU is able to filter upstream 802.1Q VLAN untagged frames.

1962 – For each source UNI, the CBU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1963 – For each source virtual UNI, the CBU is able to filter upstream 802.1Q VLAN untagged frames.

1964 – For each source virtual UNI, the CBU is able to be transparent to upstream 802.1Q VLAN untagged frames.

1965 – The CBU permits IPSec pass-through.

1966 – The CBU permits GRE pass-through.

1967 – The CBU permits L2TP pass-through.

1968 – The CBU permits PPTP pass-through.

10.4.2 Traffic limitation

1969 – For each source UNI, the CBU U is able to limit the rate of upstream broadcast frames.

1970 – For each source virtual UNI, the CBU is able to limit the rate of upstream broadcast frames.

10.4.3 VLAN (re)marking and (de)stacking

NB: All these functions can be done both for Ethernet UNIs or virtual UNIs created after the TDM/ATM adaptation.

1971 – The CBU supports untagged frames.

1972 – The CBU supports 802.1D priority-tagged frames.

1973 – The CBU supports 802.1Q VLAN-tagged frames.

1974 – The CBU provides full functionalities and support of VLAN ID numbering from 0 through 4095.

(Re)marking:

1975 – For each source UNI, the CBU is able to remark VLAN ID to upstream 802.1Q-tagged frames received from a virtual UNI at the upstream direction.

1976 – For each source virtual UNI, the CBU is able to remark VLAN ID to upstream 802.1Q-tagged frames.

1977 – For each source UNI, the CBU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1978 – For each source virtual UNI, the CBU is able to remark 802.1D user priority field of the 802.1Q header to upstream tagged frames.

1979 – For each source virtual UNI, the CBU is able to automatically remark 802.1D user priority field to upstream 802.1Q-tagged frames according to the configured CoS corresponding to this source virtual UNI.

(De)stacking:

1980 – For each source UNI, the CBU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1981 – For each source virtual UNI, the CBU is able to attach a VLAN tag to upstream untagged frames. The VLAN ID and priority values are configurable.

1982 – For each source UNI, the CBU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1983 – For each source virtual UNI, the CBU is able to remove VLAN tag to upstream 802.1Q-tagged frames.

1984 – For each UNI, the CBU allows the operator to indicate whether it is an untagged or VLAN-tagged physical port.

1985 – For each virtual UNI, the CBU allows the operator to indicate whether it is an untagged or VLAN-tagged virtual port.

1986 – For each destination UNI, the CBU allows the operator to configure this physical port to receive priority-tagged frames.

10.4.4 ToS/DSCP

NB: All these functions can be done both for Ethernet UNIs or virtual UNIs created after the TDM/ATM adaptation.

1987 – For each source UNI, the CBU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1988 – For each source UNI, the CBU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1989 – For each source virtual UNI, the CBU is able to mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets.

1990 – For each source virtual UNI, the CBU is able to remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets.

1991 – For each source UNI, the CBU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source UNI.

1992 – For each source UNI, the CBU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source UNI.

1993 – For each source virtual UNI, the CBU is able to automatically mark ToS/DSCP tag to upstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the source virtual UNI.

1994 – For each source virtual UNI, the CBU is able to automatically remark ToS/DSCP tag to upstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the source virtual UNI.

1995 – For each destination UNI, the CBU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1996 – For each destination UNI, the CBU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1997 – For each destination virtual UNI, the CBU is able to mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets.

1998 – For each destination virtual UNI, the CBU is able to remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets.

1999 – For each destination UNI, the CBU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination UNI.

2000 – For each destination UNI, the CBU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination UNI.

2001 – For each destination virtual UNI, the CBU is able to automatically mark ToS/DSCP tag to downstream Layer 3 priority-untagged packets according to the configured CoS corresponding to the destination virtual UNI.

2002 – For each destination virtual UNI, the CBU is able to automatically remark ToS/DSCP tag to downstream Layer 3 priority-tagged packets according to the configured CoS corresponding to the destination virtual UNI.

10.5 Specific OAM features

10.5.1 Supervision of the End-to-End service connectivity

IETF mechanisms:

2003 – When the TDM UNI is configured as "TDM unstructured", the CBU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-satop)*.

2004 – When the TDM UNI is configured as "TDM structured", the CBU transfers TDM OAM indications via L, R & M bits of the Pseudo-Wire Control Word (in conformance with the latest version of *draft-ietf-pwe3-cesopsn*).

2005 – When the TDM UNI is configured as "ATM" and port mode of ATMoPSN is used, the CBU transfers transparently F4 and F5 end-to-end OAM flows.

2006 – When the TDM UNI is configured as "ATM" and VP mode of ATMoPSN is used, the CBU transfers transparently F5 end-to-end OAM flows.

MEF mechanisms:

2007 – The CBU transfers TDM OAM indications via L, R & M bits of the CESoETH Control Word (in conformance with *MEF8*).

10.5.2 Supervision of the network segment connectivity

IETF mechanisms:

2008 – When frames are not received after a given time, the TDM Pseudo Wire is considered as down.

2009 – When VP mode of ATMoPSN is used, the CBU is able to support F4 segment OAM flows.

2010 – When VC mode of ATMoPSN is used, the CBU is able to support F5 segment OAM flows.

2011 – The CBU supports BFD feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

2012 – The CBU supports LSP Ping feature of VCCV in conformance with the latest version of *draft-ietf-pwe3-vccv-encap*.

2013 – A "Link down" status on the Pseudo-Wire causes "link down" status on the corresponding TDM UNI.

2014 – A "Link down" status on a TDM UNI does not cause "link down" status on the Pseudo-Wire.

MEF mechanisms:

2015 – When frames are not received after a given time, the TDM Emulated Circuit is considered as down.

2016 – A "Link down" status on the Emulated Circuit causes "link down" status on the corresponding TDM UNI.

2017 – A "Link down" status on a TDM UNI does not cause "link down" status on the Emulated Circuit.

11 Management plane

11.1 Physical alarms

2018 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for laser drive current at the OLT.

2019 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for laser drive current at the ONT/ONU.

2020 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for optical output power at the OLT.

2021 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for optical output power at the ONT/ONU.

2022 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for receiver optical power at the OLT.

2023 – The G-PON system is able to monitor, set thresholds and generate alarm conditions for receiver optical power at the ONT/ONU.

2024 – The G-PON system is able to support dry loop to report powering alarm.

2025 – The G-PON system is able to use power shedding when a powering alarm is detected. The interfaces that are priority are POTS or Lifeline Ethernet UNIs.

2026 – The G-PON system is able to support dry loop to report battery alarm.

2027 – The G-PON system is able to support dry loop to report environmental alarm.

2028 – The G-PON system is able to support dry loop to report intrusion alarm.

11.2 Ethernet OAM

2029 – The G-PON system is in conformance with the latest draft versions of *IEEE 802.1ag* and *ITU-T Y.17ethoam*. *IEEE 802.1ag* and *ITU-T Y.17ethoam* define the concept of a Maintenance association End Point (MEP) and Maintenance association Intermediate Point (MIP), which are configured on a per port, per VLAN and per Maintenance Domain Level. MEPs initiate Connectivity Fault Management (CFM) OAM messages and are configured at the far end of the service perimeter or S-VLAN. MIPs are configured across the path of the S-VLAN. Various Domain Maintenance Entity (ME) Levels can be configured, allowing the network administrator to divide the network into multiple administrative OAM domains and to allow nesting of OAM domains, where an ME Level corresponds to an OAM domain. An example of Ethernet OAM support is presented in *DSL Forum WT-101 revision 9*.

11.3 OMCI (ONT Management and Control Interface)

2030 – The OLT complies with OMCI in the applicable sections of in ITU-T Recommendation G.984.4 and referenced documents. All applicable managed entities in Table 1/G.984.4 are supported.

2031 – ONTs/ONUs complies with the applicable sections of ITU-T Recommendation G.984.4 and referenced documents. All applicable managed entities in Table 1/G.984.4 required to support the features and services outlined in this document are supported.