

# **TR-142**

## **Framework for TR-069 enabled PON Devices**

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| 1                   | March 2008        | Christele Bouchat,<br>Alcatel-Lucent | Original  |
| 2                   | February 2010     | Christele Bouchat,<br>Alcatel-Lucent | Further defines the domain of responsibilities of TR-069 and the lower layer management protocol for PON. |

Comments or questions about this Broadband Forum Technical Report should be directed to [info@broadband-forum.org](mailto:info@broadband-forum.org).

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## Executive Summary

TR-142 describes how PON devices having layer 3 capabilities can be remotely configured, troubleshot and managed by an ACS using TR-069, leveraging the same management infrastructure and procedures irrespectively:

- Whether the PON device is an ONT, a Residential Gateway, or a device connected through a home network,
- Whether the services relying on this device are operated by the access network provider, or independently by another service provider
- Whether the access network technology is GPON, EPON, 10G-EPON, XGPON, or another broadband access technology such as xDSL or 3G.

## **1 Purpose and Scope**

### **1.1 Purpose**

The goal of TR-142 is to provide a framework for the remote configuration and management of services for PON (Passive Optical Network) access.

### **1.2 Scope**

This document is intended to define a framework for remote management of CPE over various PON access technologies. TR-069 is the protocol of choice used by service providers worldwide for the remote management and configuration of many kinds of broadband CPE. The scope of this document is to detail the applicability to CPE having a PON (GPON, GEAPON, 10G-EPON, XGPON for example) WAN interface and in particular to clarify the relation between TR-069 and OMCI/IEEE 802.3ah. This document specifies the linkage between OMCI/IEEE 802.3ah and TR-069 domains, in the context of PON management.

The scope of this document addresses Single Family Units and Single Business Units. It does not address Multi-Dwelling Units, Multi-Tenant Units, GPON-fed DSLAM or OLT.

## 2 References and Terminology

### 2.1 Conventions

In this Technical Report, several words are used to signify the requirements of the specification. These words are always capitalized. More information can be found in RFC 2119.

|                   |  |
|-------------------|--|
| <b>MUST</b>       | This word, or the term “REQUIRED”, means that the definition is an absolute requirement of the specification.  |
| <b>MUST NOT</b>   | This phrase means that the definition is an absolute prohibition of the specification.   |
| <b>SHOULD</b>     | This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications need to be understood and carefully weighed before choosing a different course.   |
| <b>SHOULD NOT</b> | This phrase, or the phrase "NOT RECOMMENDED" means that there may exist valid reasons in particular circumstances when the particular behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label. |
| <b>MAY</b>        | This word, or the adjective “OPTIONAL”, means that this item is one of an allowed set of alternatives. An implementation that does not include this option <b>MUST</b> be prepared to inter-operate with another implementation that does include the option.  |

### 2.2 References

The following references are of relevance to this Technical Report. At the time of publication, the editions indicated were valid. All references are subject to revision; users of this Technical Report are therefore encouraged to investigate the possibility of applying the most recent edition of the references listed below.

A list of currently valid Broadband Forum Technical Reports is published at [www.broadband-forum.org](http://www.broadband-forum.org).

- [1] TR-069 Amendment 2. CPE WAN Management Protocol, Broadband Forum Technical Report.
- [2] TR-104 Provisioning Parameters for VoIP CPE, Broadband Forum Technical Report.
- [3] TR-098 BroadbandHome Internet Gateway Device Data Model for TR-069, Broadband Forum Technical Report.

- [4] TR-156 Using GPON Access in the context of TR-101, Broadband Forum Technical Report.
- [5] TR-101 Migration to Ethernet-Based DSL Aggregation, Broadband Forum Technical Report.
- [6] ITU-T G.983.1. Broadband optical access systems based on PON. ITU-T recommendation.
- [7] ITU-T G.983.2. ONT management and control interface specification for B-PON. ITU-T recommendation.
- [8] ITU-T G.983.3. A broadband optical access system with increased service capability by wavelength allocation. ITU-T recommendation.
- [9] ITU-T G.984.4. GPON: ONT management and control interface specification. ITU-T recommendation.
- [10] IEEE 802.3ah. Ethernet Link OAM. Clause 30 and 57 of IEEE 802.3 (2008).
- [11] IEEE 802.3av. 10Gb/s Ethernet Passive Optical Network.
- [12] ITU-T G.Impl.984.4 Implementers' Guide - Second Revision. ITU-T recommendation.

### 2.3 Definitions

The following terminology is used throughout this Technical Report.

|                    |  |
|--------------------|--|
| <b>10G-EPON</b>    | An EPON architecture operating at 10 Gbit/s data rate in either one or both directions, as defined in IEEE802.3av  |
| <b>ACS</b>         | Auto-Configuration Server. This is a component in the broadband network responsible for auto-configuration of the CPE for advanced services  |
| <b>B-NT</b>        | Broadband Network Termination, for any WAN-side access technology  |
| <b>CPE</b>         | Customer Premises Equipment, as defined in TR-069  |
| <b>GEM</b>         | GPON Encapsulation Method: A data frame transport scheme used in GPON systems that is connection-oriented and that supports fragmentation of the user data frames into variable sized transmission fragments                                       |
| <b>GEM port</b>    | A virtual flow over GEM Encapsulation identified by a series of GEM frames that share a common GEM Port Id. A unique GEM Port is assigned per Ethernet flow (or group of flows), and is used for distinguishing between the flows at the GEM layer |
| <b>GEM port id</b> | The GEM Port Id field is part of the GEM header. It is used to identify a GEM port   |
| <b>GEAPON</b>      | Gigabit Ethernet Passive Optical Network as defined in IEEE802.3ah   |
| <b>GPON</b>        | Gigabit capable Passive Optical Network as defined in ITU-T G.984 serie  |
| <b>ODN</b>         | Optical Distribution Network. In the PON context, a tree of optical fibers in the access network, supplemented with power or wavelength splitters, filters, or other passive optical devices   |



|               |  |
|---------------|--|
| <b>OLT</b>    | Optical Line Termination. A device that terminates the common (root) endpoint of an ODN, and implements a PON protocol, such as that defined by G.984. The OLT provides management and maintenance functions for the subtended ODN and ONUs                              |
| <b>OMCI</b>   | ONT Management and Control Interface as defined in ITU-T G.984.4   |
| <b>ONT</b>    | Optical Network Termination. A single subscriber device that terminates any one of the distributed (leaf) endpoints of an ODN, and implements a PON protocol. An ONT is a special case of an ONU   |
| <b>ONU</b>    | Optical Network Unit. A generic term denoting a device that terminates any one of the distributed (leaf) endpoints of an ODN, and implements a PON protocol. In some contexts, an ONU implies a multiple subscriber device   |
| <b>PLOAM</b>  | Physical Layer Operations, Administration and Maintenance.   |
| <b>PON</b>    | Passive Optical Network  |
| <b>UNI</b>    | User-Network Interface, equivalent of the U reference point in TR-156. It is the subscriber-facing interface of the ONT, and the WAN interface of the Routing Gateway  |
| <b>vUNI</b>   | Virtual UNI: it is the logical construct of a UNI internal of a PON CPE, representing the boundary between TR-069 and OMCI/IEEE 802.3ah management domains   |
| <b>T-cont</b> | T-CONTs are used for controlling the upstream bandwidth allocation in the PON. A T-CONT can carry multiple GEM ports. All the ONU traffic in the upstream direction are mapped into the T-CONTs, which carry the GEM frames, based on bandwidth allocations from the OLT |
| <b>WAN</b>    | Wide Area Network  |

### **3 Technical Report Impact**

#### **3.1 Energy Efficiency**

By enabling dual-managed PON devices, TR-142 is expected to facilitate the integration of multiple home network platforms into a single platform. For example, a routing gateway, an Analog Terminal Adapter and an ONT can be integrated into a single device, therefore improving significantly the energy efficiency of the broadband home.

#### **3.2 IPv6**

By defining the concept of a Virtual-UNI, enabling a clean separation between the management domains of TR-069 and OMCI/IEEE 802.3ah within a PON CPE, TR-142 allows independency between the management of IPv6 related functions and the management of PON-specific functions, therefore facilitating the deployment of IPv6 services over these devices.

#### **3.3 Security**

There are no relevant security issues relating to TR-142.

## 4 Applying the CPE WAN Management Protocol to PON CPE

TR-069 describes the CPE WAN Management Protocol, intended for communication between a CPE and an Auto-Configuration Server (ACS). The CPE WAN Management Protocol defines a mechanism that encompasses secure auto-configuration of a CPE, and also incorporates other CPE management functions into a common framework.

The CPE WAN Management Protocol is targeted at management of B-NTs. The protocol itself is transparent to the physical layer and link layer. The only assumption made is that the device must be IP addressable.

In broad terms, layer 3 auto-configuration is the same for a PON ONT as for a DSL B-NT. A PON ONT can be assigned an IP address via DHCP, IPCP, or static IP addressing. The main difference between the PON ONT and the DSL B-NT configuration and management is in the WAN link layer and the existence of access technology specific protocols managing PON specific functions, such as OMCI and IEEE 802.3ah.

At first, an initial configuration phase takes place on the PON layer through which e.g. for B-PON and GPON an ONT is assigned its PON ONU-ID using PLOAM (Physical Layer OAM) messaging. The VP/VC or port-ID is given to the ONT on which the OMCI channel is carried (as defined in G.983.1 for B-PON and G.984.3 for GPON). The OMCI (ITU-T G.983.2 for BPON or ITU-T G.984.4 for GPON) protocol addresses the ONT configuration management, fault management and performance management for BPON/GPON system operation.

The MultiPoint MAC Control section of the 802.3ah specification describes the GEAPON discovery and configuration mechanism on the PON layer. 802.3ah also specifies an (optional) OAM mechanism allowing link monitoring and remote failure indication.

There is quite a big difference between OMCI capabilities and 802.3ah. Briefly, the 802.3ah standard only describes some OAM capabilities on the link layer, and no provisioning capabilities to configure other CPE features. In contrast OMCI does specify quite extensive provisioning capabilities, including management of services such as voice services, circuit emulation services, etc.

Note that these protocols (PLOAM, OMCI, 802.3ah) are only used in between the OLT and the ONT, as shown in Figure 1. In contrast, Figure 2 shows that TR-069 is transparent for the OLT and going directly from the ACS to the PON CPE and other devices in the home network.

TR-069 has access to read-only parameters that are PON-dependent, meaning to parameters that might be managed through PLOAM, OMCI or 802.3ah.

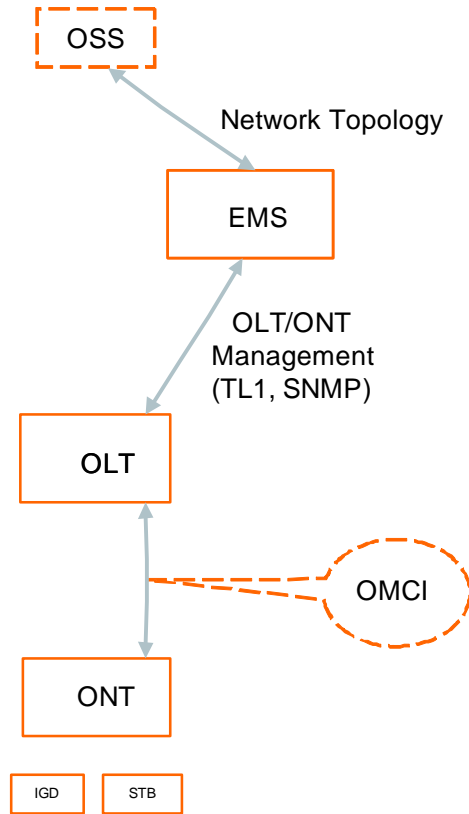


Figure 1: Example of ONT link layer configuration and management.

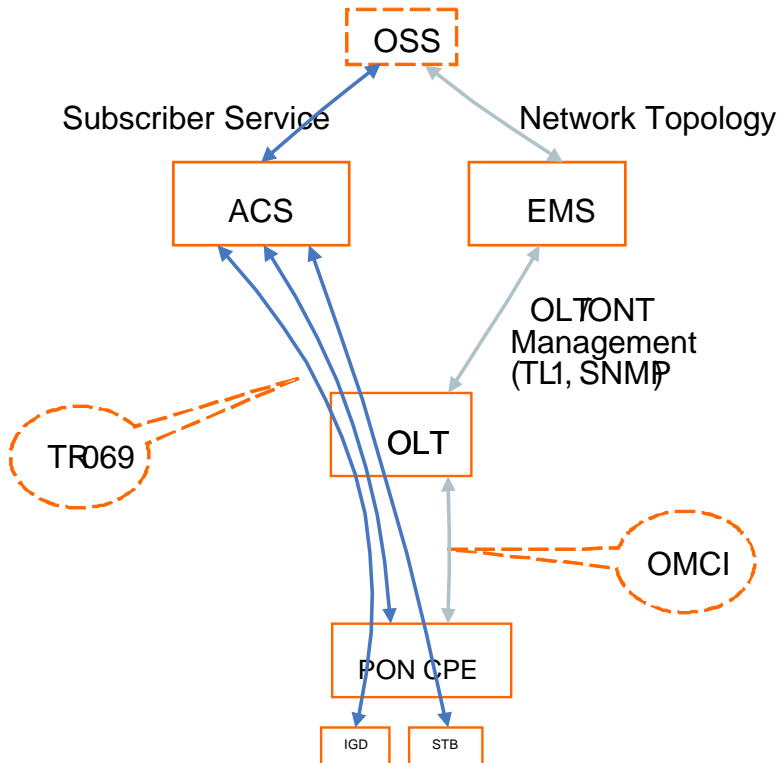


Figure 2: Example of services configuration and management with TR-069 for PON access.

For the configuration and management of the PON CPE, PLOAM messages, OMCI and 802.3ah still play the role for which they were designed. The TR-069 protocol (CPE WAN Management Protocol) can complement OMCI (and related protocols) for the configuration and management of subscriber services and interfaces. TR-069 can also overlap OMCI (and related protocols) in the configuration and management of the PON ONT itself. The next section of this document will delineate OMCI and TR-069 respective management responsibilities for GPON. TR-069 is moreover used for the configuration and management of other customer premises devices (STB, VoIP, network storage elements...) as explained in TR-106. TR-069 is transparent to the OLT, since the TR-069 connections are established over IP between the ACS and the PON CPE, as shown in Figure 2.

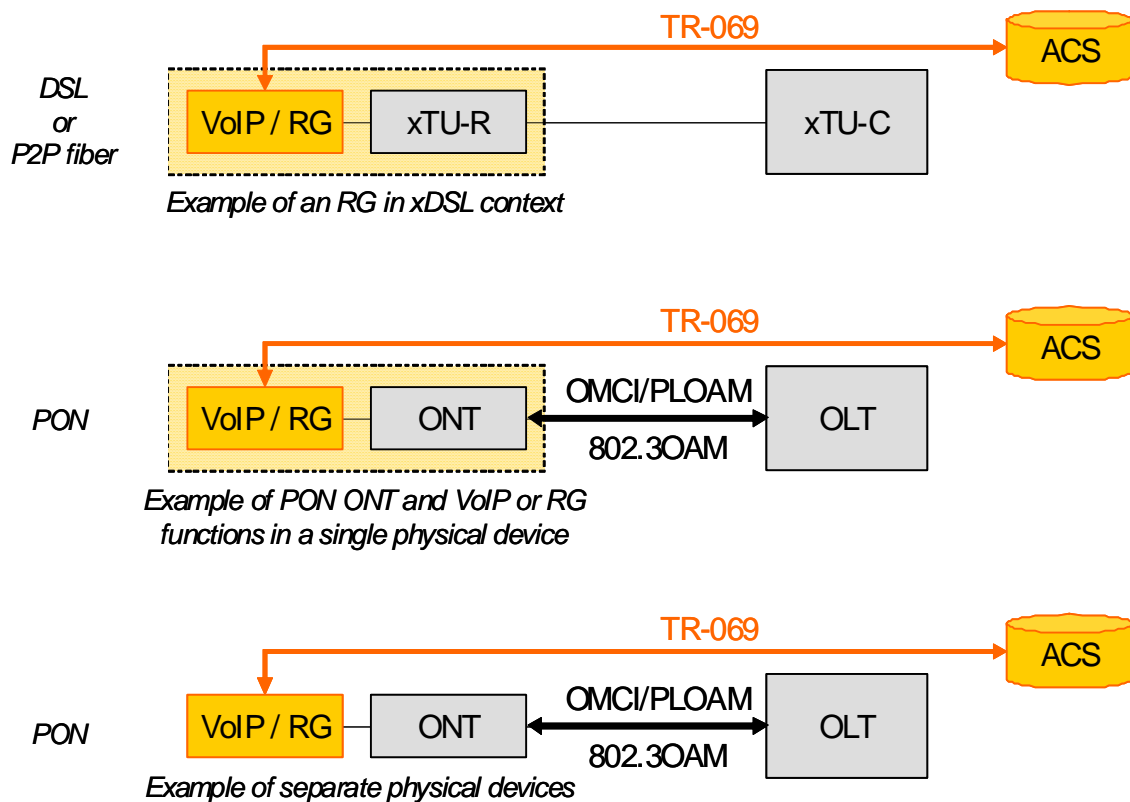


Figure 3: Example of TR-069 versus OMCI configuration and management.

Figure 3 shows 3 diagrams. The first one represents the situation today where TR-069 is used to configure and manage remotely, from the ACS, the parameters of the DSL or P2P fiber CPE, as well as the services incorporated within it, such as the RG and for example a Voice over IP client.

The second diagram of Figure 3 shows the situation of an integrated PON CPE embedding PON ONT and RG functions and/or VoIP services in a single physical device. TR-069 management of the PON CPE remains the same as for the DSL or P2P fiber CPE. OMCI/802.3ah is used to manage the ONT function. In this case, OMCI is used for

the link layer configuration and management of PON-specific features, while PON-independent features are configured and managed by TR-069.

The third diagram of Figure 3 represents the situation where the PON ONT and VoIP or RG functions are implemented in separate physical devices. TR-069 management of the VoIP and the RG functions remains the same as for the integrated PON CPE. OMCI/802.3ah management of the PON ONT also remains the same as for the integrated PON CPE.

## 5 TR-069 profiles and object models for PON CPE

The following recommendations are provided for the configuration and management of PON-independent features integrated in the PON CPE via TR-069. PON CPE includes GPON, GEAPON and 10G-EPON CPEs. TR-069 can have read-only access to PON-dependent parameters. Note that those PON read-only parameters are not defined in TR-98 Amendment 2.

### 5.1 Baseline Device profiles defined for TR-069 enabled PON CPE

**R-01** The PON CPE MUST support the EthernetWAN profile as defined in TR-098 Amendment 2.

### 5.2 Device profiles defined for PON CPE with integrated IP-based services to be configured and managed via TR-069

**R-02** The PON CPE MUST support the TR-104 EndPoint profile if a Voice IP service is supported.

**R-03** The PON CPE MUST support the SIPEndPoint profile if the device supports SIP.

**R-04** The PON CPE MUST support the MGCPEndPoint profile if the device supports MGCP.

**R-05** The PON CPE MUST support the H323EndPoint profile if the device supports H323.

**R-06** The PON CPE MUST support the TAEndPoint profile if the CPE has POTS.

## 6 TR-069 and OMCI domains of responsibilities for GPON CPE configuration and management

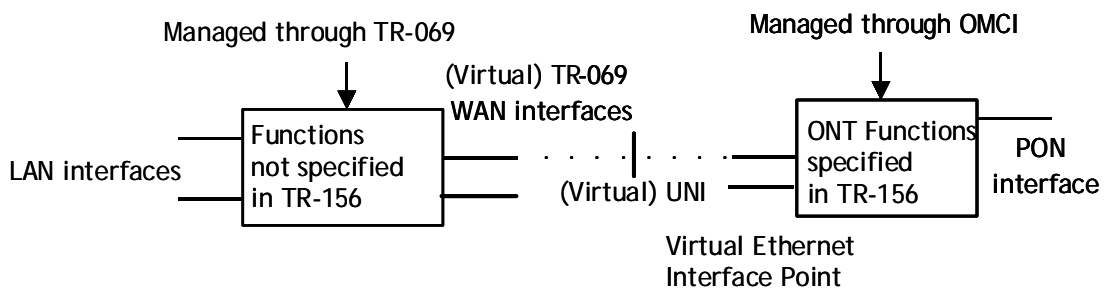
### 6.1 The Concept

We introduce the concept of a “virtual UNI” (User Network Interface) as the “glue” in between OMCI and TR-069. A Virtual UNI is an instance of the Virtual Ethernet Interface Point (VEIP), as defined in G.984.4 Amendment 2 and G.Impl.984.4 on the OMCI side, linked with a WAN Interface object from TR-098 Amendment 2. In order to link the TR-069 object models and the OMCI ME, a Virtual UNI element will have to be cross-referenced to the TR-069 WAN side interface object. This linkage does not require any change to the existing OMCI model.

The value of the proposed model resides in the facts that:

- provisioning and management will not change when migrating from a separated ONT/RG scenario towards a combined ONT/RG scenario,
- all business roles and models variations are supported,
- technologies can change within one management domain without affecting the other management domain, such as migration from IPv4 to IPv6 or from DSL to PON.

The picture below illustrates the proposed split in functionalities. Any function that could potentially be implemented outside the ONT will be managed by TR-069. The virtual UNI delimitates the boundary between TR-069 and OMCI domains of responsibilities.



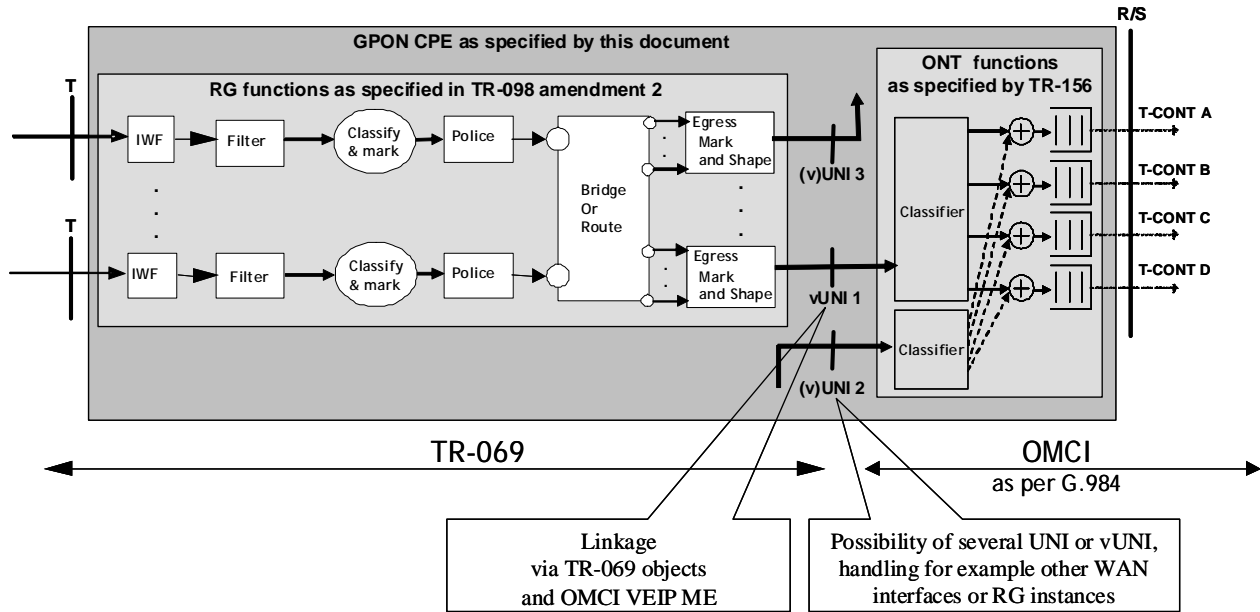
**Figure 4: Concept of a Virtual UNI for OMCI and TR-069 domains of responsibilities**

The proposed model can apply equally well to both combined and separated ONT/RG boxes - in fact, both are conceptually identical. The only difference is that the ONT has real UNI ports instead of virtual UNI ports.



### 6.2 The glue between OMCI and TR-069

The picture below, Figure 5, illustrates the proposed model by a representation of the upstream traffic, in the case of a multiple-interfaces single-family GPON CPE. The bridging or routing functionalities are taken care of via TR-069, as described in TR-098. A clean separation in between TR-069 and OMCI is created by means of a Virtual UNI interface. The vUNI represents the egress interface of the bridge or router for upstream traffic and its ingress interface for downstream traffic. This corresponds to a (virtual) WAN interface in TR-069 terms. Configuration of the TR-156 compliant ONT entity is done by OMCI. TR-069 can have read-only access to some parameters managed by OMCI.



**Figure 5: Representation of the upstream traffic; OMCI and TR-069 management of a multi-port single-subscriber GPON CPE**

As shown on the Figure 5, there might be several Virtual UNI in a GPON CPE: vUNI 1 represents the virtual interface between the RG entity and the GPON ONT entity; (v)UNI 2 might connect the GPON ONT entity with another RG instance; and (v)UNI 3 might connect the RG entity with another WAN entity, such as for example a 3G modem .

These (v)UNI might be virtual interfaces, when connecting entities implemented into the same physical device, or they might be physical interfaces, when connecting entities implemented into separate physical devices.

Figure 5 shows the different logical possibilities that can be supported by the management of the GPON CPE, it does not intend to represent the internal implementation of a GPON CPE.

## 7 TR-069 for GEPON and 10G-EPON management

This section treats the configuration and management of TR-069 enabled GEPON and 10G-EPON CPEs. The PON link is managed by IEEE 802.3ah OAM, and with the exception of a few possible read-only parameters, this management interaction is invisible to the TR-069 agent on the ONT. The TR-069 service-management messages are treated as user data by the GEPON / 10G-EPON system and pass transparently through the GEPON / 10G-EPON system.

The GEPON and 10G-EPON management functions covered by IEEE 802.3 include:

- Ranging and registration;
- Dynamic bandwidth allocation;
- Link configuration;
- Link alarms;
- Link performance monitoring;
- FEC configuration.

Once the PON layer and the link layer are configured, an IP address can be assigned to the GEPON or 10G-EPON CPE via DHCP, IPCP, or static IP addressing. Once the IP address is assigned to the GEPON or 10G-EPON CPE, a TR-069 session can take place in between this CPE and an ACS.

End of Broadband Forum Technical Report TR-142